NISI DOMINUS FRUSTRA

# ENCYCLOPAEDIA BRITANNICA

EIGHTH EDITION

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THE

# ENCYCLOPÆDIA BRITANNICA,

OR

# DICTIONARY

OF

## ARTS, SCIENCES, AND GENERAL LITERATURE.

### EIGHTH EDITION.

WITH EXTENSIVE IMPROVEMENTS AND ADDITIONS;
AND NUMEROUS ENGRAVINGS.

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# ENCYCLOPÆDIA BRITANNICA.

## A.

A. A, THE first letter of the alphabet in every known language, the Ethiopic or Abyssinian alone excepted, in which it is the thirteenth. Of the sixteen elementary sounds of the human voice, that which is represented by this initial letter is the simplest, and requires the least exertion of the organs to produce it; for its enunciation is effected by merely opening the mouth, and breathing, so that the air propelled through the glottis may resound audibly in the cavity of the mouth and nostrils. Hence this sound is remarkable for its universality as well as simplicity. Many of the lower animals possess the capacity of uttering it, as every one must be sensible who has attended to their distinguishing cries, in all, or at least in many of which, it may be easily recognised. It is also the basis, so to speak, of vocality; for, on attentive examination, it will be found that the other vowels are little more than labial, lingual, dental, or palatal modifications of this primary, universal, and most elementary sound. It is not without reason, therefore, that the symbol of this sound is (with one solitary exception) placed at the commencement of every known alphabet. Cicero seems to have disliked the sound of this letter; for in his treatise *De Oratore*, c. xlix., he denominates it *insuavissima littera*, probably on account of the out-breathing or expiration necessary to produce the sound of it; but, upon the same principle, the other vowels ought also to have shared his displeasure, seeing that they are merely modifications of this primary *στοιχειον* or element.

In the English language, A is the mark or symbol of three different sounds, termed by grammarians the *broad*, the *open*, and the *slender*; epithets, the two former of which have an immediate reference to organic modification, as well as to the impulse or volume of voice; while the latter seems to apply to the degree of intonation alone. Of these varieties of sound, the first, which resembles that of the German A, occurs in such monosyllables as *hall, wall, pall, thrall*, where the *a* is pronounced in the same manner as *au* in *cause*; that is, broad and long. The Saxons, it is probable, expressed only this sound of the letter, which is still commonly retained in the north of England, and prevails universally throughout Scotland, the only parts of the island where the genius and idiom of the Saxon language have withstood modern innovations. The open sound of A, again, resembles that of the Italian in *adagio* and such like words, and is nearly the same with that of *a* in *father, rather*, &c. But the slender sound, which is peculiar to the English language alone, is identical with the sound of the French diphthong *ai* in such words as *mais, paix, gai*, and is exemplified in *hate, late, waste, paste, place, race;* as also in polysyllables, such as *toleration, justification*, with many others which it is unnecessary to specify. So much for the varieties of this initial sound in English words. A, however, is sometimes employed as an affix in burlesque poetry; in which case it has no other effect than to add a syllable to the line, without any alteration of the sense, just as the vowel or interjection O very often does in our old ballads, and in some modern imitations of them. It is also thought to be redundant and insignificative in such words as *arise, awake, aright, adoing, agoing*. But this seems a mistake; for the *a* here used as a prefix, is probably the French abbreviation of the Latin preposition *ad;* and hence it appears to have an intensive effect, adding to and strengthening the import of the word with which it is combined. In the line, "*Arisc, awake*, or be for ever fall'n," it is evident that the words "arise, awake," convey a meaning stronger in degree than the simple words *rise, wake*, would have done. The prepositionary effect in such words as *a-doing, a-going*, is indeed admitted by grammarians; but, if this be the case, where is the distinction between these instances and *a-rise, a-wake*, where the prefix is said to be redundant, except that, by usage, it has coalesced in some measure with the word to which it is prefixed? In such compounds as *a-foot, a-sleep, a-week, a-head, a-man*, as well as when used before local surnames, as *Cornelius a Lapide, Thomas a Kempis, Thomas a Becket*, nobody has ever doubted that the *a* is a preposition. When *a* is used as an article, it is merely an abbreviation of the old primary numeral *ane*, one, and consequently it has no plural signification. Thus *a* house, *a* field, *a* ship, mean *one* house, *one* field, *one* ship; but as it is not one of two, ten, or twenty houses, fields, or ships, but of *any* number, however great or small, hence it becomes in effect quite general and indefinite, or, in other words, the opposite of *the*, which defines and limits the attention to something spoken of, pointed out, or referred to.

Among the ancients, A was a numeral letter, and stood for 500, and when a dash was placed on the top, thus, $\bar{A}$, for ten times that number, or 5000. In the Julian calendar it is the first of the seven Dominical Letters. Long before the establishment of Christianity, it had been in use among the Romans as one of the eight *Litteræ Nundinales;* and it was in imitation of this usage that the Dominical Letters were first introduced. Among logicians, the letter A is employed as a symbol or sign to denote an universal affirmative, in contradistinction to an universal negative proposition, in conformity with the following, which is the first verse of a well-known distich:

Asserit *a*, negat *e*, sed universaliter ambæ.

Thus, the first mode of the first figure, which is a syllogism consisting of three universal affirmative propositions, is said to be a syllogism in B*a*rb*a*r*a*, a word in which the *alphas* alone are significant, the repetition of that letter thrice denoting so many of the propositions to be affirmative and universal, conformably to the technical classification—

B*a*rb*a*r*a*, Cel*a*rent, D*a*rii, Ferio, dato primæ.

In the public assemblies or *comitia* of the Romans the letter A was used in giving votes or suffrages. When a new law was proposed, each voter received a couple of wooden tallies or ballots, one of them marked with a capital A, signifying *Antiquo*, q. d. *antiquam volo*; and the other with U. R., the initials of *Uti Rogas.* Those who were against the proposed law, (or *rogatio*, as it was called) threw the former of these into the urn; meaning thereby *I antiquate it*, I prefer the ancient law, and desire no innovations; while such as were favourable to the bill, as we would call it, threw in the latter, signifying, *Be it as you desire*, or I vote for the measure you propose. A was also marked on tallies or tablets used in voting in criminal trials, and standing for *Absolvo*, denoted acquittal; whence Cicero, in his speech for Milo, denominates it *littera salutaris*, or the letter of acquittal. We may add, in explanation, that, on criminal trials, three of these tallies or tablets were distributed to each of the *judices*, or persons constituting the assize, by whom the accused was to be tried; one of them marked with the letter A, *absolvo*, I acquit; another with the letter C, (*littera tristis*) *condemno*, I condemn; and a third with the letters N. L. *non liquet*, it is not clear. From the number of ballots cast into the urn, those marked with N. L. were deducted, and the *prætor* or *magistratus* pronounced sentence of acquittal or condemnation, according as the A's or the C's were the more numerous. In cases of equality the prisoner was absolved.

In ancient inscriptions, whether on marble, brass, or stone, A stands for *Augustus, Augustalis, ager, agit, aiunt, aliquando, antique, assolet, aut;* A A for *Augusti, Augustæ, Aulus Agerius, æs alienum, ante audita, apud agrum, aurum argentum;* A A A for *Augusti* when they are three in number, and *aurum, argentum, æs;* and sometimes its meaning can only be determined by the context of the inscription. Isidore adds, that when this letter occurs after the word *miles*, a soldier, it denotes him young (*miles adolescens*). On the reverse of ancient medals, it indicates the place where they were struck, as Argos or Athens; but on coins of a modern date, it is the mark of the city of Paris, probably taken anagramwise from the *last* letter of the word *Lutetia.*

A, as an abbreviation, is likewise of frequent occurrence in the works of modern authors; as A. D. for *anno Domini*, A. M. for *artium magister, anno mundi*, &c. The letter *a* with a line above it thus, *ā*, is used in medical prescriptions for *ana*, of each; and sometimes it is written thus, *ā ā;* for example, ℞ *mel. sacchar. et mann. ā vel āā* ℥j; that is, take honey, sugar, and manna, of each one ounce. Put to bills of exchange, A is, in England, an abbreviation of *accepted*, and in France of *accepté.* It is likewise usual with merchants to mark their sets of books with the letters A, B, C, &c., instead of the ordinary numerals, 1, 2, 3, &c. A A A is the chemical abbreviation for *amalgama*, or *amalgamation.*

AA, the name of several small rivers, probably derived from the Celtic *Ach* or Teutonic *Aa*, water. I. A river of Holland in North Brabant; which, passing Helmont, joins the Dommel at Bois-le-Duc. II. A river of Holland, in Groningen, distinguished by the name of Westerwolder Aa, which falls into the Dollart. III. A river of Holland in Overyssel, which, after uniting its waters with the Vecht, flows into the Zuyder Zee. IV. A river of Belgium, in the province of Antwerp, which discharges its waters into the Neethe. V. A small river of Brabant, near Breda. VI. A river of Russia in Europe, in the province of Livonia, which flows from E. to S.W., into the Bay of Riga. VII. Another river of Russia in Courland, which flows into the Dwina, near Riga. VIII. A river of France, rising in the department of Le Nord. It becomes navigable for barges at St Omer, and after a course of about 40 miles falls into the sea at Gravelines. IX. A river of Hanover, which flows into the Ems, in the province of Lingen. X. A river of Switzerland, canton Aargau, which carries the waters of the Hallwyler See into the Aar. XI. A river of Switzerland, carrying the waters of the Lake of Sarnen, canton Unterwalden, into the Lake of Lucerne. XII. Another river of Switzerland, which drains the valley of Engelberg, in Unterwalden, and flows into a bay near the middle of the south side of the Lake of Lucerne. XIII. A small river of Jutland, kingdom of Denmark.

AACHEN. See Aix-la-Chapelle.

AAGARD, Christian, a Danish poet, and Professor of Poetry at Sora. He was born in 1596, and died in 1664. His poems are published in the *Deliciæ quorundam poetarum Danorum.* Leyd. 1695.

AALBORG, one of the sees (*stifts*) into which the Danish kingdom is divided. See Denmark.

Aalborg, a city in Denmark, the capital of the see of the same name. It is situated on the Lymfiord, at the spot where the Oosteræ joins it; it is tolerably fortified; contains a cathedral and several other public buildings; and in 1847 the inhabitants amounted to 7500. There are manufactories of sugar, soap, snuff, chocolate, and scythes, with several distilleries; but the woollen and hosiery trades which formerly existed are nearly extinct. The entrance to the harbour is such as to require vessels drawing more than ten feet of water to lighten before they approach the city. The chief exports are herrings, corn, wool, hides, tar, tallow, and corn spirits. It is in Lat. 57. 2. 57. N., and Long. 9. 56. 36. E.

AALEN, a bailiwick in the circle of Jaxt, in the kingdom of Wirtemberg. Its extent is 108 square miles, or 69,120 acres. It is watered by the river Kocher, has some lofty mountains in the southern part, and is most abundantly wooded. It produces but little corn, and neither fruit nor wine, but pastures a competent number of cattle. There are some iron mines worked. Many articles of wood-ware are produced, and some wool and cotton are spun. It contains one city, one market town, and 190 smaller towns and villages, with 22,000 inhabitants.

Aalen, a city, the capital of the bailiwick of the same name. It has some ironworks, and manufactures of wool and cotton. In 1847 it contained 2800 inhabitants. It is in Lat. 48. 47. 20. N., Long. 10. 7. 27. E.

AALSMEER, a town in the arrondissement of Amsterdam, in the province of North Holland, ten miles SW. of Amsterdam. It is celebrated for its strawberries; and contains 2200 inhabitants, employed in making cotton goods.

AALTEN, a town in the arrondissement of Zutphen, and province of Guelderland, in the Netherlands.

AAM, or AHAM, a measure for liquids, used in Holland, Belgium, and several of the continental states, varying in capacity in different places from 35 to 41 English gallons. See WEIGHTS AND MEASURES.

AAR, the most considerable river in Switzerland, after the Rhine and Rhone. It rises in the glaciers of the Finsteraarhorn, Schreckhorn and Grimsel mountains in Berne; and at Handeck in the valley of Hasli forms a magnificent waterfall of above 150 feet in height. The Aar then flows through the lakes of Brienz and Thun, and on emerging from the latter it becomes navigable, and at length empties itself into the Rhine, opposite Waldshut, after a course of about 170 miles. In its course it receives numerous smaller rivers, the principal of which are the Kander, Saane, and Thiele on the left, and the Emmen, Surin, Reuss, and Limmat, on the right; and on its banks are situated Unterseen, Thun, Berne, Aarburg, Solothurn, and Aarau. It abounds in fish, and carries along with it a considerable quantity of gold sand. This is also the name of several small rivers in Germany.

AARAU, the chief city of the canton of Aargau, situated on the right bank of the river Aar, at the south base of the Jura. It is well built, paved, and lighted, and contains 4500 inhabitants, whose principal occupations are spinning and weaving cotton, making silk ribbons, bleaching, and casting cannon. Lat. 47. 23. 35. N., Long. 6. 2. 55. E. The famous baths of Schintznach are about ten miles distant along the right bank of the Aar. The inhabitants are chiefly Protestants.

AARGAU, or ARGOVIA, one of the cantons of Switzerland. It was originally a part of Berne, but by arrangements begun in 1798, and continued in 1803, it was erected into a separate and independent canton. It is bounded on the north by the river Rhine, which divides it from the duchy of Baden, on the east by Zurich, on the south-east by Zug, on the south by Lucerne, on the south-west by Berne, and on the west by Solothurn and Basle. Its extent is 502 square miles, and it is divided into eleven circles, which are again subdivided into forty-eight smaller ones. By the census taken in 1850, the number of inhabitants amounted to 199,720, comprehending 107,194 Protestants, 91,096 Catholics, and about 1500 Jews.

The greater part of the canton is either level or undulating, but some of the mountains on the right bank of the Aar are of the height of 2700 feet. The chief river is the Rhine, which forms the boundary, and is navigable, though, on account of shoals and rocks, with difficulty. That river receives into it the water of the Aar, the Wigger, the Suren, the Reuss, and the Limmat, as well as that of many smaller brooks and rivulets. The climate is milder than in most parts of Switzerland.

The rearing of cattle, agriculture, and the cultivation of vines and other fruits, are carried on with great activity; and in its towns and villages are found tradesmen, mechanics, and manufactories of all kinds. This is one of the cantons most distinguished for industry and generally diffused prosperity; and by the union of pastoral with mechanical pursuits the citizens have attained a comfort almost unparalleled. The education of the people, by the establishment of improved schools, and by popular publications, has been greatly promoted within the last thirty or forty years, especially in the Protestant parts of the canton.

The legislative power is vested in the great council, consisting of two hundred members, the one half Catholics, and the other Protestants,—who are elected by the general body of the people every six years. A lesser Council, consisting of nine members, is elected by the members of the great Council out of their own body for a like period of six years. The preparation of the annual financial reports is committed to this body, as also the initiative in legislation, subject to the approval and sanction of the great Council. Each circle has a Justice of the Peace who decides in matters under 16 francs. The District Court decides in cases above that sum; but in cases above 160 francs its decision can be appealed to the Highest Court. This canton possesses a military force of 16,000 men, and its resources amount to 16,000,000 of francs, or about £600,000; its income is about 680,000 francs or £27,200, and its expenditure about 650,000 francs or £26,000.



AARHUUS, one of the districts (*stifts*) into which Denmark is divided. It is in the most eastern part of the peninsula of Jutland. The extent is 1825 square miles, or 1,168,000 acres. It is a level country, somewhat undulating, having on its coasts several indentations forming bays, and in the interior there are several lakes, rivers, low hills, and woods. The climate is considered to be the best in Jutland. The greater part of the inhabitants are engaged in cultivation, and produce more corn, potatoes, and flax, than their consumption requires, and thus leave a portion for exportation. The ecclesiastical bishopric of Aarhuus differs from the political see. The latter is divided into two bailiwicks, Aarhuus and Rhanders, and 22 baronies (*herrerders*) comprehending 7 cities, 253 parishes, and 69 noble domains and dwellings. The inhabitants amount to 140,000, many of whom are occupied in the fisheries, and the females in spinning.

AARHUUS, one of the bailiwicks into which the see of the same name in Denmark is divided. Its extent is 864 square miles, or 552,960 acres.

AARHUUS, a city, the capital of the see and of the bailiwick of the same name. It is situated on the Cattegat, in a low plain, where an inland lake empties itself into the sea. The cathedral is a Gothic building, and the largest church in Denmark. In 1848 the inhabitants amounted to 7000. The harbour is small, but good and secure; and now one of the best in Jutland, having regular steam communication with Copenhagen and Callundborg, from which latter place a road leads to Copenhagen. Aarhuus is about 100 miles WNW. from the capital. It exports agricultural produce, spirits, cork, leather, and gloves. It has sugar refineries, and manufactories of wool, cotton, and tobacco. It is in Lat. 56. 9. 35. N., and Long. 10. 8. E.

AARLANDERVEEN, a town of the Netherlands, seventeen miles SSE. of Haarlem. It contains 2688 inhabitants.

AARON, the first high-priest of the Jews, eldest son of Amram and Jochebad, and brother of Moses. By the father's side he was great-grandson, and by the mother's, grandson of Levi. He was born B.C. 1574 (Hales B.C. 1730), three years before Moses, with whom he was associated to conduct the children of Israel from Egypt to Canaan. To this office he received the Divine appointment in consequence of his persuasive fluency of speech, a quality in which Moses was his inferior (Ex. iv. 16; vii. 1).

During the absence of Moses in Mount Sinai receiving the tables of the law, the Israelites, regarding Aaron as their head, clamorously demanded that he should provide them with a visible symbolic image of their God for worship. With this demand he weakly complied, and out of the ornaments of gold contributed for the purpose he cast the figure of the calf, doubtless the same as the Bull-god Apis, the object of Egyptian worship at Memphis. For this sin the Israelites were decimated by sword and plague (Ex. xxxii.)

In obedience to the Divine instruction received by Moses in the Mount, Aaron was appointed high-priest, his sons and descendants, priests, and his tribe, that of Levi, was set apart as the sacerdotal caste. The office was filled by Aaron for nearly forty years, his death occurring on Mount Hor, which he ascended with his brother Moses by the Divine command. He was 123 years of age when he died, his son and brother burying him in a cavern of the mountain.

Aaron, *Ben Asser*, a learned Jew of the fifth century, to whom has been ascribed the invention of the Hebrew points and accents, though some suppose them to be of much higher antiquity.

Aaron, an eminent physician at the beginning of the seventh century. He wrote in Syriac, as mentioned by Hali Abbas, and described the measles and smallpox, diseases then very little known, though in this he was perhaps anticipated by Rhazes in his *Discourse of the Pestilence.*

Aaron, the Caraite, a learned Jew who flourished about the year 1299. He left many works on the Old Testament, among which there is one entitled *A Commentary on the Pentateuch*, which has been much valued. It was written in Hebrew, and printed in folio with a Latin translation, at Jena, in 1710.

Aaron, another Caraite Jew, who lived in the fifteenth century, wrote a concise Hebrew Grammar, entitled *The Perfection of Beauty*, which was printed at Constantinople in 1581.

Aaron, *Pietro*, a Florentine monk of the sixteenth century, an elaborate writer on music. His chief works, which are curious, are *Il Toscanello della Musica*, and *Elucidario in Musica di Alcune Oppenioni Antiche e Moderne.* Venice, 1545, 4to.

Aaron and Julius, *Saints*, were brothers who suffered martyrdom together, during the persecution under the emperor Diocletian, in the year 303, about the same time with St Alban, the first martyr of Britain. We are not told what their British names were, it being usual with the Christian Britons, at the time of baptism, to take new names from the Greek, Latin, or Hebrew. Nor have we any certainty as to the particulars of their death; only that they suffered the most cruel torments. Two churches were dedicated to the brothers, in which their bodies were interred, at Caer-Leon, the ancient metropolis of Wales.

Aaron, or *Haroun, Al Raschid*, a celebrated caliph, or Mahometan sovereign of the Saracen empire; whose history is given under the article Bagdad.

AARSENS, Francis, Lord of Someldyck and Spyck, one of the greatest negotiators of the United Provinces. He was born at the Hague in 1572. His father, Cornelius Aarsens, was secretary to the States; and being acquainted with Mr Mornay du Plessis, at the court of William Prince of Orange, he prevailed upon him to take his son under him, with whom he continued some years. John Olden Barneveldt, who presided over the affairs of Holland and all the United Provinces, sent him afterwards as resident into France, where he learned to negotiate under those profound politicians Henry IV., Villeroy, Jeanin, &c. Soon after, he was invested with the character of ambassador, and was the first who was recognised as such by the French court. He resided in France fifteen years; during which time he received great marks of esteem from the king, who created him a knight and baron; and for this reason he was received among the nobles of the province of Holland. However, he became at length so odious to the French court, that they desired to have him recalled. He was afterwards deputed to Venice, and to several German and Italian Princes, upon occasion of the troubles in Bohemia. He was the first of three extraordinary ambassadors sent to England in 1620, and the second in 1641; in which latter embassy he was accompanied by the Lord of Brederode as first ambassador, and Heemsvliet as third, to negotiate the marriage of Prince William, son of the Prince of Orange, with a daughter of Charles I. He was likewise ambassador extraordinary at the French court in 1624, at the beginning of Cardinal Richelieu's administration, who had a high opinion of him. His unpublished memoirs of the negotiations in which he was engaged, shew him to have been one of the ablest men of his time, and worthy of the confidence and trust reposed in him by his country. But his character is not altogether without stain. His enmity to the Remonstrants was bitter and unrelenting; and he is supposed to have greatly encouraged the violent measures pursued by Prince Maurice against the venerable Barneveldt, and to have been the principal adviser for assembling the persecuting synod of Dordrecht. He died at a very advanced age; and his son, who survived him, was reputed the wealthiest man in Holland.



AAS, a French village in the Lower Pyrenees, 6½ leagues from Oleron, much frequented for its mineral waters and baths. In the adjoining mountains are mines of lead and iron.

AASAR, in *Ancient Geography*, a town of Palestine, in the tribe of Judah, situated between Azotus and Ascalon. In Jerome's time it was a hamlet.

AASI. See Orontes.

AATYL, a town of Syria, 54 miles SSE. of Damascus, chiefly inhabited by Druses. Its extensive ruins shew that it once was a place of importance.

AB, the eleventh month of the civil year of the Hebrews, and the fifth of their ecclesiastical year, which begins with the month Nisan. It answers to the moon of July; that is, to part of our month of the same name, and to the beginning of August: it consists of thirty days. The Jews fast on the first of this month, in memory of Aaron's death; and on the ninth, because on that day both the temple of Solomon, and that erected after the Captivity, were burnt; the former by the Chaldeans, and the latter by the Romans. The same day is also remarkable among that people for the publication of Adrian's *edict*, wherein they were forbidden to continue in Judea, or even to look back when at a distance from Jerusalem, in order to lament the desolation of that city. The eighteenth of the same month is also a fast among the Jews; because the lamp in the sanctuary was that night extinguished, in the time of Ahaz.

Ab, in the Syriac calendar, is the name of the last summer month. The first day of this month they called *Suum-Miriam*, the Fast of the Virgin, because the eastern Christians fasted from that day to the fifteenth, which was therefore called *Fathr-Miriam*, the cessation of the Fast of the Virgin.

ABA (or rather Abou) Hanifah or Hanfa, surnamed Al-Nooma, was the son of Thabet, and born at Cufah, in the 80th year of the Hegira. He is the most celebrated doctor of the orthodox Mussulmans, and his sect is the most esteemed of the four which they severally follow. Almansor caused him to be imprisoned at Bagdad, for having refused to subscribe to the opinion of absolute predestination, which the Mussulmans call Cadha; but afterwards Abou Joseph, who was the sovereign judge or chancellor of the empire under the caliph Hadi, brought his doctrine into such credit, that it became a prevailing opinion, That to be a good Mussulman was to be a Hanifite. He died in the 150th year of the Hegira, in the prison of Bagdad: and it was not till 335 years after his death, that Melick Shah, a sultan of the Seljuckian race, erected to his memory a magnificent monument in the same city, and a college for his followers, in the 485th year of the Hegira, A.D. 1107.

Aba, *Abas*, *Abos*, or *Abus*, in *Ancient Geography*, the name of a mountain in Greater Armenia, situated between the mountains Niphatos and Nibonis. According to Strabo, the Euphrates and Araxes rose from this mountain. It is in

N. Lat. $39\frac{1}{2}$, and unites at its eastern extremity with Mount Ararat.

ABA. See ABÆ.

ABA, ALBON, or OVON, a king of Hungary. He married the sister of Stephen I., and was elected king on the deposition of Peter in 1041. The emperor Henry III. preparing to reinstate Peter on the throne, Aba made an incursion into his dominions, and returned loaded with booty; but was next year obliged to make restitution, by paying a large sum, in order to prevent a threatened invasion from the emperor. He indulged in great familiarity with the lower class of the people; on account of which, and his severity to their order, he became universally odious to the nobility. The fugitive nobles, aided by the emperor, excited a revolt against him. After a bloody battle, Aba was put to flight; and was murdered by his own soldiers in 1044, having reigned three years.

ABABDE, a tribe of Bedouins who inhabit the country south of Kosseir, nearly as far as the latitude of Derr. Many of this race have settled in Upper Egypt, on the east bank of the Nile, from Kenne to Assouan, and from thence to Derr; but the greater part of them still live like Bedouins. They have a bad character, being treacherous, and altogether faithless in their dealings. Great numbers of the dispersed Mamelukes fell victims to the treachery of these Arabs. Their breed of camels, particularly dromedaries, is famed. They are possessed of considerable property, and trade largely in Senna-Mekke, and in charcoal of acacia wood, for the Cairo market, both of which are produced from trees growing abundantly in their own mountains. The Ababde have few horses: when at war with other Arab tribes they fight upon camels, arming themselves with a lance, sword, and target. Their principal tribes are El Fokara, El Ashabat, and El Meleykab. Such of them as encamp with their still more savage neighbours, the Bisharye, speak the language of the latter.

The Bisharye inhabit the mountains southwards from Derr, as far as Suakim. They live entirely upon flesh and milk, eating much of the former raw. Their women are said to be as handsome as those of Abyssinia, and mix in company with strangers, but are reported to be of very depraved habits. Encampments of the Bisharye are found on the northern frontier of Abyssinia; and the sea-coast, from Suakim to Massuah, is peopled by their tribes. They have no fire-arms, but use the bow and arrow.—*Burckhardt's Nubia.*

ABACÆNUM, in *Ancient Geography*, a town of Sicily, whose ruins are supposed to be those lying near Trippi, a citadel on a high and steep mountain not far from Messina. *Fazellus de Reb. Sic.* ix. 7.—*Diodorus Sicul.*

ABACINARE, in writers of the middle age, a cruel species of punishment, in which the criminal was deprived of sight by having a red-hot basin or bowl of metal held before his eyes.

ABACK (a sea term), the situation of the sails when the surfaces are flatted against the masts by the force of the wind. The sails are said to be *taken aback* when they are brought into this situation, either by a sudden change of the wind, or by an alteration in the ship's course. They are *laid aback*, to effect an immediate retreat, without turning to the right or left; or in the sea phrase, to give the ship *stern-way*, in order to avoid some danger discovered before her in a narrow channel, or when she has advanced beyond her station in the line of battle, or otherwise. The sails are placed in this position by slackening their lee braces, and hauling in the weather ones; so that the whole effort of the wind is exerted on the fore part of their surface, which readily pushes the ship astern, unless she is restrained by some counteracting force.



ABACOT, the name of an ancient cap of state worn by the kings of England, the upper part whereof was in the form of a double crown.

ABACTORS, or ABACTORES, a name given to those who drive away, or rather steal, cattle by herds, or great numbers at once; and are therefore very properly distinguished from *fures* or thieves.

ABACUS, among the ancients, was a kind of cupboard or buffet. Livy, describing the luxury into which the Romans degenerated after the conquest of Asia, says they had their *abaci*, beds, &c. plated over with gold.

ABACUS, or ABACISCUS, in *Architecture*, signifies the superior part or member of the capital of a column, and serves as a kind of crowning to both. Vitruvius tells us the abacus was originally intended to represent a square tile laid over an urn, or rather over a basket. The form of the abacus is not the same in all orders: in the Tuscan, Doric, and Ionic, it is generally square; but in the Corinthian and Composite, its four sides are arched inwards, and embellished in the middle with some ornament, as a rose or other flower. Scammozzi uses *abacus* for a concave moulding on the capital of the Tuscan pedestal; and Palladio calls the plinth above the echinus, or boultin, in the Tuscan and Doric orders, by the same name.

ABACUS is also the name of an ancient instrument for facilitating operations in arithmetic. The exhibition of numbers by counters appears happily fitted for unfolding the principles of calculation. In the schools of ancient Greece, the boys acquired the elements of knowledge by working on a smooth board with a narrow rim,—the *Abax;* so named, evidently, from the combination of Α, Β, Γ, the first letters of their alphabet, resembling, except perhaps in size, the tablet likewise called A, B, C, on which the children with us used to begin to learn the art of reading. The pupils, in those distant ages, were instructed to compute, by forming progressive rows of counters, which, according to the wealth or fancy of the individual, consisted of small pebbles, of round bits of bone or ivory, or even of silver coins. From ψηφος, the Greek word for a *pebble*, comes the verb ψηφιζειν, to *compute.* But the same board served also for teaching the rudiments of writing and the principles of Geometry. The *Abax* being strewed with green sand, the *pulvis eruditus* of classic authors, it was easy, with a *radius* or small rod, to trace letters, draw lines, construct triangles, or describe circles.—Besides the original word Αβαξ, the Greeks had the diminutive Αβακιον; and it seems very probable, that this smaller board was commonly used for calculations, while the larger one was reserved among them for the purpose of tracing geometrical diagrams.

Grecian Abacus.

To their calculating board the ancients make frequent allusions. It appears, from the relation of Diogenes Laertius, that the practice of bestowing on pebbles an artificial value, according to the rank or place which they occupied, remounts higher than the age of Solon, the great reformer and legislator of the Athenian commonwealth. This sagacious observer and disinterested statesman, who was, however, no admirer of regal government, used to compare the passive ministers of kings or tyrants to the counters or pebbles of arithmeticians, which are sometimes most important, and at other times quite insignificant.[1] Æschines, in his oration for the Crown, speak-

[1] Ελεγε δε τους παρα τοις τυραννοις δυναμενους παραπλησιους ειναι ταις Ψηφοις ΤΑΙΣ ΕΠΙ ΤΩΝ ΛΟΓΙΣΜΩΝ. και γαρ εκεινων ἑκαστην ποτε μει ΠΛΕΙΩ σημαινειν, ποτε δε ἩΤΤΩ. (DIOG. LAERT. *in Vita Solonis.*)

ing of balanced accounts, says, that *the pebbles were cleared away, and none left.*[1] His rival, Demosthenes, repeating his expression, employs further the verb αντανελειν, which means *to take up as many counters as were laid down.* It is evident, therefore, that the ancients, in keeping their accounts, did not separately draw together the credits and the debts, but set down pebbles for the former, and took up pebbles for the latter. As soon as the board became cleared, the opposite claims were exactly balanced. We may observe, that the phrase *to clear one's scores or accounts,* meaning to settle or adjust them, is still preserved in the popular language of Europe, being suggested by the same practice of reckoning with counters, which prevailed indeed until a comparatively late period.

Roman Abacus.

The Romans borrowed their *Abacus* from the Greeks, and never aspired higher in the pursuit of science. To each pebble or counter required for that board they gave the name of *calculus,* a diminutive formed from *calx, a stone;* and applied the verb *calculare,* to signify the operation of combining or separating such pebbles or counters. Hence innumerable allusions by the Latin authors. *Ponere calculum—subducere calculum, to put down a counter,* or *to take it up;* that is, to add or subtract; *vocare aliquid ad calculum, ut par sit ratio acceptorum et datorum—to submit any thing to calculation, so that the balance of debtor and creditor may be struck.* The emperor Helvius Pertinax, who had been taught, while a boy, the arts of writing and casting accounts, is said, by Julius Capitolinus, to be *litteris elementariis et calculo imbutus.* St Augustine, whose juvenile years were devoted to pleasure and dissipation, acquaints us, in his extraordinary Confessions, that to him no song ever sounded more odious than the repetition or *cantio,* that *one* and *one* make *two,* and *two* and *two* make *four.* The use of the *Abacus,* called sometimes likewise the *Mensa Pythagorica,* formed an essential part of the education of every noble Roman youth:

> Nec qui *abaco numeros, et secto in pulvere metas*
> Scit risisse vafer. PERS. *Sat.* i. 131.

From Martianus Capella we learn that, as refinement advanced, a coloured sand, generally of a greenish hue, was employed to strew the surface of the *abacus.*

> Sic *abacum* perstare jubet, sic *tegmine glauco*
> Pandere pulvereum formarum ductibus æquor.
> Lib. vii. *De Arithmetica.*

A small box or coffer, called a *Loculus,* having compartments for holding the *calculi* or counters, was a necessary appendage of the *abacus.* Instead of carrying a slate and satchel, as in modern times, the Roman boy was accustomed to trudge to school, loaded with his arithmetical board, and his box of counters:

> Quo pueri magnis e centurionibus orti,
> *Lævo suspensi loculos tabulamque lacerto.*
> HORAT. *Sat.* i. 6.

In the progress of luxury, *tali,* or dies made of ivory, were used instead of pebbles, and small silver coins came to supply the place of counters. Under the emperors, every patrician living in a spacious mansion, and indulging in all the pomp and splendour of eastern princes, generally entertained, for various functions, a numerous train of foreign slaves or freedmen in his palace. Of these, the *librarius* or *miniculator,* was employed in teaching the children their letters; but the *notarius* registered expenses, the *rationarius* adjusted and settled accounts, and the *tabularius* or *calculator,* working with his counters and board, performed what computations might be required. Sometimes these laborious combiners of numbers were termed reproachfully *canculones* or *calculones.* In the fervour of operation, their gestures must often have appeared constrained and risible.



> *Computat, ac cevet.* Ponatur calculus, adsint
> Cum tabula pueri.
> JUV. *Sat.* ix. 40.

The nicety acquired in calculation by the Roman youth, was not quite agreeable to the careless and easy temper of Horace.

> Romani pueri *longis rationibus* assem
> Discunt in parteis centum diducere. Dicat
> Filius Albini, Si de quincunce remota est
> Uncia, quid superet? Poteras dixisse, Triens. Eu!
> Rem poteris servare tuam. Redit uncia; quid fit?
> Semis.
> *Epist. ad Pisones.*

It was a practice among the ancients to keep a diary, by marking their fortunate days by a *lapillus,* or small white pebble, and their days of misfortune by a black one. Hence the frequent allusions which occur in the Classics:

> O diem lætum, notandumque mihi *candidissimo calculo!*
> PLIN. *Epist.* vi. 11.

> ......... diesque nobis
> Signandi *melioribus lapillis!*
> MART. ix. 53.

> Hunc, Macrine, diem numera *meliore lapillo,*
> Qui tibi labentes apponit candidus annos.
> PERS. *Sat.* ii. 1, 2.

To facilitate the working by counters, the construction of the *abacus* was afterwards improved. Instead of the perpendicular lines or bars, the board had its surface divided by sets of parallel grooves, by stretched wires, or even by successive rows of holes. It was easy to move small counters in the grooves, to slide perforated beads along the wires, or to stick large nobs or round-headed nails in the different holes. To diminish the number of marks required, every column was surmounted by a shorter one, wherein each counter had the same value as five of the ordinary kind, being half the index of the Denary Scale. The *abacus,* instead of wood, was often, for the sake of convenience and durability, made of metal, frequently brass, and sometimes silver. In the Plate entitled ARITHMETIC, we have copied, from the third volume of the Supplement added by Polenus to the immense Thesaurus of Grævius, two varieties of this instrument, as used by the Romans. They both rest on good authorities, having been delineated from antique monuments,—the first kind by Ursinus, and the second by Marcus Velserus. In the one, the numbers are represented by flattish perforated beads, ranged on parallel wires; and, in the other, they are signified by small round counters moving in parallel grooves. These instruments contain each seven capital bars, expressing in order *units, tens, hundreds, thousands, ten thousands, hundred thousands,* and *millions;* and above them are shorter bars following the same progression, but having five times the relative value. With *four* beads on each of the long wires, and

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[1] Καν καθαραι ωσιν αἱ Ψηφοι, και μηδεν περιῃ. (DEMOSTHENES *pro Corona.*)

*one* bead on every corresponding short wire, it is evident that any number could be expressed, as far as *ten millions.*

In all these, the *Denary Scale* is followed uniformly; but there is, besides, a small appendage to the arrangement founded on the *Duodenary System.* Immediately below the place of units is added a bar, with its corresponding branch, both marked Θ, being designed to signify *ounces*, or the twelfth parts of a pound. *Five* beads on the long wire, and *one* bead on the short wire, equivalent now to *six*, would therefore denote *eleven* ounces. To express the simpler fractions of an ounce, three very short bars are annexed behind the rest; a bead on the one marked S or Ʒ, the contraction for *Semissis*, denoting *half an ounce;* a bead on the other, which is marked by the inverted Ͻ, the contraction for *Sicilicum*, signifying the *quarter of an ounce;* and a bead on the last very short bar, marked Ƨ, a contraction for the symbol ϙ or *Binæ Sextulæ*, intimating a *duella* or *two-sixths*, that is, *the third part of an ounce.* The second form of the *abacus* differs in no essential respect from the first, the grooves only supplying the place of parallel wires.

We should observe that the Romans applied the same word *abacus*, to signify an article of luxurious furniture, resembling in shape the arithmetical board, but often highly ornamental, and destined for a very different purpose,—the relaxation and the amusement of the opulent. It was used in a game apparently similar to that of chess, which displayed a lively image of the struggles and vicissitudes of war. The infamous and abandoned Nero took particular delight in this sort of play, and drove along the surface of the abacus with a beautiful *quadriga*, or chariot of ivory.

The civil arts of Rome were communicated to other nations by the tide of victory, and maintained through the vigour and firmness of her imperial sway. But the simpler and more useful improvements survived the wreck of empire, among the various people again restored by fortune to their barbarous independence. In all transactions wherein money was concerned, it was found convenient to follow the procedure of the Abacus, in representing numbers by counters placed in parallel rows. During the middle ages, it became the usual practice over Europe for merchants, auditors of accounts, or judges appointed to decide in matters of revenue, to appear on a covered *bank* or *bench*, so called, from an old Saxon or Franconian word, signifying a *seat.* Hence those terms were afterwards appropriated to offices for receiving pledges, chambers for the accommodation of money-dealers, or courts for the trying of questions respecting property or the claims of the Crown. Hence also the word *bankrupt*, which occurs in all the dialects of Europe. The term *scaccarium*, from which was derived the French, and thence the English name for the *Exchequer*, anciently signified merely a *chess-board*, being formed from *scaccum*, denoting one of the movable pieces in that intricate game. The reason of this application of the term is sufficiently obvious. The table for accounts was, to facilitate the calculations, always covered with a cloth, resembling the surface of the *scaccarium* or *abacus*, and distinguished by perpendicular and *chequered* lines. The learned Skene was therefore mistaken in supposing that the Exchequer derived its name from the play of chess, because its suitors appear to fight a keen and dubious battle.[1]

Exchequer Board, and other Contrivances.

The Court of Exchequer, which takes cognizance of all questions of revenue, was introduced into England by the Norman conquest. Richard Fitznigel, in a treatise or dialogue on the subject, written about the middle of the twelfth century, says that the *scaccarium* was a quadrangular table about ten feet long and five feet broad, with a ledge or border about four inches high, to prevent any thing from rolling over, and was surrounded on all sides by seats for the judges, the tellers, and other officers. It was covered every year, after the term of Easter, with fresh black cloth, divided by perpendicular white lines, or distinctures, at intervals of about a foot or a palm, and again parted by similar transverse lines. In reckoning, they procceded, he says, according to the rules of arithmetic,[2] using small coins for counters. The lowest bar exhibited *pence*, the one above it *shillings*, the next *pounds;* and the higher bars denoted successively *tens*, *twenties*, *hundreds*, *thousands*, and *ten thousands* of pounds; though, in those early times of penury and severe economy, it very seldom happened that so large a sum as the last ever came to be reckoned. The first bar, therefore, advanced by *dozens*, the second and third by *scores*, and the rest of the stock of bars by the multiples of *ten.* The teller sat about the middle of the table; on his right hand *eleven* pennies were heaped on the first bar, and a pile of *nineteen* shillings on the second; while a quantity of pounds was collected opposite to him, on the third bar. For the sake of expedition, he might employ a different mark to represent half the value of any bar, a silver penny for ten shillings, and a gold penny for ten pounds.

In early times, a chequered board, the emblem of calculation, was hung out, to indicate an office for changing money. It was afterwards adopted as the sign of an inn or *hostelry*, where victuals were sold, or strangers lodged and entertained. We may perceive traces of that ancient practice existing even at present. It is customary in London, and in some provincial towns, to have a chequer, diced with red and white, painted against the sides of the door of a chop-house.

The use of the smaller *abacus* in assisting numerical computation was not unknown during the middle ages. In England, however, it appears to have scarcely entered into actual practice, being mostly confined to those "slender clerks" who, in such a benighted period, passed for men of science and learning. The calculator was styled, in correct Latinity, *abacista;* but, in the Italian dialect, *abbachista*, or *abbachiere.* A different name came afterwards to be imposed. The Arabians, who, under the appellation of Saracens or Moors, conquered Spain, and enriched that insulated country by commendable industry and skill, had likewise introduced their mathematical science. Having adopted a most refined species of numeration, to which they gave the barbarous name of *algarismus*, *algorismus*, or *algorithmus*, from the definite article *al*, and the Greek word *αριθμος*, or *number*, this compound term was adopted by the Christians of the West, in their admiration of superior skill, to signify calculation in general, long before the peculiar mode had become known and practised among them. The term *algarism* was corrupted in English into *augrim* or *awgrym*, as printed by Wynkyn

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[1] "Because mony persons conveenis in the Checker to playe their causes, contrare uthers, as gif they were fechtand in an arrayed battell, quilk is the forme and ordour of the said playe." (SKENE, ad voc. *Scaccarium.*)

[2] He calls it *Arismetica:* In the *Myrrour of the Worlde*, printed by Caxton, in 1481, it is strangely named *Ars Metrike*, a proof of the total ignorance of Greek at that period in England.

de Worde, at the end of the fifteenth century; and applied even to the pebbles or counters used in ordinary calculation. In confirmation of this remark, we shall not scruple to quote a passage from our ancient poet Chaucer, who flourished about a century before, and whose verses, however rude, are sometimes highly graphic.

> This clerk was cleped hendy Nicholas;
> Of derne love he coude and of solas;
> And therto he was slie and ful prive,
> And like a maiden meke for to se.
> A chambre had he in that hostelrie
> Alone, withouten any compagnie,
> Ful fetisly ydight with herbes sote,
> And he himself was swete as is the rote
> Of licoris, or any setewale.
> His almageste, and bokes gret and smale,
> His astrelabre, longing for his art,
> *His augrim stones, layen faire apart*
> *On shelves couched at his beddes hed,*
> His presse ycovered with a falding red.
> And all above ther lay a gay sautrie,
> On which he made on nightes melodie,
> So swetely, that all the chambre rong:
> And *Angelus ad virginem* he song.
> And after that he song the kinge's note;
> Ful often blessed was his mery throte.
>
> *The Milleres Tale*, v. 13–32.

The *abacus*, with its store of counters, wanted the valuable property of being portable, and was at all times evidently a clumsy and most incommodious implement of calculation. In many cases, it became quite indispensable to adopt some sure and ready method of expressing at least the lower numbers. The ancients employed the variously combined inflections of the fingers on both hands to signify the numerical series, and on this narrow basis they framed a system of considerable extent. In allusion to the very ancient practice of numbering by the arbitrary play of the fingers, Orontes, the son-in-law of Artaxerxes, having incurred the weighty displeasure of that monarch, is reported by Plutarch to have exclaimed in terms exactly of the same import as those before ascribed to Solon, that "the favourites of kings resemble the fingers of the arithmetician, being sometimes at the top and sometimes at the bottom of the scale, and are equivalent at one time to ten thousand, and at another to mere units."[1]

Digital Numeration.

Among the Romans likewise, the allusions to the mode of expressing numbers by the varied inflection of the fingers, are very frequent. Hence the classical expressions, *computare digitis*, and *numerare per digitos*; and hence the line of Ausonius,

> Quot ter luctatus cum pollice computat index.

In this play of the fingers great dexterity was acquired; and hence the phrase which so frequently occurs in the Classics—*micare digitis*. It was customary to begin with the left hand, and thence proceed to the right hand, on which the different combined inflections indicated exactly one hundred times more. Hence the peculiar force of this passage from Juvenal:

> Rex Pylius, magno si quicquam credis Homero,
> Exemplum vitæ fuit a cornice secundæ;
> Felix nimirum, qui tot per sæcula mortem
> Distulit, atque suos jam *dextra* computat annos.
>
> *Sat.* x. 246–249.

Many such allusions to the mode of indicating numbers by the varied position of the fingers or the hands, occur in the writings of Cicero and Quintilian. The ancients, indeed, for want of better instruments, were tempted to push that curious art to a very great extent. By a single inflection of the fingers of the left hand, they proceeded as far as ten; and by combining another inflection with it, they could advance to an hundred. The same signs on the right hand, being augmented, as we have seen, an hundredfold, carried them as far as ten thousand; and by a further combination, those signs, being referred successively to different parts of the body, were again multiplied an hundred times, and therefore extended to a *million*. This kind of pantomime outlived the subversion of the Roman empire, and was particularly fitted for the slothful religious orders who fattened on its ruins, and, relinquishing every manly pursuit, recommended silence as a virtue, or enjoined it as an obligation. Our venerable Bede has explained the practice of manual numeration at some length; and we have given (see Plate Arithmetic) a small specimen of such inflections and digital signs.

These signs were merely fugitive, and it became necessary to adopt other marks, of a permanent nature, for the purpose of recording numbers. But of all the contrivances adopted with this view, the rudest undoubtedly is the method of registering by *tallies*, introduced into England along with the Court of Exchequer, as another badge of the Norman conquest. These consist of straight well-seasoned sticks, of hazel or willow, so called from the French verb *tailler*, to *cut*, because they are squared at each end. The sum of money was marked on the side with notches, by the cutter of tallies, and likewise inscribed on both sides in Roman characters, by the writer of the tallies. The smallest notch signified a penny, a larger one a shilling, and one still larger a pound; but other notches, increasing successively in breadth, were made to denote ten, a hundred, and a thousand. The stick was then cleft through the middle by the deputy-chamberlains, with a knife and a mallet; the one portion being called the *tally*, or sometimes the *scachia*, *stipes*, or *kancia*; and the other portion named the *countertally*, or *folium*.

After the union with Scotland had been concluded in 1707, a store of hazel rods for tallies was sent down to Edinburgh, being intended, no doubt, as a mighty refinement on the Scottish mode of keeping accounts. Their advantages, however, were not perceived or acknowledged, and they have since been suffered, we believe, to lie as so much useless lumber. But the case was very different in England, which is more addicted to a slavish attachment to ancient forms, and opposed to the general progress of society.

This ridiculous plan of keeping the public accounts was maintained up to the year 1834, when a more rational system was adopted, and the old wooden tallies were ordered to be destroyed. The parties entrusted with this duty burnt them in the stoves which heated the House of Lords; and so intense was the heat occasioned by the burning of so great a quantity of dry wood, that it set fire to the building, and consumed the Houses of Parliament, on the 16th October 1834.

Chinese Swan-Pan.

The Chinese have, from the remotest ages, used in all their calculations, an instrument called the *Swan-Pan*, or *Computing Table*, similar in its shape and construction to the *abacus* of the Romans, but more complete and uniform. It consists of a small oblong board surrounded by a high ledge, and parted lengthwise near the top by another ledge. It is then divided vertically by ten smooth and slender rods of bamboo, on which are strung two

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[1] Καθαπερ οἱ των αριθμητικων ΔΑΚΤΥΛΟΙ νυν μεν ΜΥΡΙΑΔΑΣ, νυν δε ΜΟΝΑΔΑ τιθεναι δυνανται. το αυτο και των βασιλεων φιλους, νυν μεν το παν δυνασθαι νυν δε τουλαχιστον. (Plut. *Apophthegm.*)

small balls of ivory or bone in the upper compartment, and five such balls in the lower and larger compartment; each of the latter on the several bars denoting unit, and each of the former, for the sake of abbreviation, expressing five. See Plate (Arithmetic), where the balls are actually set to signify the numbers annexed.

The system of measures, weights, and coins, which prevails throughout the Chinese empire, being entirely founded on the decimal subdivision, the swan-pan was admirably suited for representing it. The calculator could begin at any particular bar, and reckon with the same facility either upwards or downwards. This advantage of treating fractions exactly like integers was, in practice, of the utmost consequence. Accordingly, those arithmetical machines, but of very different sizes, are constantly used in all the shops and booths of Canton and other cities, and are said to be handled by the native traders with such rapidity and address as quite astonish the European factors.

But the Chinese have also contrived a very neat and simple kind of digital signs for denoting numbers, greatly superior, both in precision and extent, to the method practised by the Romans. Since every finger has three joints, let the thumb-nail of the other hand touch those joints in succession, passing up the one side of the finger, down the middle, and again up the other side, and it will give nine different marks, applicable to the *Denary Scale* of arrangement. On the little finger those marks signify units, on the next finger tens, on the mid-finger hundreds, on the index thousands, and on the thumb hundred thousands. With the combined positions of the joints of the one hand, therefore, it was easy to advance by signs as far as a million. To illustrate more fully this ingenious practice, we have, immediately below the *koua* of the Emperor Fou-hi, copied (See Plate), from a Chinese elementary treatise of education, the figure of a hand, noted at the several joints of each finger, by characters along the inside, corresponding to *one, two,* and *three,* down the middle by those answering to *four, five,* and *six,* and again up the outside by characters expressing *seven, eight,* and *nine.* It is said that the merchants in China are accustomed to conclude bargains with each other by help of those signs; and that often, from selfish or fraudulent views, they conceal the pantomime from the knowledge of by-standers, by only seeming to seize the hand with a hearty grasp. (J. L.)

*Abacus Pythagoricus*, the common multiplication table, so called from its being invented by Pythagoras.

*Abacus Logisticus* is a rectangled triangle, whose sides, forming the right angle, contain the numbers from 1 to 60; and its area, the facta of each two of the numbers perpendicularly opposite. This is also called a *canon of sexagesimals.*

*Abacus et Palmulæ*, in the *Ancient Music*, denote the machinery whereby the strings of polyplectra, or instruments of many strings, were struck with plectra made of quills.

*Abacus Harmonicus* is used by Kircher for the structure and disposition of the keys of a musical instrument, whether to be touched with the hands or the feet.

*Abacus Major*, in metallurgic operations, the name of a trough used in the mines, wherein the ore is washed.

ABADDON, or Apollyon (אבדון, *destruction;* Ἀβαδδων in Rev. ix. 11, where it is rendered by the Greek Ἀπολλυων, *destroyer.*) The former is the Hebrew name, and the latter the Greek, for the angel of death, or the angel of the abyss or 'bottomless pit.' In the Bible, and in every Rabbinical instance, the word אבדון (*abaddon*) means destruction (Job xxxi. 12), or the place of destruction, *i. e.* the subterranean world, Hades, the region of the dead (Job xxvi. 6; xxviii. 22; Prov. xv. 11.) It is in fact the second of the seven names which the Rabbins apply to that region; and they deduce it particularly from Psalm lxxxviii. 11, "Shall thy loving kindness be declared in the grave, or thy faithfulness in (*abaddon*) destruction?"

ABADEH, a Persian town in Fars, 115 miles north of Shirauz, formerly a place of importance but now decayed, though still with a population of about 5000. It is famous for its gardens, the fruits of which are sent to Shirauz.

ABADIR, a title which the Carthaginians gave to gods of the first order. In the Roman mythology, it is the name of a stone which Saturn swallowed, by the contrivance of his wife Ops, believing it to be his new-born son Jupiter: hence it became the object of religious worship.

ABÆ, Ἄβαι, in *Ancient Geography*, a town of Phocis near the frontiers of the Opuntians Locrians famous for an ancient oracle of Apollo, and the treasures of its temple, which was plundered and burnt by the Persians, B.C. 480; and again by the Bœotians, B.C. 346. Hadrian built a smaller temple near the site of the former one. The ruins of Abæ may still be traced on the S.W. side of a peaked hill to the west of Exarkhó. (See Leake's *Northern Greece;* Gell's *Itinerary.*)

ABAFT, a sea term, signifying the hinder part of a ship, or all those parts both within and without which lie towards the stern, in opposition to *afore. Abaft* is also used as a preposition, and signifies *further aft,* or *nearer the stern:* as, the barricade stands *abaft* the main-mast, *i. e.* behind it, or nearer the stern.

ABAISSED, *abaisse*, in *Heraldry*, an epithet applied to the wings of eagles, &c. when the tip looks downwards to the point of the shield, or when the wings are shut; the natural way of bearing them being extended.

ABAKA, Khan, the eighth emperor of the Moguls, a wise and good prince, ascended the throne in 1264. He reigned 17 years, and is by some authors said to have been a Christian. It may be admitted, indeed, that he joined with the Christians in keeping the feast of Easter, in the city Hamadan, a short time before his death. But this is no proof of his Christianity; it having been a common practice, in these times, for Christians and Mahometans to join in keeping the same feasts, when each would compliment the other by doing honour to his solemnity.

ABAKANSK, a range of mountains in the government of Tomsk, in Siberia, extending from the river Tom to the Jenisei, parallel to the Altai mountains.

Abakansk, a fortified town of Siberia, in the government of Tomsk, on the river Abakan. This is considered the mildest and most salubrious place in Siberia; and is remarkable for the tumuli in its neighbourhood, and for some statues of men from seven to nine feet high covered with hieroglyphics. Pop. 1200. Lat. 54. N. Long. 91. 14. E.

ABALLABA, an ancient Roman castle mentioned in the *Notitia Imperii*, the site of which is referred by antiquaries to Appleby in Westmoreland. It was one of the forts erected by Hadrian, A.D. 120.

ABALUS, in *Ancient Geography*, is described as an island in the German Ocean, where amber was found in great abundance. It is called *Basilia* by Timæus, and *Baltia* by Xenophon of Lampsacus. It was probably one of the narrow peninsulas on the Prussian coast, which lie between the Baltic and the lakes called the Frisch and Curisch Haffs.

ABANA, or Amana, and PHARPAR, are called "rivers of Damascus" in 2 Kings v. 12. The main stream by which Damascus is now irrigated is called Barrada (the ancient Chrysorrhoas), and it seems probable that this was the ancient Pharpar: the Abana has been sought in its subsidiary streams, and also in the Fijih, a deep, rapid stream, which falls into the Barrada 15 or 20 miles N.W. of Damascus. See DAMASCUS.

ABANCAY, a district of Peru in the *partido* of Cuzco. Its length is 26 leagues from east to west, its breadth 14. It contains several towns, of which the chief is Abancay. The surface is varied; the plains produce very rich crops of sugar cane, and the principal cereals, as well as much hemp, which is manufactured into cloth in the chief town, where also there are excellent sugar refineries. The mountains afford some silver, and pasturage for large herds of cattle. The town of Abancay is 65 miles from Cuzco, and has one of the finest bridges in Peru.

ABANDONMENT, in *Marine Insurance*, is the surrendering of the ship or goods insured, to the insurers, in consequence of damage or loss sustained from any of the causes insured against. In every case of loss or damage from these causes, the insured is not entitled to abandon, but only when serious injury has been sustained; as where the voyage is lost or not worth pursuing, and the projected adventure frustrated, or where the thing insured is so damaged and spoiled as to be of little or no value to the owner. It was held that, where the damage sustained in a voyage was to the extent of forty-eight per cent. of the value of the vessel, the insured were not entitled to abandon. By abandonment all the rights of the insured are vested in the insurers, who thus become the legal owners of the vessel or goods, and are obliged to pay the full amount of the insurance. The insured must intimate his intention to abandon, within a reasonable time after receiving intelligence of the loss; any unnecessary delay being held as an indication of his intention not to abandon. An abandonment when once made is irrevocable; but in no circumstances is the insured obliged to abandon. In the case of shipwreck or other misfortune, the captain and crew are bound to do all in their power to save the property, without prejudice to the right of abandonment; for which they are entitled to wages and remuneration from the insurers, at least so far as what is saved will allow. (See Marshall and Park, on the *Law of Insurance*.)

ABANO, a town in the Austrian division of Italy, at the foot of the Vicentine Hills, the ancient *Montes Euganei*. It is visited by invalids for the benefit of its baths, which were well known to the ancients, and are noticed by Martial and Claudian as Fontes Aponi. There are five thermal springs, viz., Fonte d'Abano, Mont'-Ortone, San Pietro, Monte Gratto, and San Bartolomeo, besides the hot mud bath, Bagno di Fango; which latter is considered more efficacious for the cure of diseases than the springs. These springs rise through tertiary strata, resting on trap-porphyry, which Breislac considers of volcanic origin. Besides their medicinal virtues, Suetonius relates that they were frequented for the purposes of divination by means of *tali* cast into the basin of the fountain. Suet. *Tib.* xiv. Claud. *Idyll.* 6.

ABANTES, a people of ancient Greece who came originally from Thrace, and settled in Phocis, where they built a town which they called *Aba*, after the name of Abas their leader. If we may credit some ancient authors, the Abantes afterwards migrated to the island of Eubœa; according to other authorities the Abantes of Eubœa came from Athens. The national character of the Abantes was very warlike.

ABANTIAS, or ABANTIS, in *Ancient Geography*, a name of the island Eubœa. See EUBŒA.

ABAPTISTON, in *Surgery*, the perforating part of the instrument called a TREPAN. This instrument, which is mentioned by Galen, Fabricius ab Aquapendente, and others, was a conical saw with a circular edge. Modern practitioners, however, prefer the cylindrical form; and various contrivances have been recommended to obviate the danger that may arise from want of dexterity, or from rashness, in performing the operation of trepanning. The instrument most commonly employed in Britain is the *trephine*, in which the circular saw is moved backward and forward by the hand; but on the Continent the preference is usually given to the *trepan*, in which the circular saw is attached to a handle like that of a carpenter's brace; and this is preferred by Professor Syme, and some of our other eminent surgeons, to the *trephine*, as the latter renders the operation more tedious and laborious. See SURGERY.

ABARAN, a small town in the department of Ziezar, and province of Murcia, in Spain.

ABARAN, a Persian town, about 15 miles north of Nuckschivan, in which the Dominicans had a mission.

ABARIM, high mountains of steep ascent separating the country of the Ammonites and Moabites from the land of Canaan, where Moses died. According to Josephus, they stood opposite to the territory of Jericho, and were the last station but one of the Israelites coming from Egypt. Nebo and Pisgah were parts of these mountains.

ABARIS, the Hyperborean, a celebrated sage of antiquity, whose history and travels have been the subject of much learned discussion. Such a number of fabulous stories[1] were told of him, that Herodotus himself seems to scruple to relate them. He tells us only,[2] that this barbarian was said to have travelled with an arrow, and to have taken no sustenance; but this does not acquaint us with the marvellous properties which were attributed to that arrow; nor that it had been given him by the Hyperborean Apollo. With regard to the occasion of his leaving his native country, Harpocration[3] tells us, that the whole earth being infested with a deadly plague, Apollo, upon being consulted, gave no other answer than that the Athenians should offer up prayers in behalf of all other nations; upon which, several countries deputed ambassadors to Athens, among whom was Abaris the Hyperborean. In this journey, he renewed the alliance between his countrymen and the inhabitants of the island of Delos. It appears that he also went to Lacedæmon; since according to some writers,[4] he there built a temple consecrated to Proserpine the Salutary. It is asserted that he was capable of foretelling earthquakes, driving away plagues, laying storms,[5] &c. He wrote several books, as Suidas[6] informs us, viz., Apollo's arrival in the country of the Hyperboreans; the nuptials of the river Hebrus; Θεογονια or the Generation of the Gods; a collection of oracles, &c.—If the Hebrides, or Western islands of Scotland, (says Mr Toland)[7] were the Hyperboreans of Diodorus,[8] then the celebrated Abaris was of that country; and likewise a Druid, having been the priest of Apollo. Suidas, who knew not the distinction of the insular Hyperboreans, makes him a Scythian; as do some others, misled by the same vulgar error; though Diodorus has truly fixed his country in an island, and not on the Continent. But every thing relating to him is apocryphal, and even his era is doubtful. Some refer his appearance in Greece to the third Olympiad, others to the 21st, while some transfer him to the 52d Olympiad, or 570 years B.C., or somewhat later, about the time of Crœsus of Lydia.

[1] Jamblichi *Vita Pythag.*
[2] Lib. iv. cap. 36.
[3] Under the word Αβαρις
[4] Pausanias lib. iii. p. 94.
[5] Porphyry in *Vita Pythagor.*
[6] Under the word Αβαρις
[7] Account of the Druids, in his *Posthumous Works*, i. p. 161.
[8] Diod. Sic. lib. ii. iii.

ABARTICULATION, in *Anatomy*, a species of articulation, admitting of a manifest motion; called also *Diarthrosis*, and *Dearticulatio*, to distinguish it from that sort of articulation which admits of a very obscure motion, and is called *Synarthrosis*.

ABAS, a weight used in Persia for weighing pearls. It is equal to 2·25 grains Troy.

ABAS, in heathen mythology, the son of Meganira, who entertained Ceres, and offered a sacrifice to that goddess; but Abas ridiculing the ceremony, and giving her opprobrious language, she sprinkled him with a certain mixture she held in her cup, on which he became a newt or water lizard.

ABASSI, or ABASSIS, a silver coin current in Persia, equivalent in value to a French livre, or at present tenpence sterling. It took its name from Schah Abbas II., king of Persia, under whom it was struck.

ABATAMENTUM, in *Law*, is an entry to lands by interposition, *i. e.* when a person dies seized, and another who has no right enters before the heir.

ABATE, in the manege, implies the performing any downward motion properly. Thus a horse is said to *abate* or take down his curvets, when he puts both his hind legs to the ground at once, and observes the same exactness in all the times.

To ABATE, (from the French *abattre*, to pull down, overthrow, demolish, batter down, or destroy,) a term used by the writers of the English common law both in an active and neuter sense; as, To *abate* a castle, is to beat it down. To *abate* a writ, is, by some exception to defeat or overthrow it. A stranger *abateth;* that is, entereth upon a house or land void by the death of him that last possessed it, before the heir takes possession, and so keepeth him out: wherefore, as he that putteth out him in possession is said to disseize, so he that steppeth in between the former possessor and his heir is said to *abate*. In the neuter signification thus: The writ of the demandant shall *abate;* that is, shall be disabled, frustrated, or overthrown. The appeal *abateth* by covin; that is, the accusation is defeated by deceit.

ABATEMENT, in *Heraldry*, an accidental figure supposed to have been added to coats of arms, in order to denote some dishonourable demeanour or stain, whereby the dignity of coat armour was rendered of less esteem.

ABATEMENT, REBATE, or REBATEMENT, in *Commerce*, is a discount for ready money; and it also means a deduction sometimes made at the custom-house from the fixed duties on certain kinds of goods, on account of damage or loss sustained in warehouses. The rate of such deduction is regulated by Act 3 and 4 Will. IV. c. 52.

ABATI, NICCOLO, a celebrated fresco-painter of Modena, born in 1512. His best works are at Modena, and in the Institute of Bologna; and have been highly praised by Zanotti, Algarotti, and Lanzi. He accompanied Primaticcio to France, and assisted in decorating the palace at Fontainbleau. He united skill in drawing, grace, and natural colouring in his pictures. Some of his easel pieces in oil are in different collections; and the finest of them, to be seen in the Dresden Gallery, represents the martyrdom of St Peter and St Paul. Abati died at Paris, in 1571. There are several good painters of his name and family mentioned by Lanzi. *Storia Pittorica*, tom. iv.

ABATIS, an ancient term for an officer of the stables.

ABATIS, or ABATTIS, in military affairs, a kind of defence made of felled trees. In sudden emergencies, the trees are merely laid lengthwise beside each other, with the branches pointed outwards to prevent the approach of the enemy, while the trunks serve as a breast-work to the defendants. When the abatis is employed for the defence of a pass or entrance, the boughs of the trees are stripped of their leaves and pointed, the trunks are planted in the ground, and the branches interwoven with each other.

ABATON, a building at Rhodes, erected as a fence to the trophy of Artemisia, queen of Halicarnassus, Coos, &c. raised in memory of her victory over the Rhodians, or rather to conceal the disgrace of the Rhodians from the eyes of the world; for, to efface or destroy the trophy was with them a point of religious abhorrence.

ABATOR, in *Law*, a term applied to a person who enters a house or lands void by the death of the last possessor, before the true heir.

ABATOS, in *Ancient Geography*, an island in the Nile near Philæ, sacred to Osiris, which the priests alone were permitted to enter.



ABATTOIR, the term applied by the French to designate slaughter-houses for cattle. These useful establishments were introduced into Paris and other large cities by Napoleon. Formerly the multitude of animals slaughtered in Paris, became a nuisance of great magnitude to the inhabitants, from the exhibition of the barbarities practised on the poor animals by the butchers, the piteous cries of sheep and cattle pent up, without food or water, in the confined stalls in which they were crowded, and from the offensive exhalations of putrid blood and offal that proceeded from slaughter-houses, often planted in the most populous parts of the city. The same nuisance, till lately, disgraced the British metropolis, and most of our other great towns. It appears hardly conceivable that London should, till 1852, have tolerated the nuisance of Smithfield market. When this mart was established five centuries ago, it was far beyond the precincts of the city. There, in the midst of a dense population, no fewer than 243,537 head of cattle, and 1,455,249 sheep were sold in 1852, to be afterwards slaughtered in the crowded lanes and ill-ventilated courts of the metropolis; while our more judicious neighbours the French, and our transatlantic brethren in New York and Philadelphia, do not tolerate such sources of disgust and disease in the interior of their great towns.

The abattoirs of Paris, created by Napoleon's decree of 1810, amounted to five in 1818, when they were all completed, and put under excellent regulation. There are three on the north, and two on the south side of Paris; and all are in the outskirts of the town, about two miles from its centre. The largest to the north is in the Rue Rochechouart, between the Barrieres Poissonnieres and des Martyres; the largest on the south side is just behind the Place Breteuil; the rest are near the banks of the Seine. The cattle-markets are all at the distance of some miles from Paris; and the cattle are driven from them to the abattoirs, round by the external Boulevards, so as to avoid the streets as much as possible.

Each butcher goes to his own abattoir; to which are attached proper places for preserving the meat, provided with an iron rack for the fat, pans for melting the tallow, and stalls for the cattle before they are slaughtered. The stalls are furnished with proper racks and troughs for hay and water, that the animals may suffer as little as possible before they are slaughtered. The abattoirs, and the whole establishment are kept very clean, by an abundant supply of water that carries off the blood and all impurities into sewers. Considering the nature of the place, every thing is commendably clean.

An inspector is appointed to each abattoir, whose business it is to prevent the sale of unwholesome meat, and to enforce order and cleanliness. For these accommodations a butcher pays according to the number of animals he slaughters. The sum now paid for each ox is six francs, four for a cow, two for a calf, and one for a sheep or lamb. The money thus raised from all the Parisian abattoirs in 1842, amounted to about £48,000 sterling.

It is greatly to be wished that some regulations like those of the French abattoirs were introduced into all our large towns, especially London, Liverpool, Manchester, Glasgow, &c., as has lately been done at Edinburgh.

In 1851, the corporation of Edinburgh constructed a greatly improved abattoir in that city, from designs prepared by Mr David Cousin, the city architect. It occupies an area of four acres and a quarter, surrounded by a screen-wall, with entrance gates on each side in the Egyptian style of architecture; behind the screen-wall is a large open area, from which access is given to all the different buildings connected with the establishment. The slaughtering booths consist of a double row of buildings, extending in a straight line to about 376 feet in length, with a centre roadway 25 feet wide. There are three separate blocks of building on each side of the roadway, the extreme blocks being each 100 feet in length, and the central one 140 feet, with cross roads 18 feet wide, between these, giving access to the other portions of the grounds. The different ranges of building contain 42 booths in all; each booth is 18 feet wide, 24 feet in length, and 20 feet in height, having a cattle shed attached, 18 feet by 22 feet, and a small enclosed yard behind, with a separate back entrance, by which all the cattle are driven into the sheds, where they are kept previously to being slaughtered. By a series of large ventilators along the roof, and by other contrivances, these buildings are thoroughly ventilated. The large doors of the booths, instead of being hinged in the usual manner, are hung by balance weights, so as to slide up and down similarly to an ordinary sash-window, so that they never interfere with the operations within, or with the thoroughfare of the road.

Improved mechanical contrivances have been introduced, some of them of a novel application, which have secured great facilities in the dressing and preparation of the meat. Each booth is amply provided with water.

In addition to the slaughtering booths, there is large accommodation for triperies, pig-slaughtering houses, tallow-weighing houses, and all the other necessaries of such an establishment.

The whole of the booths have been laid with thick well-dressed pavement, resting on a stratum of concrete twelve inches thick, and the walls to the height of seven feet are formed of solid ashler, so as to prevent the possibility of rats burrowing in them. With this view also, the whole surface of the roadways have been laid with concrete and causewayed with well-dressed whinstone pavement. The drainage also consists entirely of glazed earthenware tubes, so that the whole area of the buildings is rendered impervious to these destructive vermin.

There are two distinct sets of drains, one for surface water, which is conveyed directly into Lochrin burn; the other for soil from the booths, which is conveyed into large tanks formed for its reception, and sold for agricultural purposes.

Before the erection of these buildings, private slaughter-houses were scattered all over the city, often in the most populous districts, where, through want of drainage and imperfect ventilation, they contaminated the whole neighbourhood. Since the opening of the public abattoir, all private slaughter-houses are prohibited.

ABA-UJVAR, one of the palatinates into which the Austrian kingdom of Hungary is divided. It is bounded on the east and south by the county of Zemplin, on the west by those of Torna Borschod and Zips, and on the north by Saros. It is mountainous, and nearly one-half covered with wood. Its chief productions are wine, tobacco, wood, corn, flax, fruit, metals, and precious stones; and it has also some valuable quarries of marble. Its extent is about 1118 square miles, and it contains one city, 10 market-towns, and 227 villages. Population in 1838, 204,000.

ABAUZIT, Firmin, a learned Frenchman, was born at Usez, in Languedoc, in November 1679. His father died when he was but two years of age. To avoid the persecution to which the Protestants of France were exposed in the time of Louis XIV., Abauzit's mother fled with her son to Geneva. From his 10th to his 19th year, his time was wholly devoted to literature; and having made great progress in languages, he studied mathematics, physics, and theology. In the year 1698, he travelled into Holland, where he became acquainted with Bayle, Basnage, and Jurieu. Thence he passed over to England, and was introduced to Sir Isaac Newton, who entertained a very high opinion of his merit. For this philosopher afterwards sent him his *Commercium Epistolicum*, accompanied with a very honourable testimony: "You are well worthy," says Newton, "to judge between Leibnitz and me." The reputation of Abauzit reached the ears of King William, who encouraged him by a very handsome offer to settle in England; which he declined, and returned to Geneva. In 1715 he entered into the society formed for the purpose of translating the New Testament into the French language, and contributed valuable assistance to this work. The chair of philosophy in the university was offered to him in 1723, which he refused; but in 1727 he accepted the office of librarian to the city, the duties of of which were not burdensome, and did not subject him to any particular restraint.



Abauzit was one of the first who embraced the grand truths which the sublime discoveries of Newton disclosed to the world. He defended the doctrines of that philosopher against Father Castel; and discovered an error in the *Principia*, which was corrected by Newton in the second edition of his work. He was a perfect master of many languages; his knowledge was extensive and profound; and the different sciences which he had studied were so well digested and arranged in his retentive mind, that he could at once bring together all that he ever knew on any subject. Rousseau (in his *Heloise*) addressed to Abauzit one of the finest panegyrics which he ever wrote; and a stranger having addressed Voltaire in a flattering manner, by saying he had come to Geneva to see a great man, the poet asked him whether he had seen Abauzit.

This excellent man, having lived universally respected to the great age of 87 years, died in the year 1767, lamented by the republic, and regretted by the learned.

ABAVO, in *Botany*, a synonyme of the Adansonia.

ABB, a term among clothiers applied to the yarn of a weaver's warp. They say also *Abb-wool* in the same sense.

Abb, a town of Yemen in Arabia, situated on a mountain in the midst of a very fertile country, 73 miles N.E. of Mocha. Lat. 13. 58. N., Long. 44. 15. E. It contains about 800 houses, and is surrounded by a strong wall; the strects are well paved; and an aqueduct from a neighbouring mountain supplies it with water, which is received in a great reservoir in front of the principal mosque. Population about 5000.

ABBA, in *Ancient Geography*, a town of Africa Propria, near Carthage. *Liv.* xxx. 7.

Abba, in the Syriac and Chaldee languages, literally signifies *a father;* and figuratively, a superior, reputed as a father in respect of age, dignity, or affection. It is more particularly used in the Syriac, Coptic, and Ethiopic churches, as a title given to the bishops. The bishops themselves bestow the title of *Abba* more eminently on the bishop of Alexandria; which occasioned the people to give him the title of *Babba*, or *Papa*, that is *Grandfather;* a title which he bore before the bishop of Rome. It is a Jewish title of honour given to certain Rabbis called *Tanaites:* and it was particularly used, by some writers of the middle age, for the superior of a monastery, usually called abbot.

ABBADIE, James, an eminent Protestant divine, born at Nay in Berne in 1657; first educated there under the famous John la Placette, and afterwards at the university of Sedan, from whence he went into Holland and Germany, and was minister in the French church of Berlin. He left that place in 1690; came into England; was some time minister in the French church in the Savoy, London; and was made dean of Killalo in Ireland. He was strongly attached to the cause of King William, as appears in his elaborate defence of the Revolution, and his History of the *Assassin-*

*ation Plot.* The materials for the last were furnished by the secretaries of state. He had great natural abilities, which he improved by useful learning. His best known and ablest works are, *Traité de la Divinité de Jesus-Christ*, and *Traité de la Religion Chrétienne.* He died in London in 1727, after his return from a tour in Holland.

ABBAS-BEN-ABDUL-MOTALLEB, Mahomet's uncle, opposed his nephew with all his power, regarding him as an impostor and traitor to his country; but in the second year of the Hegira, being overcome and made a prisoner at the battle of Beder in 623, when a great ransom was demanded for him, he represented to Mahomet that his paying it would reduce him to beggary, which would bring dishonour on the family. Mahomet, who knew that he had concealed large sums of money, said to him, "Where are the purses of gold that you gave your mother to keep when you left Mecca? Abbas, who thought this transaction secret, was much surprised; and conceiving that his nephew was really a prophet, embraced his religion. He became one of his principal captains, and saved his life when in imminent danger at the battle of Honain, against the Thakesites, soon after the reduction of Mecca. But besides being a great commander, Abbas was one of the first doctors of Islamism. He is said to have read lectures on every chapter of the Koran, as his nephew pretended to receive them from heaven. He died in 652, and his memory is held in the highest veneration among the Mussulmans to this day.

ABBAS, *Schah*, the Great, was third son of Codabendi, seventh king of Persia of the race of the Sophis. Succeeding to his father in 1585, at the age of 18, he found the affairs of Persia at a low ebb, occasioned by the conquests of the Turks and Tartars. He regained several of the provinces they had seized; but death put a stop to his victories in 1629, after a reign of 44 years. He was the greatest prince who had reigned in Persia for many ages; and it was he who made Ispahan the metropolis of Persia: but his memory is stained with many atrocities.

ABBAS, *Schah*, his great-grandson, ninth king of Persia of the race of the Sophis, succeeded his father Sesi at 13 years of age. He was but 18 when he made himself master of the city of Candahar, which had surrendered in his father's reign to the Great Mogul, and all the province about it; and he preserved it afterwards against this Indian emperor, though he besieged it more than once with an army of 300,000 men. He was a very merciful prince, and openly protected the Christians. He had formed a design of extending the limits of his kingdom toward the north, and for that purpose had levied a powerful army; but death put a stop to all his great designs, at 37 years of age, A.D. 1666.

ABBAS-ABAD, a town founded by Abbas the Great, now a frontier town of Persia, on the Araxes, near which is a strong fortress. It once contained 40,000 houses, and an immense population, which is now reduced to 3388 Tartars, and 1779 Armenians.

ABBASSA, sister of the celebrated Khaliph Haroun Al Raschid, who was given in marriage to his vizier Ghiaffr, on the strange condition that she should remain a virgin; the violation of which, and its terrible consequences, have been the theme of oriental story.

ABBASSIDES, the name of a race who possessed the caliphat for 524 years. There were 37 caliphs of this race who succeeded one another without interruption. They drew their descent from Abbas-Ben-Abdul-Motalleb, a brother of the PROPHET's father. The princes of this family made war on the dynasty of Ommiades, A.D. 746; and in 750 defeated the last caliph of the rival family in the bloody battle of Zab near Mosul. The most celebrated monarchs of this family were Al-Mansur, and Haroun-al-Raschid. Their empire terminated in Mostazem, who fell in battle against the Tartar Prince Hulaku in 1257.



ABBE', in a monastic sense, the same with ABBOT.

ABBE', in a modern sense, the denomination of a class of persons which has been popular in France. They were not in orders; but having received the ceremony of tonsure, were entitled to enjoy certain privileges in the church. The dress of abbés was that of academics or professed scholars. In colleges they were the instructors of youth, and were employed as tutors in private families. Many of them have risen to a distinguished rank in the state, while others have been no less eminent in science and literature.

ABBESS, the superior of an abbey or convent of nuns. The abbess has the same rights and authority over her nuns that the abbots regular have over their monks. The sex indeed does not allow her to perform the spiritual functions annexed to the priesthood, with which the abbot is usually invested; but there are instances of some abbesses who have a right, or rather a privilege, to commission a priest to act for them. They have even a kind of episcopal jurisdiction, as well as some abbots who are exempted from the visitation of their diocesans.

Martene, in his treatise on the rights of the church, observes, that abbesses formerly confessed nuns; but he adds, that their excessive curiosity carried them to such lengths, that there arose a necessity for checking it. However, St Basil, in his Rule, allows the abbess to be present with the priest at the confession of her nuns.

ABBEVILLE, an arrondissement of the department of the Somme, in the north-west of France, which extends over 610 square miles, or 390,300 acres. It is divided into 11 cantons, which are subdivided into 172 communes, and in 1846 contained 137,111 inhabitants.

ABBEVILLE, a city of France, capital of the arrondissement of the same name, situate in a pleasant and fertile valley on both sides of the river Somme, 12 miles above its mouth, and 25 miles N.W. of Amiens. This town, which is strongly fortified on Vauban's system, is neat and well built, and has several bridges, squares, and churches, one of them, St Wulfram's, very antique and curious. A cloth manufactory was established here by Van Robais, a Dutchman, under the patronage of the minister Colbert, as early as 1669; and since that time Abbeville has continued to be one of the most thriving manufacturing towns in France. Besides black cloths of the best quality, there are produced velvets, cottons, linens, serges, sackings, hosiery, packthread, jewellery, soap, glass-wares, &c. It has also establishments for spinning wool, print-works, bleaching-works, tanneries, a paper manufactory, &c.; and being situate in the centre of a fruitful district, it has a considerable trade with the surrounding country. By help of the tides, vessels of 150 tons come up to the town. According to the census of 1846, it had a population of 17,035. A treaty was concluded here in 1225, between Henry III. of England and Louis IX. of France, by which the province of Guienne was ceded to the English. Lat. 50. 7. 4. N. Long. 1. 59. 58. E.

ABBEVILLE, a fertile district of the United States, North America, in S. Carolina, between the rivers Savannah and Saluda. The population in 1850 was 32,148. The chief town of the same name is on Little River, 97 miles west of Columbia.

ABBEY, a monastery, or religious house, governed by a superior under the title of *abbot* or *abbess.*

*Abbeys* differ from *priories* in this, that the former are under the direction of an abbot, the latter of a prior; for abbot and prior (we mean a prior conventual) are much the same thing, differing in little but the name.

Fauchet observes, that, in the early days of the French monarchy, dukes and counts were called *abbots*, and duchies and counties *abbeys*. Even some of their kings are mentioned in history under the title of *abbots*. Philip I., Louis VI., and afterwards the Duke of Orleans, are called *abbots of the monastery of St Aignan*. The dukes of Aquitain were called *abbots of the monastery of St Hilary at Poictiers*; and the earls of Anjou, *of St Aubin, &c.*

Monasteries were at first established as religious houses, to which persons retired from the bustle of the world to spend their time in solitude and devotion. But they soon degenerated from their original institution, and obtained large privileges, exemptions, and riches. They prevailed greatly in Britain before the Reformation, particularly in England; and as they increased in riches, so the state became poor: for the lands which these regulars possessed were *in mortua manu*, i.e. could never revert to the lords who gave them. This inconvenience gave rise to the statutes against gifts *in mortmain*; and Lord Coke tells us, that several lords, at their creation, had a clause in their grant, that the donor might give or sell his land to whom he would (*exceptis viris religiosis et Judæis*) excepting monks and Jews.

These places were wholly abolished in England at the time of the Reformation; Henry VIII. having first appointed visitors to inquire into the lives of the monks and nuns, which were found in some places to be extremely irregular. The abbots, perceiving their dissolution unavoidable, were induced to resign their houses to the king, who by that means became invested with the abbey lands: these were afterwards granted to different persons, whose descendants enjoy them at this day.

Though the suppression of religious houses, even considered in a political light only, was a national benefit, it must be owned, that at the time they flourished, they were far from useless. Abbeys or monasteries were then the repositories, as well as the seminaries, of learning; many valuable books and national records, as well as private history, having been preserved in their libraries, the only places in which they could have been safely lodged in those turbulent times. Many of those which had escaped the ravages of the Danes, were destroyed with more than Gothic barbarity at the dissolution of the abbeys. These ravages are pathetically lamented by John Bale: "A number of those," says he, "who purchased these superstitious mansions, reserved of the library books, some to serve their jakes, some to scour the candlesticks, and some to rub their boots; some they sold to the grocer and soapseller; and some they sent over sea to the bookbinders, not in small numbers, but in whole ships full; yea, the universities of this realm are not clear of so detestable a fact. I know a merchant that bought the contents of two noble libraries for 40s. price; a shame it is to be spoken! This stuff hath he occupied instead of gray paper, by the space of more than these ten years, and yet he hath store enough for as many years to come. I shall judge this to be true, and utter it with heaviness, that neither the Britons under the Romans and Saxons, nor yet the English people under the Danes and Normans had ever such damage of their learned monuments as we have seen in our time."

Every abbey had at least one person whose office it was to instruct youth; and the historians of this country are chiefly beholden to the monks for the knowledge they have of former national events. In these houses also the arts of painting, architecture, and printing, were cultivated. They were hospitals for the sick and poor, and afforded entertainment to travellers at a time when there were no inns. They were likewise an asylum for aged and indigent persons of good family.

ABBEYBOYLE. See Boyle.

ABBEYFEALE, a village of Ireland, in the county of Limerick, on the river Feale, with a population in 1851 of 717. The parish of the same name has an area of 18,150 acres, and 4364 inhabitants.



ABBEYHOLM, a town in Cumberland, so called from an abbey built there by David king of Scots, five miles W.N.W. of Wigton.

ABBEYLEIX, a small town of Ireland, Queen's County, 9 miles S.S.W. of Maryborough. In 1851 the population was 1341. The parish of the same name has an area of 13,547 acres, and 5646 inhabitants.

ABBIATE GRASSO, a town in the Austrian delegation of Pavia, in Italy. It is situate on the canal of Bereguardo, 14 miles W.S.W. of Milan. It contains 4600 inhabitants.

ABBITIBBEE, a district, river, and trading station in British North America, forming part of the Hudson's Bay Company's possessions. The station is situate in Lat. 49. N. Long. 78. 10. W.

ABBON, or Abbo Cernuus, a monk of Saint Germain-des-Prés, who flourished towards the end of the 9th century. He wrote an epic poem in Latin on the siege of Paris by the Northmen in 886-7, of which he was an eye-witness. As a poem his work is of little value; but it is of considerable importance to the historian, as being an accurate narrative of the event.

Abbon, or *Abbo Floriacensis*, a learned Frenchman, born in the vicinity of Orleans, in the year 945. He was educated at the schools of Paris and Rheims, where he greatly distinguished himself; and devoted himself with great ardour to the study of all the sciences of his time. In 970, he was chosen abbot of the monastery of Fleury, of which he was a monk; and was engaged in disputes with several of the bishops of his time in defending the rights of his order. In 986, and again in 996, he was sent by King Robert to Rome, in order to appease the pope, who had threatened to interdict the kingdom, and on both occasions he was successful. He was killed in 1004, while endeavouring to quell a tumult between two contending parties of French and Gascons. His chief works were the Lives of the Popes, published in 1602, and some collections of canons, letters, &c.

ABBOT, or Abbat, the superior of a monastery of monks erected into an abbey or priory.

The name *Abbot* is originally Hebrew, where it signifies *father*. The Jews call *father*, in their language, *Ab*; whence the Chaldeans and Syrians formed *Abba*; thence the Greek Ἀββα, which the Latins retained; and hence our *Abbot*, the French *Abbé*, &c. St Mark and St Paul use the Syriac *Abba* in their Greek, by reason it was then commonly known in the synagogues and the primitive assemblies of the Christians; adding to it, by way of interpretation, the word *father*, Ἀββα Ὁ Πατηρ, "Abba, father;" *q. d.* Abba, that is to say, Father. But the name Ab, or Abba, which at first was a term of tenderness and affection, became at length a title of dignity and honour. The Jewish doctors affected it; and one of their most ancient books, containing the sayings or apophthegms of divers of them, is entitled Pirke Abboth or Avoth; *i. e.* Chapter of the Fathers. It was in allusion to this affectation, that Jesus Christ forbade his disciples to call any man their father on earth; which word St Jerome turns against the superiors of the monasteries of his time, for assuming the titles of *Abbots*, or Fathers.

The name *Abbot*, then, appears as old as the institution of monks itself. The governors of the primitive monasteries assumed indifferently the titles *Abbots* and *Archimandrites*. They were really distinguished from the clergy; though frequently confounded with them, because a degree above laymen.

In those early days, the abbots were subject to the bishops and the ordinary pastors. Their monasteries being remote from cities, built in the farthest solitudes, they

Abbot. had no share in ecclesiastical affairs. They went on Sundays to the parish church with the rest of the people; or, if they were too remote, a priest was sent them to administer the sacraments; till at length they were allowed to have priests of their own body. The abbot or archimandrite himself was usually the priest: but his function extended no farther than to the spiritual assistance of his monastery; and he remained still in obedience to the bishop. There being among the abbots several persons of learning, they made a vigorous opposition to the rising heresies of those times; which first occasioned the bishops to call them out of their deserts, and fix them about the suburbs of cities, and at length in the cities themselves; from which era their degeneracy is to be dated. Then the abbots threw off their former plainness and simplicity, assumed the rank of prelates, aspired at being independent of the bishops, and grasped at so much power, that severe laws were made against them at the council of Chalcedon. Many of them, however, carried the point of independency, obtained the appellation of *lord*, and were distinguished by other badges of the episcopate, particularly the mitre.

Hence arose new distinctions between the abbots. Those were termed *mitred* abbots, who were privileged to wear the mitre, and exercise episcopal authority within their respective precincts; being exempted from the jurisdiction of the bishop. Others were called *crosiered* abbots, from their bearing the crosier or pastoral staff. Others were styled *ecumenical* or universal abbots, in imitation of the patriarch of Constantinople: while others were termed *cardinal* abbots, from their superiority over all other abbots. In Britain, the mitred abbots were lords of parliament, and called abbots-sovereign, and abbots-general, to distinguish them from the other abbots. And as there were lords-abbots, so there were also lords-priors, who had exempt jurisdiction, and were likewise lords of parliament.

In Roman Catholic countries, the principal distinctions observed between abbots are those of *regular* and *commendatory*. The former take the vow and wear the habit of their order; whereas the latter are seculars who have received tonsure, but are obliged by their bulls to take orders when of proper age.

Anciently the ceremony of creating an abbot consisted in clothing him with the habit called *cuculus*, or cowl; putting the pastoral staff into his hand, and the shoes called *pedales* on his feet: but at present, it is only a simple benediction, improperly called, by some, consecration.

Abbot is also a title given to others beside the superiors of monasteries: thus bishops whose sees were formerly abbeys, are called abbots. Among the Genoese, the chief magistrate of the republic formerly bore the title of *abbot* of the people.

Abbot, *George*, archbishop of Canterbury, born Oct. 29. 1562, at Guildford in Surrey, was the son of Maurice Abbot, a cloth-worker, who suffered religious persecution in the reign of Queen Mary. He studied at Oxford, and in 1597 was chosen principal of University college. In 1599, he was installed dean of Winchester: the year following he was chosen vice-chancellor of the university of Oxford, and a second time in 1603. In 1604, the translation of the Bible now in use was begun by the direction of King James; and Dr Abbot was the second of eight divines of Oxford, to whom the care of translating the whole New Testament (excepting the Epistles) was committed. The year following, he was a third time vice-chancellor. In 1608, he went to Scotland with George Hume earl of Dunbar, to assist in establishing an union between the churches of Scotland and England; and in this business he conducted himself with so much address and prudence, that it laid the foundation of all his future preferment. King James ever after paid great deference to his advice and counsel; and upon the death of Dr Overton, bishop of Litchfield and Coventry, he named Dr Abbot for his successor, who was accordingly constituted bishop of those two united sees in December 1609. About a month afterwards he was translated to the see of London, and on the second of November following was raised to the archiepiscopal see. Abbot.

It is not however improbable, that his extravagant adulation of his royal master, in which he went as far as any other court chaplain could do, contributed not a little to his rapid preferment. In the preface to a pamphlet which he published, the following specimen of ridiculous flattery occurs: Speaking of the king, he says, "whose life hath been so immaculate and unspotted, &c. that even malice itself, which leaves nothing unsearched, could never find true blemish in it, nor cast probable aspersion on it.—Zealous as a David; learned and wise, the *Solomon* of our age; religious as Josias; careful of spreading Christ's faith as Constantine the Great; just as Moses; undefiled in all his ways as a Jehoshaphat and Hezekiah; full of clemency as another Theodosius."—Yet, as we shall immediately see, Abbot could sometimes oppose the will of the sovereign with courage and constancy.

His great zeal for the Protestant religion made him a strenuous promoter of the match between the Elector Palatine and the Princess Elizabeth; which was accordingly concluded and solemnized the 14th of February 1612, the archbishop performing the ceremony on a stage erected in the royal chapel. In the following year happened the famous case of divorce between the lady Frances Howard, daughter of the earl of Suffolk, and Robert earl of Essex; which has been considered as one of the greatest blemishes of King James's reign. The part which the archbishop took in the business added much to the reputation he had already acquired for incorruptible integrity. It was referred by the king to a court of delegates, whose opinion the king and court wished and expected to be favourable to the divorce. But the archbishop, unawed by royal authority, with inflexible firmness resisted it, and published his reasons for persisting in his opinion; to which the king, disappointed in his views, thought fit to reply: Sentence was given in the lady's favour. In 1618, the king published a declaration, which he ordered to be read in all churches, permitting sports and pastimes on the Lord's day: this gave great uneasiness to the archbishop, who happening to be at Croydon on the day it was ordered to be read, had the courage to forbid it.

Being now in a declining state of health, the archbishop used in the summer to go to Hampshire for the sake of recreation; and being invited by Lord Zouch to hunt in his park at Bramzill, he met there with the greatest misfortune that ever befell him; for he accidentally killed the game-keeper by an arrow from a cross-bow which he shot at one of the deer. This fatal accident threw him into a deep melancholy; and he ever afterwards kept a monthly fast on Tuesday, the day on which it happened; and he settled an annuity of L.20 on the widow.[1] Advantage was taken of this misfortune, to lessen him in the king's favour; but his majesty said, "An angel might have miscarried in this sort." His enemies alleging that he had incurred an irregularity, and was thereby incapacitated for performing the offices of a primate, the king directed a commission to ten persons to inquire into this matter. The result was not satisfactory to his Grace's enemies; it being declared, that, as the murder was involuntary, he had not forfeited his archiepiscopal character.

[1] Fuller's *Church Hist.* cent. xvii. p. 87.

The archbishop after this seldom assisted at the coun-

Abbot.

cil, being chiefly hindered by his infirmities; but in the king's last illness he was sent for, and constantly attended till his majesty expired on the 27th of March 1622. He performed the ceremony of the coronation of King Charles I. though very infirm and distressed with the gout. He was never greatly in this king's favour; and the duke of Buckingham being his declared enemy, watched an opportunity of making him feel the weight of his displeasure. This he at last accomplished, upon the archbishop's refusing to license a sermon, preached by Dr Sibthorpe to justify a loan which the king had demanded, and pregnant with principles which tended to overthrow the constitution. The archbishop was immediately after suspended from all his functions as primate; and they were exercised by certain bishops commissioned by the king, of whom Laud, the archbishop's enemy, and afterwards his successor, was one; while the only cause assigned for this procedure was, that the archbishop could not at that time personally attend those services which were otherwise proper for his cognizance and direction. He did not, however, remain long in this situation; for a parliament being absolutely necessary, his Grace was sent for, and restored to his authority and jurisdiction. But not proving friendly to certain rigorous measures adopted by the prevailing church party, headed by Laud, whose power and interest at court were now very considerable, his presence became unwelcome there; so that, upon the birth of the prince of Wales, afterwards Charles II., Laud had the honour to baptize him, as dean of the chapel. The archbishop being worn out with cares and infirmities, died at Croydon, the 5th of August 1633, aged 71 years; and was buried at Guildford, the place of his nativity, where he had endowed an hospital with lands to the amount of L.300 per annum. A stately monument was erected over the grave, with his effigy in his robes.

He proved himself, in most circumstances of his life, to be a man of great moderation to all parties; and was desirous that the clergy should gain the respect of the laity by the sanctity and purity of their manners, rather than claim it as due to their function. His opinions and principles, however, have drawn upon him many severe reflections; particularly from the earl of Clarendon. But Dr Welwood has done more justice to his merit and abilities.[1] The following is a list of his works, as given in Chalmers's *Biographical Dictionary*:—1. Quæstiones Sex, totidem prælectionibus in Schola Theologica Oxoniæ, pro forma habitis, discussæ et disceptatæ anno 1597, in quibus e Sacra Scriptura et Patribus, quid statuendum sit definitur. Oxon. 1598, 4to. 2. Exposition on the Prophet Jonah, contained in certain Sermons preached in St Marie's Church in Oxford. 1600, 4to. 3. Answer to the Questions of the Citizens of London in January 1600, concerning Cheapside Cross; not printed until 1641. 4. The Reasons which Dr Hill hath brought for the upholding of Papistry unmasked, and showed to be very weak, &c. Oxon. 1604, 4to. 5. A Preface to the Examination of George Sprot, &c. 6. Sermon preached at Westminster, May 26. 1608, at the funeral of Thomas Earl of Dorset, late Lord High Treasurer of England, on Isaiah xl. 6. 1608, 4to. 7. Translation of a part of the New Testament, with the rest of the Oxford divines. 1611. 8. Some Memorials, touching the Nullity between the Earl of Essex and his Lady, pronounced September 25. 1613, at Lambeth; and the difficulties endured in the same. 9. A Brief Description of the whole World, wherein is particularly described all the Monarchies, Empires, and Kingdoms of the same, with their Academies, &c. 1617, 4to. 10. A short Apology for Archbishop Abbot, touching the death of Peter Hawkins, dated October 8. 1621. 11. Treatise of perpetual Visibility and Succession of the true Church in all ages. Lond. 1624, 4to.; published without his name; but his arms, impaled with those of Canterbury, are put before it. 12. A Narrative containing the true cause of his sequestration and disgrace at Court; in two parts; written at Ford, in Kent, 1627, printed in Rushworth's Historical Collections, vol. i. p. 438–461, and in the Annals of King Charles, p. 213–224. 13. History of the Massacre in the Valteline, printed in the third volume of Fox's Acts and Monuments. 14. Judgment on bowing at the Name of Jesus. Hamburgh, 1632, 8vo.

[1] *Memoirs*, 8vo. 1700, p. 38.

Abbot, *Robert*, elder brother to the former, was born at Guildford in 1560, and completed his studies at Baliol college, Oxford. In 1582, he took his degree of master of arts, and soon became a celebrated preacher; and to this talent he chiefly owed his preferment. Upon the first sermon at Worcester, he was chosen lecturer in that city, and soon after rector of All-saints in the same place. In 1597, he took his degree of doctor in divinity: and, in the beginning of King James's reign, was appointed chaplain in ordinary to his majesty; who had such an opinion of him as a writer, that he ordered the doctor's book *De Antichristo* to be printed, with his own commentary upon part of the Apocalypse. In 1609, he was elected master of Baliol college; which trust he discharged with the utmost care and assiduity, by his frequent lectures to the scholars, by his continual presence at public exercises, and by promoting temperance in the society. In November 1610, he was made prebendary of Normanton in the church of Southwell; and, in 1612, his majesty appointed him regius professor of divinity at Oxford. The fame of his lectures became very great; and those which he gave upon the supreme power of kings, against Bellarmine and Suarez, so much pleased his majesty, that when the see of Salisbury became vacant, he named him to that bishopric, and he was consecrated by his own brother at Lambeth, December 3. 1615. When he came to Salisbury, he found the cathedral falling to decay, through the avarice and negligence of the clergy belonging to it; however, he found means to draw five hundred pounds from the prebendaries, which he applied towards repairing it. Here he devoted himself to the duties of his function with great diligence and assiduity, visiting his whole diocese in person, and preaching every Sunday. But his sedentary life, and close application to study, brought upon him the gravel and stone; of which he died on the 2d of March 1618, in the 58th year of his age; having filled the see only two years and three months.

Abbot, *Charles, Lord Colchester*, the son of a clergyman at Colchester, was born October 14, 1757, and was educated at Westminster School, from which he was elected a student to Christ Church, Oxford, in 1775. He was called to the bar in 1795, and soon after published a legal work, in which he strongly recommended the abolition of the separate Welsh judicature, a measure which has since been carried out. The same year introduced him into Parliament, where his activity and habits of business soon brought him into notice, and he was proposed by Mr Pitt as chairman of the finance committee. In Mr Addington's administration, he filled the office of chief secretary of state for Ireland; and in 1802 he was elected speaker of the House of Commons, an office which he filled with dignity and general approbation, under successive administrations, till 1817, when a severe attack of erysipelas induced him to resign the laborious duties of the speaker's chair. While he held that situation, it was his lot, on April 8, 1805, to give the casting vote in a House of 433 members, which drove Henry Lord Melville from public life. On Abbot's retirement, he was created Lord Colchester, and obtained a pension of L.4000 a-year; but he afterwards took no very prominent part in public affairs, except in strenuous opposition to the Roman Catholic Emancipation. In 1828 he published six of his parliamentary speeches on that subject. He died May 8. 1829.

ABBOTSBURY, a parish and market-town on the coast of Dorsetshire. It has the ruins of an abbey, founded about the year 1044. In the vicinity is a Roman camp, a cromlech, and the ruins of St Catherine's chapel. Pop. in 1851, 1077.

ABBOTSFORD, two miles W. of Melrose, and 30 miles S.S.E. of Edinburgh, the celebrated residence of Sir Walter Scott, built by himself on the plan of a castellated Gothic mansion, on the south bank of the river Tweed, near the Abbot's ford.

ABBOTS-LANGLEY, a village of Herts, four miles from St Albans, famous as the birth-place of Pope Adrian IV. Population of parish in 1851, 2384.

ABBREVIATION, or ABBREVIATURE, a contraction of a word or passage, made by dropping some of the letters, or by substituting certain marks or characters in their place. Harris, in his treatise called *Hermes*, divides the parts of speech into words which are necessary for the communication of thought, as the noun and verb, and *abbreviations* which are employed for the sake of despatch. The latter, strictly speaking, are also parts of speech, because they are all useful in language, and each has a different manner of signification Mr Tooke, however, seems to allow that rank only to the necessary words, and to consider all others as merely substitutes of the first sort, under the title of abbreviations. They are employed in language in three ways—in terms, in sorts of words, and in construction. Locke in his *Essay on the Human Understanding* treats of the first class; numerous authors have written on the last; and for the second class of abbreviations, see the work of Mr Tooke entitled *Diversions of Purley*. Lawyers, physicians, &c. use many abbreviations, for the sake of expedition. But the Rabbis are the most remarkable for this practice, so that their writings are unintelligible without the Hebrew abbreviatures. The Jewish authors and copyists do not content themselves with abbreviating words like the Greeks and Latins, by retrenching some of the letters or syllables; they frequently take away all but the initial letters. They even take the initials of several succeeding words, join them together, and, adding vowels to them, make a sort of barbarous words, representative of all those which they have thus abridged. Thus, *Rabbi Moses ben Maimon*, in their abbreviature, is *Rambam*, &c.

*The following* ABBREVIATIONS *are of most frequent occurrence in the Writings and Inscriptions of the Romans.*

A.

AB. Abdicavit.
AB. AUG. M. P. XXXXI. Ab Augusta millia passuum quadraginta unum.
AB. AUGUSTOB. M. P. X. Ab Augustobriga millia passuum decem.
ABN. Abnepos.
AB. U. C. Ab urbe condita.
A. CAMB. M. P. XI. A Camboduno millia passuum undecim.
A. COMPL. XIIII. A Compluto quatuordecim.
A. C. P. VI. A capite *vel* ad caput pedes sex.
A. D. Ante diem.
ADJECT. H-S. IX. ∞. Adjectis sestertiis novem mille.
ADN. Adnepos.
ADQ. Adquiescit, *vel* adquisita *pro* acquisita.
ÆD. II. $\overline{II}$. VIR. II. Ædilis iterum, duumvir iterum.
ÆD. II. VIR. QUINQ. Ædilis duumvir quinquennalis.



ÆD. Q. II. VIR. Ædilis quinquennalis duumvir.
ÆL. Ælius, Ælia.
ÆM. *vel* AIM. Æmilius, Æmilia.
A. G. Animo grato, *vel* Aulus Gellius.
AG. Ager, *vel* Agrippa.
A. K. Ante kalendas.
ALA. I. Ala prima.
A. MILL. XXXV. A milliariis triginta quinque, *vel* ad milliaria triginta quinque.
A. M. XX. Ad milliare vigesimum.
AN. A. V. C. Anno ab urbe condita.
AN. C. H. S. Annorum centum hic situs est.
AN. DCLX. Anno sexcentesimo sexagesimo.
AN. II. S. Annos duos semis.
AN. IVL. Annos quadraginta sex.
AN. N. Annos natus.
ANN. LIII. H. S. E. Annorum quinquaginta trium hic situs est.
ANN. NAT. LXVI. Annos natus sexaginta sex.
ANN. PL. M. X. Annos *vel* annis plus minus decem.
AN. Θ. XVI. Anno defunctus decimo sexto.
AN. V. XX. Annos vixit viginti.
AN. P. M. Annorum plus minus.
A. XII. Annis duodecim.
AN. P. M. L. Annorum plus minus quinquaginta.
A. XX. H. EST. Annorum viginti hic est.
AN. P. R. C. Anno post Romam conditam.
AN. V. P. M. II. Annis vixit plus minus duobus.
AN. XXV. STIP. VIII. Annorum viginti quinque stipendiorum octo.
A. P. M. Amico posuit monumentum.
AP. Appia, Appius.
A. P. V. C. Anno post urbem conditam.
APVD. L. V. CONV. Apud lapidem quintum convenerunt.
A. RET. P. III. S. Ante retro pedes tres semis.
AR. P. Aram posuit.
ARG. P. X. Argenti pondo decem.
ARR. Arrius.
A. V. B. A viro bono.
A. V. C. Ab urbe condita.

B.

B. Balbus, Bulbius, Brutus, Belenus, Burrus.
B. Beneficiario, beneficium, bonus.
B. Balnea, beatus, bustum.
B *pro* V, berna *pro* verna, bixit *pro* vixit, bibo *pro* vivo, bictor *pro* victor, bidua *pro* vidua.
B. A. Bixit annis, bonus ager, bonus amabilis, bona aurea, bonum aureum, bonis auguriis, bonis auspiciis.
B. B. Bona bona, bene bene.
B. DD. Bonis deabus.
B. F. Bona fide, bona femina, bona fortuna, bene factum.
B. F. *reversed thus*, ꟻ. Ⅎ. Bona femina, bona filia.
B. H. Bona hereditaria, bonorum hereditas.
B. I. I. Boni judicis judicium.
B. L. Bona lex.
B. M. P. Bene merito posuit.
B. M. P. C. Bene merito ponendum curavit.
B. M. S. C. Bene merito sepulcrum condidit.
BN. EM. Bonorum emptores.
BN. H. I. Bona hic invenies.
B. RP. N. Bono reipublicæ natus.
B. A. Bixit, *id est*, vixit annis.
BIGINTI. Viginti.
BIXIT. BIXSIT. BISSIT. Vixit.
BIX. ANN. XXCI. M. IV. D. VII. Vixit annis octoginta unum, mensibus quatuor, diebus septem.
BX. ANVS. VII. ME. VI. DI. XVII. Vixit annos septem, menses sex, dies septemdecim.

Abbrevia-
tions.

C.

C. Cæsar, Caia, Caius, censor, civitas, consul, condemno.
C. C. Carissimæ conjugi, calumniae causa, consilium cepit.
C. C. F. Caius Caii filius.
C. B. Commune bonum.
C. D. Comitialibus diebus.
C. H. Custos hortorum *vel* heredum.
C. I. C. Caius Julius Cæsar.
CC. VV. Clarissimi viri.
CEN. Censor, centuria, centurio.
CERTA. QUINQ. ROM. CO. Certamen quinquennale Romæ conditum.
CL. Claudius.
CL. V. Clarissimus vir.
CH. COH. Cohors.
C. M. *vel* CA. M. Causa mortis.
CN. Cneus.
C. O. Civitas omnis.
COH. I. *vel* II. Cohors prima *vel* secunda.
COS. ITER. ET. TERT. DESIG. Consul iterum et tertium designatus.
COS. TER. *vel* QUAR. Consul tertium *vel* quartum.
COSS. Consules.
COST. CUM. LOC. H-S. ∞. D. Custodiam cum loco sestertiis mille quingentis.
C. R. Civis Romanus.
CS. IP. Cæsar imperator.
C. V. Centumviri.

D

D. Decius, decimus, decuria, decurio, dedicavit, dedit, devotus, dies, divus, Deus, dii, Dominus, domus, donum, datum, decretum, &c.
D. A. Divus Augustus.
D. B. I. Diis bene juvantibus.
D. B. S. De bonis suis.
DCT. Detractum.
DDVIT. Dedicavit.
D. D. Dono dedit, Deus dedit, decurionum decreto.
D. D. D. Datum decreto decurionum.
D. D. D. D. Dignum Deo donum dedicavit.
DDPP. Depositi.
D. D. Q. O. H. L. S. E. V. Diis deabusque omnibus hunc locum sacrum esse voluit.
DIG. M. Dignus memoria.
D. M. S. Diis manibus sacrum.
D. O. M. Deo optimo maximo.
D. O. Æ. Deo optimo æterno.
D. PP. Deo perpetuo.
DR. Drusus.
DR. P. Dare promittit.
D. RM. De Romanis.
D. RP. De republica.
D. S. P. F. C. De sua pecunia faciendum curavit.
DT. Duntaxat.
DVL. *vel* DOL. Dulcissimus.
DEC.*XIII. AVG. XII. POP. XI. Decurionibus denariis tredecim, augustalibus duodecim, populo undecim.
D. IIII. ID. Die quarta idus.
D. VIIII. Diebus novem.
D. V. ID. Die quinta idus.

E.

E. Ejus, ergo, esse, est, erexit, exactum, &c.
E. C. F. Ejus causa fecit.
E. D. Ejus domus.
ED. Edictum.
E. E. Ex edicto.
EE. N. P. Esse non potest.
EG. Egit, egregius.
E. H. Ejus heres.
EID. Idus.
EIM. Ejusmodi.
E. L. Ea lege.
E. M. Elexit *vel* erexit monumentum.
EQ. M. Equitum magister.
EQ. O. Equester ordo.
EX. A. D. K. Ex ante diem kalendas.
EX. A. D. V. K. DEC. AD. PRID. K. IAN. Ex ante diem quintum kalendas Decembris ad pridie kalendas Januarias.
EX. H-S. X. P. F. I. Ex sestertiis decem parvis fieri jussit.
EX. H-S. CIↃ. N. Ex sestertiis mille nummum.
EX. H-S. ∞ ∞ ∞ ∞. Ex sestertiis quatuor millia.
EX. H-S. N. CC. L. ∞. D. XL. Ex sestertiis nummorum ducentis quinquaginta millibus quingentis quadraginta.
EX. H-S. DC. ∞. D. XX. Ex sestertiis sexcentis millibus quingentis viginti.
EX. KAL. IAN. AD. KAL. IAN. Ex kalendis Januarii ad kalendas Januarii.

F.

F. Fabius, fecit, factum, faciendum, familia, famula, fastus, Februarius, feliciter, felix, fides, fieri, fit, femina, filia, filius, frater, finis, flamen, forum, fluvius, faustum, fuit.
F. A. Filio amantissimo, *vel* filiæ amantissimæ.
F. AN. X. F. C. Filio *vel* filiæ annorum decem faciendum curavit.
F. C. Fieri *vel* faciendum curavit, fidei commissum.
F. D. Flamen Dialis, filius dedit, factum dedicavit.
F. D. Fidejussor, fundum.
FEA. Femina.
FF. C. Ferme centum.
F. F. Fabre factum, filius familias, fratris filius
F. F. F. Ferro, flamma, fame ; fortior, fortuna, fato.
FF. Fecerunt.
FL. F. Flavii filius.
F. FQ. Filiis filiabusque.
FIX. ANN. XXXIX. M. I. D. VI. HOR. SCIT. NEM. Vixit annos triginta novem, mensem unum, dies sex, horas scit nemo.
FO. FR. Forum.
F. R. Forum Romanum.

G.

G. Gellius, Gaius *pro* Caius, genius, gens, gaudium, gesta, gratia, gratis, &c.
GAB. Gabinius.
GAL. Gallus, Galerius.
G. C. Genio civitatis.
GEN. P. R. Genio populi Romani.
GL. Gloria.
GL. S. Gallus Sempronius.
GN. Gneus *pro* Cneus, genius, gens.
GNT. Gentes.
GRA. Gracchus.
GRC. Græcus.

H.

H. Hic, habet, hastatus, heres, homo, hora, hostis, herus.
H. A. Hoc anno.
HA. Hadrianus.
HC. Hunc, huic, hic.
HER. Heres, hereditatis, Herennius.
HER. *vel* HERC. S. Herculi sacrum.
H. M. E. H-S. CCIↃↃ. CCIↃↃ. IↃↃ. N. Hoc monumentum erexit sestertiis viginti quinque mille nummum.
H. M. AD. H. N. T. Hoc monumentum ad heredes non transit.
H. O. Hostis occisus.
HOSS. Hostes.
H. S. Hic situs *vel* sita, sepultus *vel* sepulta.
H-S. N. IIII. Sestertiis nummum quatuor.

H-S. CCCC. Sestertiis quatuor centum.
H-S. ∞. N. Sestertiis mille nummum.
H-S. ∞. CCIƆƆ. N. Sestertiis novem mille nummum.
H-S. CCIƆƆ. CCIƆƆ. Sestertiis viginti mille.
H-S. XX. M. N. Sestertiis viginti mille nummum.
H. SS. Hic suprascriptis.

I.

I. Junius, Julius, Jupiter, ibi, immortalis, imperator, inferi, inter, invenit, invictus, ipse, iterum, judex, jussit, jus, &c.
IA. Intra.
I. AG. In agro.
I. AGL. In angulo.
IAD. Jamdudum.
IAN. Janus.
IA. RI. Jam respondi.
I. C. Juris consultus, Julius Cæsar, judex cognitionum.
IC. Hic.
I. D. Inferis diis, Jovi dedicatum, Isidi deæ, jussu Dei.
ID. Idus.
I. D. M. Jovi Deo magno.
I. F. *vel* I. FO. In foro.
IF. Interfuit. IFT. Interfuerunt.
I. FNT. In fronte.
IG. Igitur.
I. H. Jacet hic.
I. I. In jure.
IM. Imago, immortalis, imperator.
I. M. CT. In medio civitatis.
IMM. Immolavit, immortalis, immunis
IM. S. Impensis suis.
IN. Inimicus, inscripsit, interea.
IN. A. P. XX. In agro pedes viginti.
IN. *vel* INL. V. I. S. Inlustris vir infra scriptus.
I. R. Jovi regi, Junoni reginæ, jure rogavit.
I. S. *vel* I. SN. In senatum.
I. V. Justus vir.
IVD. Judicium.
IVV. Juventus, Juvenalis.
II. V. Duumvir, *vel* duumviri.
III. V. *vel* III. VIR. Triumvir, *vel* triumviri.
IIII. VIR. Quatuorvir, *vel* quatuorviri, *vel* quatuorviratus.
IIIII. V. *vel* VIR. Sextumvir, *vel* sevir, *vel* sexvir.
IDNE. *vel* IND. *aut* INDICT. Indictione *vel* indictio.

K.

K. Cæso, Caius, Caio, Cælius, Carolus, calumnia, candidatus, caput, carissimus, clarissimus, castra, cohors, Carthago, &c.
K. KAL. KL. KLD. KLEND. Kalendæ, *aut* kalendis ; *et sic de cæteris ubi mensium apponuntur nomina.*
KARC. Carcer.
KK. Carissimi.
KM. Carissimus.
K. S. Carus suis.
KR. Chorus.
KR. AM. N. Carus amicus noster.

L.

L. Lucius, Lucia, Lælius, Lollius, lares, Latinus, latum, legavit, lex, legio, libens *vel* lubens, liber, libera, libertus, liberta, libra, locavit, &c.
L. A. Lex alia.
LA. C. Latini coloni.
L. A. D. Locus alteri datus.
L. AG. Lex agraria.
L. AN. Lucius Anius, *vel* quinquaginta annis.
L. AP. Ludi Apollinares.
LAT. P. VIII. E. S. Latum pedes octo et semis.
LONG. P. VII. L. P. III. Longum pedes septem, latum pedes tres.
L. ADQ. Locus adquisitus.
LB. Libertus, liberi.
L. D. D. D. Locus datus decreto decurionum.
LECTIST. Lectisternium.
LEG. I. Legio prima.
L. E. D. Lege ejus damnatus.
LEG. PROV. Legatus provinciæ.
LIC. Licinius.
LICT. Lictor.
LL. Libentissime, liberi, libertas.
L. L. Sestertius magnus.
LVD. SÆC. Ludi sæculares.
LVPERC. Lupercalia.
LV. P. F. Ludos publicos fecit.

M.

M. Marcus, Marca, Martius, Mutius, maceria, magister, magistratus, magnus, manes, mancipium, marmoreus, Marti, mater, maximus, memor, memoria, mensis, meus, miles, militavit, militia, mille, missus, monumentum, mortuus, &c.
MAG. EQ. Magister equitum.
MAR. VLT. Mars ultor.
MAX. POT. Maximus pontifex.
MD. Mandatum.
MED. Medicus, medius.
MER. Mercurius, mercator.
MERK. Mercurialia, mercatus.
MES. VII. DIEB. XI. Mensibus septem, diebus undecim.
M. I. Maximo Jovi, matri Ideæ *vel* Isidi, militiæ jus, monumentum jussit.
MIL. COH. Miles cohortis.
MIN. *vel* MINER. Minerva.
M. MON. MNT. MONET. Moneta.
M. *vel* MS. Mensis *vel* menses.
MNF. Manifestus.
MNM. Manumissus.
M. P. II. Millia passuum duo.
MV. MN. MVN. MVNIC. Municipium, *vel* municeps.

N.

N. Neptunus, Numerius, Numeria, nonis, Nero, nam, non, natus, natio, nefastus, nepos, neptis, niger, nomen, nonæ, noster, numerarius, numerator, numerus, nummus *vel* numisma, numen.
NAV. Navis.
N. B. Numeravit bivus, *pro* vivus.
NB. *vel* NBL. Nobilis.
N. C. Nero Cæsar, *vel* Nero Claudius.
NEG. *vel* NEGOT. Negotiator.
NEP. S. Neptuno sacrum.
N. F. N. Nobili familia natus.
N. L. Non liquet, non licet, non longe, nominis Latini.
N. M. Nonius Macrinus, non malum, non minus.
NN. Nostri. NNR. *vel* NR. Nostrorum.
NO. Nobis.
NOBR. November.
NON. AP. Nonis Aprilis.
NQ. Namque, nusquam. nunquam.
N. V. N. D. N. P. O. Neque vendetur, neque donabitur, neque pignori obligabitur.
NVP. Nuptiæ.

O.

O. Officium, optimus, olla, omnis, optio, ordo, ossa, ostendit, &c.
OB. Obiit.
OB. C. S. Ob cives servatos.
OCT. Octavianus, October.
O. E. B. Q. C. Ossa ejus bene quiescant condita.
O. H. F. Omnibus honoribus functus.
ONA. Omnia.

OO. Omnes, omnino. O. O. Optimus ordo.
OP. Oppidum, opiter, oportet, optimus, opus.
ORN. Ornamentum.
OTIM. Optimæ.

P.

P. Publius, passus, patria, pecunia, pedes, perpetuus, pius, plebs, populus, pontifex, posuit, potestas, præses, prætor, pridie, pro, post, provincia, puer, publicus, publice, primus, &c.
PA. Pater, patricius.
PAE. ET. ARR. COS. Pæto et Arrio consulibus.
P. A. F. A. Postulo an fias auctor.
PAR. Parens, Parilia, Parthicus.
PAT. PAT. Pater patriæ.
PBLC. Publicus.
PC. Procurator.
P. C. Post consulatum, patres conscripti, patronus coloniæ, ponendum curavit, præfectus corporis, pactum conventum.
PED. CXV. S. Pedes centum quindecim semis.
PEG. Peregrinus.
P. II. ∽. L. Pondo duarum semis librarum.
P. II. S :·. Pondo duo semis cum triente.
P. KAL. Pridie kalendas.
POM. Pompeïus.
P. P. P. C. Propria pecunia ponendum curavit.
P. R. C. A. DCCCXLIIII. Post Romam conditam annis octingentis quadraginta quatuor.
PROC. Proconsul. P. PR. Proprætor. P. PRR. Proprætores.
PR. N. Pronepos.
P. R. V. X. Populi Romani vota decennalia.
PS. Passus, plebiscitum.
PUD. Pudicus, pudica, pudor.
PUR. Purpureus.

Q.

Q. Quinquennalis, quartus, quintus, quando, quantum, qui, quæ, quod, Quintus, Quintius, Quintilianus, quæstor, quadratum, quæsitus.
Q. B. AN. XXX. Qui bixit, *id est*, vixit, annos triginta.
QM. Quomodo, quem, quoniam.
QQ. Quinquennalis. QQ. V. Quoquo versum.
Q. R. Quæstor reipublicæ.
Q. V. A. III. M. II. Qui *vel* quæ vixit annos tres, menses duo.

R.

R. Roma, Romanus, rex, reges, Regulus, rationalis, Ravennæ, recta, recto, requietorium, retro, rostra, rudera, &c.
RC. Rescriptum.
R. C. Romana civitas.
REF. C. Reficiendum curavit.
REG. Regio.
RP. RESP. Respublica.
RET. P. XX. Retro pedes viginti.
REQ. Requiescit.
RMS. Romanus.
ROB. Robigalia, Robigo.
RS. Responsum.
RVF. Rufus.

S.

S. Sacrum, sacellum, scriptus, semis, senatus, sepultus, sepulcrum, sanctus, servus, serva, Servius. sequitur, sibi, situs, solvit, sub, stipendium, &c.
SAC. Sacerdos, sacrificium.
SÆ. *vel* SÆC. Sæculum, sæculares.
SAL. Salus.
S. C. Senatus consultum.
SCI. Scipio.
S. D. Sacrum diis.
S. EQ. Q. O. ET. P. R. Senatus equesterque ordo et populus Romanus.
SEMP. Sempronius.
SL. SVL. SYL. Sylla.
S. L. Sacer ludus, sine lingua.
S. M. Sacrum manibus, sine manibus, sine malo.
SN. Senatus, sententia, sine.
S. P. Sine pecunia.
S. P. Q. R. Senatus populusque Romanus.
S. P. D. Salutem plurimam dicit.
S. T. A. Sine *vel* sub tutoris auctoritate.
SLT. Scilicet.
S. E. T. L. Sit ei terra levis.
SIC. V. SIC. X. Sicuti quinquennalia, sic decennalia.
SSTVP. XVIIII. Stipendiis novemdecim.
ST. XXXV. Stipendiis triginta quinque.

T.

T. Titus, Tullius, tantum, terra, tibi, ter, testamentum, titulus, terminus, triarius, tribunus, turma, tutor, tutela, &c.
TAB. Tabula. TABVL. Tabularius.
TAR. Tarquinius.
TB. D. F. Tibi dulcissimo filio.
TB. PL. Tribunus plebis.
TB. TI. TIB. Tiberius.
T. F. Titus Flavius, Titi filius.
THR. Thrax.
T. L. Titus Livius, Titi libertus.
TIT. Titulus.
TM. Terminus, thermæ.
TR. PO. Tribunitia potestas.
TRAJ. Trajanus.
TUL. Tullus *vel* Tullius.
TR. V. Triumvir.
TT. QTS. Titus Quintus.
Θ. *vel* TH. AN. Mortuus anno.
Θ. XIII. Defunctus viginti tribus.

V.

V. Quinque, quinto, quintum.
V. Vitellius, Volera, Volero, Volusus, Vopiscus, vale, valeo, Vesta, vestalis, vestis, vester, veteranus, vir, virgo, vivus, vixit, votum, vovit, urbs, usus, uxor, victus, victor, &c.
V. A. Veterano assignatum.
V. A. I. D. XI. Vixit annum unum, dies undecim.
V. A. L. Vixit annos quinquaginta.
V. B. A. Viri boni arbitratu.
V. C. Vale conjux, vivens curavit, vir consularis, vir clarissimus, quintum consul.
VDL. Videlicet.
V. E. Vir egregius, visum est, verum etiam.
VESP. Vespasianus.
VI. V. Sextumvir. VII. V. Septemvir. VIII. VIR. octumvir.
VIX. A. FF. C. Vixit annos ferme centum.
VIX. AN. ⋈. Vixit annos triginta.
ULPS. Ulpianus, Ulpius.
V. M. Vir magnificus, vivens mandavit, volens merito.
V. N. Quinto nonas.
V. MUN. Vias munivit.
VOL. Volcania, Voltinia, Volusus.
VONE. Bonæ.
VOT. V. Votis quinquennalibus.
VOT. V. MULT. X. Votis quinquennalibus, multis decennalibus.
VOT. X. Vota decennalia.

Abbreviations.

VOT. XX. *vel* XXX. *vel* XXXX. Vota vicennalia, aut tricennalia, aut quadragenalia.
V.R. Urbs Roma, votum reddidit.
VV.CC. Viri clarissimi.
UX. Uxor.

X.

X. AN. Decennalibus.
X. K. OCT. Decimo kalendas Octobris.
X. M. Decem millia. X. P. Decem pondo.
X. V. Decemvir. XV. VIR. Quindecimvir.

*The following are the principal* ABBREVIATIONS *in common use:—*

A. Associate.
A.B. or B.A. Bachelor of Arts.
Abp. Archbishop.
A.C. Anno Christi, in the year of Christ.
A.D. Anno Domini, in the year of our Lord.
A.M. Anno Mundi, in the year of the World.
A.M. or M.A. Artium magister, Master of Arts.
A.M. Ante meridiem, forenoon.
A.R.A. Associate of the Royal Academy.
A.R.S.A. Associate of the Royal Society of Arts, or of the Royal Scottish Academy.
Bart. or Bt. Baronet.
B.C. Before Christ.
B.C.L. Bachelor of Civil Law.
Bp. Bishop.
C. or Cent. Centum, a hundred; or Chap. Chapter.
C.B. Companion of the Bath.
C.E. Civil Engineer.
C.P.S. Custos Privati Sigilli, Keeper of the Privy Seal.
Cr. Creditor.
C.S. Custos Sigilli, Keeper of the Seal.
Cwt. Hundredweight.
D. Five hundred.
d. Denarius, a penny.
D.B. or B.D. Bachelor of Divinity.
D.C.L. Doctor of Civil Law.
D.D. Doctor of Divinity.
D.F. or F.D. Fidei defensor, Defender of the Faith.
D.G. Dei gratia, by the grace of God.
Do. ditto, the same.
Dr. Doctor, debtor.
D.V. Deo volente, God willing.
Dwt. Pennyweight.
E. East.
E.C.P. Evangelii Christi Prædicator, Preacher of the Gospel of Christ.
e.g. Exempli gratia, for example.
Esq. Esquire.
Ex. Example.
Exr. Executor.
F.A.S. Fellow of the Antiquarian Society.
F.G.S. Fellow of the Geological Society.
F.L.S. Fellow of the Linnæan Society.
F.R.C.S. Fellow of the Royal College of Surgeons.
F.R.S. Fellow of the Royal Society.
F.R.C.P. Fellow of the Royal College of Physicians.
F.S.A. Fellow of the Society of Arts, or of Antiquaries.
F.S.S. Fellow of the Statistical Society.
G.C.B. Knight of the Grand Cross of the Bath.
H.E.I.C.S. The Honourable the East India Company's Service.
H.M.S. Her Majesty's Ship.
H.R.H. His or Her Royal Highness.
Ib. or Ibid, Ibidem, in the same place.
Id. Idem, the same.
i.e. id est, that is.
I.H.S. Jesus Hominum Salvator, Jesus the Saviour of mankind.
I.H.✠S. In hac cruce salus, safety in this cross.
J.P. Justice of the Peace.
I.P.D. In præsentia Dominorum, in presence of the Lords.
K.B. Knight of the Bath.
K.C. Knight of the Crescent.
K.C.B. Knight Commander of the Bath.
K.C.G. Knight Commander of the Guelphs of Hanover.
K.G. Knight of the Garter.
K.P. Knight of St Patrick.
K.T. Knight of the Thistle.
Kt. or Knt. Knight.
L. or Lib. libra, a pound; or liber, a book.
L.B. or B.L. Bachelor of Law.
L.C.J. Lord Chief-Justice.
L.D. Lady day.
Ldp. Lordship.
LL.D. Legum doctor, Doctor of Laws.
L.S. Locus sigilli, the place of the seal.
M. Mille, a thousand.
M.B. or B.M. Bachelor of Medicine.
M.C. Member of the Congress.
M.D. Medicinæ doctor, Doctor of Medicine.
M.P. Member of Parliament.
M.R.I.A. Member of the Royal Irish Academy.
M.S. Memoriæ sacrum, sacred to the memory.
MS. Manuscript. MSS. Manuscripts.
Mus. D. Doctor of Music.
M.W.S. Member of the Wernerian Society.
N. North, note, or noon.
N.B. Nota bene, mark well.
Nem. con. or nem. diss. nemine contradicente, or nemine dissentiente, without opposition, unanimously.
No. Number.
N.P. Notary public.
N.S. New style.
O.S. Old style.
Oxon. Oxford.
Oz. Ounce.
Parl. Parliament.
P.C. Privy Councillor.
Ph. D. Doctor of Philosophy.
P.M. Post meridiem, afternoon.
P.S. Postscript.
q.d. Quasi dicet, as if he should say; quasi dictum, as if it were said.
Q.E.D. Quod erat demonstrandum, which was to be demonstrated.
Q.E.F. Quod erat faciendum, which was to be done.
Q.S. Quantum sufficit, a sufficient quantity.
Q.V. Quod vide, which see.
Rp. Recipe, take.
R.A. Royal Academy.
R.E. Royal Engineers.
Reg. Prof. Regius Professor.
Rev. Reverend.
R.M. Royal Marines.
R.N. Royal Navy.
Rt. Hon. Right Honourable.
Rt. Wpful. Right Worshipful.
S. South; or Solidus, a shilling.
St. Saint.
S.S.C. Solicitor of the Supreme Court.
S.T.P. Sacro-Sanctæ Theologiæ Professor, Professor of Divinity.
Ult. Ultimo, last month.
U.S. United States.
T.D. Theologiæ doctor, Doctor of Theology.
V.D.M. Minister of God's Word.
Viz. Videlicet, namely.
W. West.
W.S. Writer to the Signet.
Xmas. Christmas.
& et, and.
&c. et cætera, and so forth.

Abbreviations ‖ Abchasia.

ABBREVIATORS, a college of 72 persons in the chancery of Rome, who draw up the pope's brieves, and reduce petitions, when granted by him, into proper form for being converted into bulls.

ABBS, St, a promontory on the eastern coast of Scotland, Lat. 55. 55. N. Long. 2. 8. 30. W. The shore around is steep and rocky, and there is a depth of 30 or 40 fathoms water not far from land. The tide runs by it with a strong current, and a little wind causes a great rolling sea.

ABCHASIA, or Abasia, a province of Asiatic Russia, on the border of the Black Sea, comprehended between Lat. 42. 30. and 44. 45. N. and between Long. 37. 3. and 40. 36. E. The high mountains of the Caucasus on the north and north-east divide it from Circassia; on the south-east it is bounded by Mingrelia; and on the south and west by the Black Sea. The country is generally mountainous, with some deep well-watered valleys, and the climate mild, being defended from the northerly winds by the lofty range of mountains. The land is fertile, and produces grain, grapes, and other fruits. Some of the inhabitants devote themselves to agriculture, some to the rearing of cattle and horses, and not a few support themselves by piracy, robbery, and the chase. These people still carry on a considerable slave trade, selling even their children to the Turks for slaves. This country, as bordering on the ancient Colchis, was early known to the ancients; and the Abasci, at least as early as the time of Herodotus, (lib. iii. 97.), carried on a considerable slave trade, especially in beautiful boys, whom they sold for eunuchs. In later times this country was subject to Colchis, until subdued by the Emperor Justinian, who introduced civilisation and Christianity. Afterwards the Persians, Georgians, Mongolians, and more recently the Turks, in turn, ruled over the country. Under the Turks Christianity gradually disappeared, and Mahomedanism was introduced in its stead. By the treaty of Akerman in 1826, a part, and by the treaty of Adrianople the rest of this country was ceded to Russia; but except the possession of a few commanding fortresses on the coast, it has very little authority over the people, and the chiefs have almost unlimited power. Mahomedanism is the religion of the higher classes, but the people generally are buried in idolatry.

ABCHERON, or APCHERON, or APSHERON. See BAKU.

ABDALLA, the son of Abdulmotalleb, was the father of the prophet Mahomet. He was the most beautiful and modest of the Arabian youth. Several other Arabians of eminence bore the same name.

ABDALLATIF, or ABDOLLATIPH, a celebrated physician and traveller, and one of the most voluminous writers of the East, was born at Bagdad, in the 557th year of the Hegira, being the 1179th of the Christian era. Of the life of this learned person there has fortunately been preserved a memoir, written by himself, together with some additions by a contemporary biographer, named Osaiba. The whole of this curious piece has been translated into French, and published with a work of Abdallatif's, of which we shall afterwards give some account. Long before the period of his birth, the empire of the Caliphs had begun to decline; but their capital still continued to enjoy those advantages for education which it had originally derived from their liberal patronage of learning and science. Abdallatif was carefully instructed in every branch of knowledge then taught in that renowned city; and the biographical piece just alluded to is not a little interesting, from the glimpses it affords of the studies which engaged the attention of the more aspiring of the Mussulman youth.

After learning to read, the rules of grammar appear to have been studied with a degree of care and earnestness, which has not perhaps been equalled in any other country. With the study of grammar was joined that of the Koran and the traditionary doctrines, and the whole of the sacred book was carefully committed to memory. This faculty seems, indeed, to have been severely taxed; for it was also thought necessary to be able to repeat several treatises on grammar and jurisprudence, besides some of the choicer collections of Arabian poetry. In these arduous exercises, Abdallatif says that he was for a considerable time accustomed to pass the greater part of the night.

Having attained to great proficiency in the usual studies, he afterwards applied to the natural philosophy of that day, and to medicine; and with the view of still further improving himself by converse with the learned of other places, he set out, when in his twenty-eighth year, to Mosul in Mesopotamia. Having resided about a year in this city, he next proceeded to Damascus, then a place of great resort to the learned of the surrounding countries. Abdallatif found here many of the most eminent men of that age, part of whom were busied in the chimerical pursuits of the Hermetic art, and part in philological and speculative inquiries. He seems always to have entertained great contempt for the sort of chemistry then in vogue, but he entered with eagerness into speculative discussions; and he at this time composed a treatise upon the Divine essence and attributes, in consequence of some discussions with Alkendi, a philosopher of eminence, who was not, however, thought to be quite orthodox in his faith.



The active curiosity of Abdallatif was next directed to Egypt; and he accordingly proceeded to Acre, where its sultan, the great Saladin, was at the time encamped, in order to solicit his permission to visit that country. This monarch was a liberal protector of the learned, and fond of their conversation; but having been lately defeated by the crusaders under Richard Cœur de Lion, he was too much occupied with the cares consequent upon this disaster, to admit Abdallatif to the expected honour of a personal interview. He was, however, received in a courteous manner by the Vizier Al Fadhel, whom he found in his tent writing and dictating at the same time to two secretaries; employments which he continued whilst he conversed with his visitor upon sundry points of grammar and philology. Having obtained the necessary credentials from this minister, he proceeded to Cairo; and the munificence which Saladin and his courtiers extended towards the learned, was strikingly exemplified in his reception and treatment in that city. He was provided with a house, with provisions, and money; and the vizier seldom failed to recommend him anew, in those letters of business which he had occasion to write to the governor of the place.

Here Abdallatif enjoyed the long wished-for opportunity of conversing with that *Eagle of the Doctors*, as he was called, the celebrated Maimonides, who had been for a considerable time settled in Egypt, and was physician to the sultan. Here, too, he was fortunate enough to meet with a sage, who weaned him of his admiration for the writings of Avicenna, by pointing out the superior value of the ancients. But the philosophers of Grand Cairo were not all of this stamp; for some of them were pretenders to the transmutation of metals, and one boasted that his art enabled him to fabricate a tent of the waters of the Nile. Having passed a considerable time in making various observations and collections in this interesting city, Abdallatif set out for Jerusalem, on learning that he would there see Saladin, who had at length concluded a truce with the crusaders.

Saladin received him with every mark of respect for his talents, and bestowed upon him a pension. He was then busied in repairing the walls of the Holy City, himself, says Abdallatif, often carrying stones upon his shoulders, to animate the undertaking. But in spite of all his cares and projects, he daily conversed with the learned men whom his bounty had drawn around him. Abdallatif mentions, that when first introduced, he found him in the midst of a circle of this description; and he adds, that upon all the various subjects which were discussed, the sultan spoke with the most agreeable address, as well as ingenuity. From Jerusalem, Abdallatif returned to Damascus; and, after a considerable interval, a fresh opportunity having occurred of revisiting Egypt, he again proceeded to Cairo, where he taught medicine and philosophy for several years.

During this period, Egypt was visited with a terrible famine and pestilence, of which, and the horrors and crimes that ensued, he has given a most appalling description in the last two chapters of his Account of this country. Human nature was scarcely ever presented to observation under so hideous an aspect; the wretched Egyptians were driven, not only to feed upon the bodies of those who had fallen victims to want or disease, but to seize upon children, whom they killed and devoured; and Abdallatif asserts, that they thus came to acquire such a relish for those inhuman repasts, that they with difficulty refrained from them after the famine had subsided. It was likewise during his second stay in Egypt that he witnessed an insane attempt to pull down the Pyramids; a project to which the reigning sultan (a son of Saladin's, who, after his death, succeeded to this part of his dominions) had been instigated by some of his favourites, and in which he persisted for eight months, without being able to make any sensible impression upon these indestructible monuments of the ancient world.

About the year 1207, Abdallatif left Egypt for his former residence, Damascus; and here he for some time practised as a physician, and lectured upon medicine with great success. But his love of new scenes, and desire of extending his knowledge and fame, still urged him to travel; and he seems to have passed the rest of his life in Aleppo, and various parts of Armenia and Asia Minor, acquiring both wealth and glory by his abilities as a physician and an author. Having returned to his native city, purposing to present some of his works to the caliph, and then to set out on a pilgrimage to Mecca, he was seized with illness soon after his arrival, and died there in the year 1231.

He was undoubtedly a person of great knowledge, and of an ardent, inquisitive, and penetrating mind. According to his Arabian biographer, to whom he was well known, he showed himself, in conversation, somewhat vain of his own attainments; and was accustomed to speak rather scornfully of most of his contemporaries. But it ought to be mentioned, to the credit of his understanding, that his derision seems partly to have flowed from his contempt of those chemical fooleries to which they were so much addicted, that, to use the words of Gibbon, "the reason and the fortune of thousands were evaporated in the crucibles of Alchemy."

Of that long list of treatises on medicine, philosophy, and literature, which Osaiba has appended to the account of Abdallatif's life, one only has found its way into Europe; nor do any of the others appear to be known at this day in the East. The work here alluded to is his *Account of Egypt*, which was fortunately discovered and brought to this country by our celebrated orientalist Pococke. The manuscript, which is a very old one, is still preserved in the Bodleian Library. Of this work, an elegant edition, with a Latin translation, notes, and a life of Abdallatif, was published in 1800, by Dr White, professor of Arabic in the University of Oxford. A French translation, with enlarged notes, was published at Paris in 1810, by M. Silvestre de Sacy; and to this, among other valuable illustrations, is appended a translation from an Arabic manuscript, of the curious biographical memoir to which we have above alluded.

This account of Egypt consists of two books; the first of which, in six chapters, gives a general view of the country, of its plants, animals, antiquities, buildings, and modes of navigating on the Nile; and the second, in three chapters, treats at large of this river, and of that terrible famine already mentioned, which was occasioned by a failure in the usual annual increase of its waters. The book undoubtedly is, upon the whole, one of the most interesting productions which has come to us from the East; inasmuch as it presents us with a detailed and authentic view of the state of Egypt during the middle ages, and thus supplies a link which was wanting between the accounts of ancient and of modern times.

See *Abdollatiphi Historiæ Ægypti Compendium, Arabice et Latine*, Lond. 1800, 4to. *Relation de l'Egypte, par Abdallatif*, traduite par M. Silvestre de Sacy, de l'Institut de France. Paris, 1810, 4to.

ABDALMALEK, or ABDULMELECH, the son of Mirvan, and the fifth caliph of the race of the Ommiades. He surpassed all his predecessors in power and dominion; for in his reign the Indies were conquered in the east, and his armies penetrated Spain in the west: he likewise extended his empire toward the south, by making himself master of Medina and Mecca. Under his reign the Greek language and characters were excluded from the accounts of the public revenue. If this change, says Gibbon, was productive of the invention or familiar use of the Arabic or Indian ciphers, which are our present numerals, a regulation of office has promoted the most important discoveries of arithmetic, algebra, and the mathematical sciences. He began his reign in the 65th of the Hegira, A.D. 684; reigned 15 years; and four of his sons successively enjoyed the caliphate.

ABDALMALEK. See AVENZOAR.

ABDALONYMUS, or ABDOLONYMUS, in classic history, of the royal family of Sidon, and descended from King Cinyras, lived in obscurity, and subsisted by cultivating a garden, while Strato was in possession of the crown of Sidon. Alexander the Great having deposed Strato, inquired whether any of the race of Cinyras was living, that he might set him on the throne. It was generally thought that the whole race was extinct; but at last Abdalonymus was thought of, and mentioned to Alexander, who immediately ordered some of his soldiers to fetch him. They found the good man at work, happy in his poverty, and entirely a stranger to the noise of arms, with which all Asia was at that time disturbed; and they could scarcely persuade him they were in earnest. Alexander was convinced of his high descent by the dignity of his person; and not only bestowed on him all that belonged to Strato, but augmented his dominions, and gave him a large present out of the Persian spoils. This story is related variously by different authors. See *Q. Curtius*, iv. c. i.; *Justin*, xi. c. x.

ABDALS, in the eastern countries, a kind of fanatics supposed to be inspired to a degree of madness. The word is perhaps derived from the Arabic, *Abdallah*, the servant of God. Hurried on by excess of zeal, especially in the Indies, they often run about the streets, and kill all they meet who are of a different religion. The English sailors call this *running a muck*, from the name of the instrument, a sort of poniard, which they employ on those desperate occasions. If they are killed, as it commonly happens before they have done much mischief, they reckon it highly meritorious; and are esteemed, by the vulgar, martyrs for their faith.

ABDERA, in *Ancient Geography*, a maritime town of Thrace, not far from the mouth of the river Nessus, on the east side. The Abderites, or Abderitani, were very much derided for their want of wit and judgment: yet their city has given birth to several eminent persons; as Protagoras, Democritus, Anaxarchus, Hecatæus the historian, Nicænetus the poet, and many others, who were mentioned among the illustrious men. In the reign of Lysimachus, Abdera was afflicted for some months with a most extraordinary disease:[1] this was a burning fever, whose crisis was always on the seventh day, and then it left them; but it so distracted their imaginations, that they fancied themselves players. After this, they were ever repeating verses from some tragedy, and particularly from the 'Andromeda' of Euripides, as if they had been upon the stage; so that many of these pale meagre actors were pouring forth their tragic exclamations in every street. This delirium continued till the following winter, which was a very cold one, and therefore fitter to remove it. Lucian, who has described this disease, endeavours to account for it in this manner: Archelaus, an excellent player, acted the 'Andromeda' of Euripides before the Abderites, in the height of a very hot summer. Several fell into a fever on coming out of the theatre; and as their imaginations were full of the tragedy, the delirium which the fever raised perpetually presented Andromeda, Perseus with the Medusa, and the several dramatic incidents, calling up the ideas of those objects, and the pleasure of the representation, so strongly, that they could not forbear imi-

[1] Lucianus, *quomodo Historia conscribenda sit, initio.*

tating Archelaus's action and declamation: and from these the fever spread to others by infection.

ABDERAHMAN, a Saracen viceroy in Spain, who revolted and formed an independent principality at Cordova. He had several successors of the same name. The first Abderahman, in the year 756, became Moorish sovereign of Spain, whither he had fled on the ruin of his family, in the battle of the Zab. He was born at Baghdad, and was a grandson of one of the Ommiad caliphs. A viceroy and captain-general of this name led the Saracens and their followers into France, ravaging the country wherever they came. At length he was met at Tours by Charles Martel, who had received reinforcements of Germans and Gepidæ. The Saracen army was totally routed in a general action, and Abderahman fell in the general slaughter, which the Monkish writers reckon at the exaggerated number of 370,000. This great event, which first broke the power of the Saracens, happened about the year 732 of the Christian era.

Abderahman III., the most eminent and accomplished of the Moorish sovereigns of Spain. See Spain.

ABDEST, a Persian word, properly signifying the water placed in a basin for washing the hands; but it is used to imply the legal purifications practised by the Mahometans before prayer, entering the mosque, or reading the Koran.

ABDIAS of Babylon, the supposititious author of a book, setting forth that he had seen Christ, that he was one of the 70 disciples, had been eye-witness of the actions and prayers of several of the apostles at their deaths, and had followed into Persia St Simon and St Jude, who, he said, made him the first bishop of Babylon. This book, entitled *Historia Certaminis Apostolici*, was published by Wolfgang Lazius, at Basil, 1551; and has passed through several editions in other places.

ABDICATION, properly speaking, is the act whereby a person renounces and gives up any right, office, or dignity, particularly the supreme power. By a nice distinction, abdication is supposed to differ from resignation, and to imply an unconditional surrender; whereas by resignation is meant relinquishment, as a free and voluntary act, usually in favour of another: but this distinction is rather conventional than real, and of so little practical utility, that many abdications have been called voluntary, while in fact they were the result of necessity, or of court intrigue. The flight of a sovereign from his dominions has usually been styled an abdication, which, although the act be virtually such, is a meaning not strictly proper, as nullifying its true sense of renunciation.

Since the Revolution of 1688, the throne of England can only lawfully be abdicated with consent of the two houses of Parliament; but by precedent it is established, that by actions subversive of the constitution, the sovereign virtually renounces the authority which he claims by that very constitution. The flight of James II. was declared by Parliament to be an abdication; and the power that could unmake a king, might easily invest a word with a new signification; for in a full assembly of the lords and commons, met in convention upon the supposed vacancy of the throne, both houses, in spite of James's protest, came to this resolution, "that King James the Second having endeavoured to subvert the constitution of the kingdom, by breaking the original contract between king and people; and, by the advice of Jesuits and other wicked persons having violated the fundamental laws, and having withdrawn himself out of this kingdom, has abdicated the government, and that the throne is thereby vacant." See *Blackstone's Commentaries*, vol. i. p. 211; vol. iv. p. 78.

The Roman magistrates were said "to abdicate," when, from informality in the auspices, *utpote vitiosi*, or for any other reason, they quitted their office before the usual term had expired. Abdication was also used for the act whereby a father discarded or disclaimed his son, and expelled him from the family. See Rubino, *Römische Staatsverfassung*, p. 88.

Among the most memorable abdications of antiquity may be especially mentioned, that of Sylla the dictator, B. C. 79; and that of the Emperor Diocletian, the fierce persecutor of the Christians, A.D. 305. The following are the most important abdications of later times in chronological order:—

| | A.D. |
|---|---|
| Henry IV. of Germany, | 1080 |
| Stephen II. of Hungary, | 1114 |
| Albert of Saxony, | 1142 |
| Lestus V. of Poland, | 1200 |
| Vladislaus III. of Poland, | 1206 |
| Baliol of Scotland, | 1306 |
| Otho of Hungary, | 1309 |
| Eric IX. of Denmark, | 1439 |
| Eric XIII. of Sweden, | 1441 |
| Emperor Charles V., | 1556 |
| Christina of Sweden, | 1654 |
| John Casimir of Poland, | 1669 |
| James II. of England, | 1688 |
| Frederick Augustus II. of Poland, | 1704 |
| Philip V. of Spain, | 1724 |
| Victor Amadeus II. of Sardinia, | 1730 |
| Charles of Naples, | 1795 |
| Stanislaus of Poland, | 1795 |
| Victor of Sardinia, | June 4, 1802 |
| Charles IV. of Spain, | Mar. 19, 1808 |
| Joseph Buonaparte of Naples, | June 1, 1808 |
| Napoleon of France, | April 5, 1814 |
| Victor Emanuel of Sardinia, | Mar. 13, 1821 |
| Pedro of Portugal, | May 2, 1826 |
| Charles X. of France, | Aug. 2, 1830 |
| Pedro of Brazil, | April 7, 1831 |
| Don Miguel of Portugal, | May 26, 1834 |
| William I. of Holland, | Oct. 8, 1840 |
| Louis Philippe of France, | Feb. 24, 1848 |
| Louis Charles of Bavaria, | Mar. 21, 1848 |
| Ferdinand of Austria, | Dec. 2, 1848 |
| Charles Albert of Sardinia, | Mar. 26, 1849 |

ABDOMEN, in *Anatomy*, is that part of the trunk of the body which lies between the thorax and the bottom of the pelvis.

ABDOMINALES, or Abdominal Fishes, constitute the Fourth Order of the *Fourth Class* of Animals, in the Linnæan system.

ABDON, (*a servant*,) the son of Hillel, of the tribe of Ephraim, and tenth judge of Israel. He died B.C. 1112. See Judges xii. Three other persons of the same name are mentioned in 1 Chron. viii. 29; ix. 36; xxxiv. 20.

Abdon, a city of the tribe of Asher, which was given to the Levites of Gershom's family. See Job xxi. 30; 1 Chron. vi. 74.

ABDUCTION, in *Law*, is the forcible or fraudulent removal of a person. Custom has limited its general application to the case where a woman is the victim, with the view of her marriage or seduction. The forcible carrying off a woman constituted the *crimen raptus* of the Roman law, and was a capital offence, though unattended with violation of the person of the woman. In the case of men or children, it has been usual to substitute the term kidnapping. There are many old severe laws against abduction, generally contemplating its object as the possession of an heiress and her fortune. The offence was frequent at a comparatively late period in Scotland and in Ireland, an account of the feebleness of the law and the geographical facilities of these countries, and severe laws were directed against it in vain. So late as the Act of 10 Geo. IV. c. 34, in Ireland it was made punishable with death; but by 5 and 6 Vict. c. 28, § 16, this is reduced to transportation, the punishment which had been assigned to it in England fourteen years earlier, by Sir Robert Peel's Consolidation Act, 9 Geo. IV. c. 31. In Scotland, where there is no statutory adjustment, a similar punishment has been awarded by practice.

Abduction, in *Logic*, a kind of argumentation, by the Greeks called *apagoge*, wherein the greater extreme is evidently contained in the medium, but the medium not so evidently in the lesser extreme as not to require some farther medium or proof to make it appear. It is called *abduction*, because, from the conclusion, it draws us on to prove the proposition assumed.

ABDUCTOR, or Abducent, in *Anatomy*, a name given to several of the muscles, on account of their serving to withdraw, open, or pull back the parts to which they belong.

ABEDNEGO, *i.e.* servant of Nego or Nebo, the Chaldee name imposed by the king of Babylon's officer upon Azariah, one of the three companions of Daniel.

ABEL, properly Hebel, which means *grief*, the second son of Adam, who was slain by Cain his elder brother, (Gen. iv. 1-16,) while engaged in offering sacrifice, God having testified his acceptance of that of Abel, and his rejection of Cain's. Abel, it appears, brought two offerings, the one an oblation, the other a sacrifice. Cain brought but the former, a mere acknowledgment, it is supposed, of the sovereignty of God, neglecting to offer the sacrifice which would have been a confession of fallen nature, and typically an atonement for sin; it was not therefore the mere difference of feeling with which the two offerings were brought, which constituted the virtue of the one or the guilt of the other. God's righteous indignation against sin had been plainly revealed, and there can be no doubt that the means of safety, of reconciliation and atonement, were as plainly made known to Adam and his offspring; the refusal therefore of the sacrifice was a virtual denial of God's right to condemn the sinner, and at the same time a proud rejection of the proffered means of grace.

In ancient times heretics existed who represented Cain and Abel as embodying two spiritual powers, of which the mightier was that of Cain, and to which they accordingly rendered divine homage.

An obscure sect arose in the early church under the title of Abelites, which inculcated certain fanatical notions respecting marriage; but it was speedily lost amidst a host of more popular parties. See Abelians.

*Abel* is likewise employed as a prefix to the names of places, seemingly indicating their verdant appearance: thus in Scripture we read of Abel-Beth-Maacah, Abel-Carmaim, Abel-Shittim, &c.

Abel, *Carl Frederich*, a celebrated German musician, a pupil of Sebastian Bach, and highly praised by Burney for his adagio compositions in the age preceding Mozart, Haydn, Beethoven. He died in 1787.

Abel, *Niels Henri*, an eminent mathematician of Norway, who was born at Christiania in 1802, and died of consumption in 1829. His works, which were published by the Norwegian government in two 4to volumes in 1839, give the unfortunate author a high place among the mathematicians of his age.

Abel, *Thomas*. See Able.

ABELARD, Peter, an eminent scholastic philosopher of France, of noble descent, was born at Palais near Nantes in Bretagne, in the year 1079. Devoted to letters by his father's appointment, and by his own inclination, his literary attainments could at this time only be exhibited in the field of scholastic philosophy; and, that he might be fitted for his destined career of life, he was placed, after a previous course of grammatical studies, under the tuition of Rosceline, a celebrated metaphysician, and founder of the sect of the Nominalists. Under the instructions of this able master, at the early age of sixteen, he furnished himself with a large store of scholastic knowledge, and acquired a subtilty and quickness of thought, a fluency of speech, and facility of expression, which were necessary qualifications in scholastic disputation.





Having spent some time in visiting the schools of several provinces, in the twentieth year of his age he fixed his residence in the university of Paris, then the first seat of learning in Europe. The master, William de Champeaux, was at that time in high repute for his knowledge of philosophy, and his skill in the dialectic art; to him he committed the direction of his studies, and was at first contented with receiving instruction from so eminent a preceptor. De Champeaux was proud of the talents of his pupil, and admitted him to his friendship. But the aspiring youth ventured to contradict the opinions of his master, and in the public school held disputations with him, in which he was frequently victorious. The jealousy of the master and the vanity of the pupil naturally occasioned a speedy separation.

Elated by success, and confident of his own powers, Abelard, without hesitation, at the age of twenty-two, opened a public school of his own. Melun, a town ten leagues from Paris, where the court frequently resided, was the place which he chose for this bold display of his talents. But it was not without considerable difficulty that Abelard executed his plan; for De Champeaux, who regarded him as a rival, openly employed all his interest against him. Abelard at length prevailed, his school was opened, and his lectures were attended by crowded and admiring auditories. Emboldened by this success, and perhaps stimulated by unworthy resentment, Abelard resolved to maintain an open contest with his master, and for this purpose removed his school to Corbeil near Paris. The disputants frequently met in each other's schools; and the contest was supported on each side with great spirit, amidst crowds of their respective scholars. The young champion was in the end victorious, and his antagonist was obliged to retire.

Constant application and violent exertions had now so far impaired Abelard's health, that it was become necessary for him to interrupt his labours; and, with the advice of his physician, he withdrew to his native country. Two years afterwards, he returned to Corbeil, and found that De Champeaux had taken the monastic habit among the regular canons in the convent of St Victor; but that he still continued to teach rhetoric and logic, and to hold public disputations in theology. Returning to the charge, he renewed the contest, and his opponent was obliged to acknowledge himself defeated. The scholars of De Champeaux deserted him, and went over in crowds to Abelard. Even the new professor, who had taken the former school of De Champeaux, voluntarily surrendered the chair to the young philosopher, and requested to be enrolled among his disciples. A triumph so complete, while it gratified the vanity of Abelard, could not fail to provoke the resentment of his old master, who had influence to obtain the appointment of a new professor, and drive Abelard back to Melun. De Champeaux's motive for this violent proceeding was soon perceived; even his friends were ashamed of his conduct; and he retired from the convent into the country. When Abelard was informed of the flight of his adversary, he returned towards Paris, and took a new station at the abbey on Mount St Genevieve. His rival, the new professor, was unequal to the contest, and was soon deserted by his pupils, who flocked to the lectures of Abelard. De Champeaux, too, returning to his monastery, renewed the struggle; but so unsuccessfully, that Abelard was again victorious.

During a short absence, in which Abelard visited his native place, De Champeaux was preferred to the see of Chalons. The long and singular contest between these philosophers terminated; and Abelard, perhaps for want of a rival to stimulate his exertions, or possibly through envy of the good fortune of his rival, determined to exchange the study and profession of philosophy for that of theology. He therefore quitted his school at St Genevieve, and removed to Laon, to become a scholar of Anselm. From this celebrated master he entertained high expectations; but they were soon disappointed. On attending his lectures, he found that, though he possessed uncommon fluency of language, he left his auditors without instruction. Abelard gradually retired from these unprofitable lectures, but without offering offence either to the veteran professor or his scholars. In conversation one of them asked him, what he thought of the study of the Scriptures? Abelard replied that he thought the explanation of them a task of no great difficulty; and to prove his assertion, he undertook to give a comment, the next day, upon any part of the Scriptures they should mention. They fixed upon the beginning of the prophecy of Ezekiel; and the next morning he explained the passage in a theological lecture, which was heard with admiration. For several successive days, the lectures were, at the request of the audience, continued; the whole town pressed to hear them; and the name of Abelard was echoed through the streets of Laon. Anselm, jealous of the rising fame of this young theologian, prohibited his lectures, under the pretence that so young a lecturer might fall into mistakes, which would bring discredit upon his master. Abelard, whose ambition required a wider field than that of Laon, obeyed the prohibition, and withdrew. He returned to Paris, whither the fame of his theological talents had arrived before him, and opened his school with his lectures on the prophecy of Ezekiel. His auditors were delighted; his school was crowded with scholars; and he united in his lectures the sciences of theology and philosophy with so much success, that multitudes repaired to him from various parts of France, from Spain, Italy, Germany, Flanders, and Great Britain.

Hitherto Abelard has appeared with high distinction, as an able disputant, and a popular preceptor: we must now view him under a different character, and when nearly arrived at the sober age of forty, see him, on a sudden, exchanging the school of philosophy for the bower of pleasure, and even disgracing himself, as will too plainly appear in the sequel, by forming and executing a deliberate plan for the seduction of female innocence. It happened that there was at this time, resident in Paris, Heloise, the niece of Fulbert, one of the canons of the cathedral church, a lady about eighteen years of age, of great personal beauty, and highly celebrated for her literary attainments. Abelard, whose vanity had been satiated with fame, and the vigour of whose mind was now enervated by repose, found himself inclined to listen to the voice of passion. He beheld with ardent admiration the lovely Heloise, and confident that his personal attractions were still irresistible, he determined to captivate her affections. Fulbert, who doubtless thought himself honoured by the visits of so eminent a scholar and philosopher, received him into his house as a learned friend. He was soon afterwards prevailed upon, by a handsome payment which Abelard offered for his board, to admit him into his family; and, apprehending no hazard from a man of Abelard's age and profession, requested him to undertake the instruction of Heloise. Abelard accepted the trust, but, as it seems, without any other intention than to betray it. The hours of instruction were employed in other lessons than those of learning and philosophy; but Fulbert's respectful opinion of the philosopher, and his partiality for his niece, long concealed from him an amour, which was become the subject of general conversation. Upon discovering her pregnancy, it was thought necessary for her to quit her uncle's house; and Abelard conveyed her to Bretagne, where his sister was prepared to receive them. Here Heloise was delivered of a son, to whom they gave the whimsical name of Astrolabus. Abelard, upon the birth of the child, proposed to Fulbert to marry his niece, provided the marriage might be kept secret: Fulbert consented, and Abelard returned to Bretagne to fulfil his engagement. Heloise, partly out of regard to the honour of Abelard, whose profession bound him to celibacy, and partly from a romantic notion that love like hers ought not to submit to ordinary restraints, at first gave Abelard a peremptory refusal. He, however, at last prevailed, and they were privately married at Paris. Heloise from this time met with severe treatment from her uncle, which furnished Abelard with a plea for removing her from his house, and placing her in the abbey of Benedictine nuns, in which she had been educated. Fulbert concluded, perhaps not without reason, that Abelard had taken this step, in order to rid himself of an encumbrance which obstructed his future prospects. Deep resentment took possession of his soul, and he meditated revenge. He employed several ruffians to enter his chamber by night, and inflict upon his person a disgraceful and cruel mutilation. The deed was perpetrated; the ruffians were taken, and suffered, according to the *Lex Talionis*, the punishment they had inflicted; and Fulbert, for his savage revenge, was deprived of his benefice, and his goods were confiscated. Unable to support his mortifying reflections, Abelard resolved to retire to a convent. At the same time he formed the selfish resolution, that, since Heloise could no longer be his, she should never be another's, and ungenerously demanded from her a promise to devote herself to religion; and even insisted upon her taking the holy vow before him, suspecting, as it seems, that if he first engaged himself, she might violate her promise, and return to the world.

A few days after Heloise had taken her vows, Abelard assumed the monastic habit in the abbey of St Denys, determined, as it seems, to forget, in hope of being forgotten by the world. However, his admirers and scholars in Paris were unwilling that the world should lose the benefit of his labours, and sent deputies to entreat him to return to his school. After some deliberation, he again yielded to the call of ambition; and at a small village in the country, he resumed his lectures, and soon found himself surrounded with a numerous train of scholars. The revival of his popularity renewed the jealousy of other professors, who took the first opportunity of bringing him under ecclesiastical censure. A treatise which he published at this time, entitled, *The Theology of Abelard*, was supposed to contain some heretical tenets. A synod was called at Soissons in the year 1121; the work was condemned to be burnt, and Abelard was commanded to throw it into the flames. After being involved in other controversies, new charges were brought against him, and he fled to the convent of St Ayoul at Provins in Champagne, the prior of which was his intimate friend. The place of his retreat was soon discovered, and threats and persuasions were in vain employed to recal him: at last he obtained permission to retire to some solitary retreat, on condition that he should never again become a member of a convent.

The spot which he chose was a vale in the forest of Champagne, near Nogent upon the Seine. Here Abelard, in 1122, erected a small oratory, which he dedicated to the Trinity, and which he afterwards enlarged, and consecrated to the Third Person, the Comforter, or Paraclete. Here he was soon discovered, and followed by a train of scholars. A rustic college arose in the forest, and the number of his pupils soon increased to six hundred. Jealousy again provoked the exertions of his enemies, and he was meditating his escape, when, through the interest of the duke of Bretagne, and with the consent of the abbot of St Denys, he was elected superior of the monastery of St Gildas, in the diocese of Vannes, where, though not without frequent and grievous vexations, he remained several years.

About this time, Suger, the abbot of St Denys, on the

Abelard.

plea of an ancient right, obtained a grant for annexing the convent of Argenteuil, of which Heloise was now prioress, to St Denys; and the nuns, who were accused of irregular practices, were dispersed. Abelard, informed of the distressed situation of Heloise, invited her, with her companions, eight in number, to take possession of the Paraclete.

It was during Abelard's residence at St Gildas that the interesting correspondence passed between him and Heloise, which is still extant. The letters of Heloise, in this correspondence, abound with proofs of genius, learning, and taste, which might have graced a better age. Upon these letters Pope formed his celebrated Epistle from Eloisa to Abelard. Here, too, Abelard probably wrote his *Theology*, which again subjected him to persecution. His opinions were pronounced heretical by a council; and although he appealed to Rome, the judgment of the council was confirmed by the pope; and he was sentenced, unheard, to perpetual silence and imprisonment. By the interposition of some friends, however, and by a submissive apology, he obtained his pardon, with permission to end his days in the monastery of Cluny.

At Cluny he was retired, studious, and devout. The monks of the convent importuned him to resume his instructions. In a few occasional efforts he complied with their solicitations; and his lectures were heard with undiminished applause. But his health and spirits were much enfeebled, and gradually declined till he died, in the 63d year of his age, on the 21st of April 1142. His body was sent to Heloise to be interred in the convent of the Paraclete. Heloise survived her husband 21 years, a pattern of conjugal affection and monastic virtue; and was buried in the same grave. An elegant Gothic monument to their memory, constructed out of the ruins of the abbey of the Paraclete, forms one of the most interesting objects in the cemetery of Père la Chaise.

The writings of Abelard do not give a high idea of his genius or taste; but it cannot be questioned, that the man who could foil the first masters of the age at the weapons of logic, draw round him crowded and admiring auditors, and collect scholars from different provinces and countries wherever he chose to form a school, must have possessed extraordinary talents. Had his love of truth been equal to his thirst of fame, and his courage in adhering to his principles equal to his ingenuity in defending them, his sufferings and persecutions might have excited more regret, and his title to honourable remembrance would have been better established.

His principal works, written in Latin, are, An Address to the Paraclete on the Study of the Scriptures; Problems and Solutions; Sermons on the Festivals; A Treatise against Heresies; An exposition of the Lord's Prayer; A Commentary on the Romans; A System of Theology; and his Letters to Heloise and to others. Of some of those letters, and the answers, there are translations in Berrington's *History of the Lives of Abelard and Heloise.* Besides these, there was published for the first time, from ancient MSS., by M. V. Cousin, in 1836, a quarto volume, entitled "*Ouvrages inédits d'Abélard,*" containing, with some smaller pieces, his celebrated treatise, *Sic et Non*, and his Dialectics. The most perfect edition of the complete works of Abelard is from the same eminent hand, Paris, 4to, 1849–50.

ABELIANS, Abelites, or Abelonians, in *Church History*, a sect of heretics mentioned by St Augustin, which pretended to follow the example of Abel; who, they alleged, had died without ever having known his wife.

ABELLA, now Avella, anciently a town of Campania, near the river Clanius. The inhabitants were called Abellani, and said to have been a colony of Chalcidians. The nux Avellana, called also *Prænestina*, or the *hazel-nut*, takes its name from this town, according to Macrobius.

ABELLINUM. See Avellino.

ABELLIO, a name of Apollo, from Ἀβέλιος, his name in Crete and elsewhere.

ABENBERG, chief town of the district of the same name in Bavaria, about 16 miles S.S.W. of Nuremberg. It has a population of 1100, and manufactories of lace and needles.

ABEN-BITAR (Abdalla ben Ahmed), a celebrated naturalist and physician of Spain, who wrote a very useful work on all the herbs, animals, minerals, &c. used in medicine. He died at Damascus A.D. 1248.

ABENCERRAGES, and Zegris, the names of two noble families, frequently mentioned by the Spanish chroniclers and romance writers. See *Guerras Civiles de Granada* by Guies Perez de Hyta, part of which has been translated by T. Rodd; and Conde's *Hist. de la Dominacion de los Arabes en Espagna*, vol. iii.

ABEN-EZRA, Abraham, a celebrated rabbi, born at Toledo in Spain, called by the Jews the wise, great, and admirable Doctor, was a very able interpreter of the Holy Scriptures; and was well skilled in grammar, poetry, philosophy, astronomy, and medicine. He was also a perfect master of the Arabic. His principal work, *Commentaries on the Old Testament*, is printed in Bomberg's and Buxtorf's Hebrew Bibles, and is much esteemed. His style is clear, elegant, and concise: he almost always adheres to the literal sense, and everywhere gives proof of his genius and good sense. The scarcest of all his books is entitled *Jesud Mora*, which is a theological work, intended as an exhortation to the study of the Talmud. He also wrote *Elegantiæ Grammaticæ*, printed in octavo at Venice in 1548. He died in 1194, aged 75, or, according to De Rossi, in 1168.

ABENHEIM, a market town in the bailiwick of Alzey, and province of the Rhine, in the grand duchy of Hesse Darmstadt, with 940 inhabitants, who make excellent wine.

ABENMELECH, Solomon, a learned rabbi, a native of Spain, who flourished in the sixteenth century. He wrote Scholia on the whole of the Old Testament, in which he has interspersed the best of Kimchi's grammatical observations. His Commentaries are inserted in the Biblia Rabbinica, Ven. 1518.

ABENSBERG, a small city, capital of the bailiwick of the same name, in the circle of Regen in Bavaria, containing, in 1847, 254 houses and 1200 inhabitants. It was formerly the seat of the Counts Abenberg. Here Napoleon defeated the Austrians in a great battle on the 20th of April 1809. It is the Abusina of the Romans; and ancient ruins exist in its neighbourhood.

ABENSPERG, a small town of Germany, in the kingdom of Bavaria, and in the government of Munich. It is seated on the river Abentz, near the Danube. Long. 11. 38. E. Lat. 48. 45. N.

ABERAVON, a borough town of Glamorganshire, in Wales, at the mouth of the Avon, 192 miles west of London. Long. 3. 35. W. Lat. 51. 40. N. Until lately, Aberavon was a mere village; but has recently increased rapidly, from the extension of the mines of coal and iron in its vicinity, and the establishment of extensive works for the smelting of copper and zinc. At Port Talbot, about a mile distant, is an excellent float dock, much frequented by numerous coasting vessels. It unites with Swansea in returning a member to parliament. Pop. in 1841, 3665; in 1851, 6567.

ABERBROTHICK. See Arbroath.

ABERCONWAY, or Conway, a town of Caernarvonshire in North Wales, at the mouth of the Conway, as its name implies. It is finely situate on a steep slope, and is entirely enclosed by its lofty old walls of more than a mile in circuit, forming a triangle, and fenced with 24 round towers. It is a fine example of the style of fortification in

Abercrombie. the reign of Edward I.; and contains some curious half-timber houses of Elizabeth's time, with the ruins of a Cistertian priory, and other objects of interest. The castle, which exhibits very extensive ruins, was built in 1284 by Edward I., and must have been one of the noblest fortresses in Britain. An elegant suspension-bridge across the river (constructed by Telford), was opened in 1826; and the tubular bridge by Stevenson, the first of its kind, for the Chester and Holyhead Railway, was completed in 1848. The population in 1851 was 2105, chiefly occupied in the coasting trade and in ship-building. The pearl-mussel fishery which subsisted for a long period has been lately abandoned. It is one of the contributory boroughs to Caernarvon in returning a member to parliament. Distance from London, 224 miles. It is the ancient *Conovium.*

ABERCROMBIE, John, M.D., an eminent physician of Edinburgh, and most estimable man, was the son of the Rev. George Abercrombie of Aberdeen; in which city he was born in 1780.

Young Abercrombie received his elementary education at the grammar school of his native place, and his literary and philosophical education in Marischal College; but his medical studies were commenced at Edinburgh in 1800; where, after the usual academical curriculum, he obtained his degree of M.D. in 1803. Soon afterwards he went to London, and for about a year gave diligent attention to the medical practice and lectures in St George's Hospital. In 1804, Dr Abercrombie returned to Edinburgh, became a Fellow of the College of Surgeons, and commenced as general practitioner in that city; where, in dispensary and private practice, he laid the foundation of that character for sagacity as an observer of disease, and judgment in its treatment, that eventually elevated him to the head of his profession. He early began the laudable practice of preserving accurate notes of the cases that fell under his care; and at a period when pathological anatomy was far too little regarded by practitioners in this country, Abercrombie had the merit of sedulously pursuing it, and collecting a body of most important facts on the changes produced by disease on different organs; so that, before the year 1824, he had more extended experience, and more correct views in this interesting field, than most of his contemporaries engaged in extensive practice. From 1816 to 1824, he occasionally enriched the pages of the *Edinburgh Medical and Surgical Journal* with various essays, that display originality and industry, particularly those "on the diseases of the spinal cord and brain," and "on diseases of the intestinal canal, of the pancreas, and spleen." The first of these subjects formed the basis of his great and very original *Pathological and Practical Researches on Diseases of the Brain and Spinal Cord*, which appeared at Edinburgh in 1828, and a second edition in 1830. This work is illustrated by interesting cases, and the admirable observations of the author. Besides these works, he contributed to the Journal "An Essay on the Pathology of Consumptive Diseases," "Observations on Ischuria Renalis;" and to the *Transactions of the Edinburgh Medico-Chirurgical Society* a valuable paper "on Diseases of the Heart."

In 1823, he had become a Licentiate of the College of Physicians; in 1824 a fellow of that body; and from the death of Dr Gregory in 1822, Dr Abercrombie was considered as the first physician in Scotland. His practice was very extensive and lucrative; yet he found time for other speculations and occupations. In 1830, he published his *Inquiries concerning the Intellectual Powers of Man, and the Investigation of Truth.* This work, though far less original and profound than his medical speculations, contains a popular view of an interesting subject, and was very extensively read, from the simplicity of diction, and integrity of purpose. It was followed in 1833 by his *Philosophy of the Moral Feelings*, a sequel to the former, the object of which, as stated in the preface, "was to divest the subject of all improbable speculations," and to shew "the important relation which subsists between the science of mind and the doctrines of revealed religion." Though less profound even than the last, soon after its publication, the University of Oxford conferred on the author the honorary degree of *Doctor* of Medicine; and in 1833 his first *alma mater* elected him its *Lord Rector.*

Abercromby.

Dr Abercrombie continued in good health until 1841, when he suffered from an alarming irregularity in the circulation of his brain, which induced him to consider it as the forerunner of paralysis, for which he insisted on being profusely bled. This was followed by extreme debility, approaching to syncope; but he eventually recovered, after about a fortnight's illness, and continued his professional duties, until the 14th November 1844; when he was found on the floor of his room in a state of insensibility, and almost immediately expired. The examination of his body showed that the immediate cause of his death was a very uncommon disease of the *heart*—softening of its muscular substance, which induced a separation of the fibres of the left ventricle, with laceration of the coronary vessels, by which the pericardium was filled with blood.

In private life, Dr Abercrombie was much beloved by numerous friends, for the suavity and kindness of his manners, and esteemed by all for his well-directed talents and unaffected piety. (T. S. T.)

ABERCROMBY, The Honourable Alexander (Lord Abercromby), a Judge in the Courts of Session and Justiciary in Scotland, was the youngest son of George Abercromby of Tullibody, Esq., of a respectable family in Clackmannanshire, and was born on the 15th October 1745. Mr Abercromby was early destined for the profession of the law, and with this view he was educated at the university of Edinburgh, where he passed through the requisite course of languages, philosophy, and law, and was admitted advocate in the year 1766. In 1780 he resigned the office of sheriff-depute of Stirlingshire, which he had held for several years, and accepted that of depute-advocate, with the hope of extending his employment in the line of his profession. In this step he was not disappointed; for his reputation and business rapidly increased, and soon raised him to the first rank at the Scottish bar. But he still retained a taste for the elegant amusements of polite literature, and was one of that society who set on foot two periodical papers, the *Mirror* and *Lounger*, published at Edinburgh; the former in 1779, and the latter in 1785. To the *Mirror* he contributed ten papers, and to the *Lounger* nine. The names of the authors have been published in the late editions of these works, which renders it unnecessary to point out those papers of which Mr Abercromby was the author. In May 1792, he was appointed one of the Judges of the Court of Session, and in December following he was called to a seat in the Court of Justiciary. Lord Abercromby continued to discharge the arduous duties of these important offices till summer 1795, when he was seized with a pectoral complaint, of which he died on the 17th November the same year, at Exmouth in Devonshire, where he had gone for the recovery of his health.

Abercromby, *Sir Ralph*, knight of the Bath, and a lieutenant-general in the British army, an elder brother of the preceding, was born in the year 1738. Being destined for the army, he obtained, in May 1756, a cornet's commission in the 2d dragoon guards; and rose, April 24. 1762, to the rank of a captain in the 3d regiment of horse. Ascending through the intermediate gradations of rank, he was appointed, November 3. 1781, to the colonelcy of the 103d infantry. September 28. 1787, he was promoted to the rank of major-general. November 5. 1795 he obtained the command of the 7th regiment of dragoons. Having been nearly 40 years in the army, having served with honour in two wars, and being esteemed one of the ablest, coolest, and most intrepid officers in the whole British forces, he was employed on the continent under his Royal Highness the Duke of York, in the commencement of the war against the French republic. In the action on the heights of Cateau, he commanded the advanced guard, and was wounded at Nimeguen. He conducted the march of the guards from Deventer to Oldensal, in the retreat of the British out of Holland, in the winter of 1794–5. In August 1795, he was appointed to succeed Sir Charles Grey, as commander-in-chief of the British forces in the West Indies. March 24. 1796, Grenada was suddenly attacked and taken by a detachment of the army under his orders. He afterwards obtained possession of the settlements of Demerara and Essequibo, in South America. St Lucia was next taken by more difficult exertions, in which his ability was signally displayed. St Vincent was, by the middle of June, added to the British conquests. Trinidad, in February 1797, shared the same fate. He returned the same year to Europe, and, in reward for such important services, was invested with the red ribbon, appointed to the command of the regiment of Scots Greys, intrusted with the governments of the Isle of Wight, Fort George, and Fort Augustus, and raised to the rank of lieutenant-general. He held, for a time, the chief command of the forces in Ireland. In that command, he laboured to maintain the discipline of the army, to suppress the rising rebellion, and to protect the people from military oppression, with a care worthy alike of the great general and the enlightened and beneficent statesman. When Sir Ralph was appointed to the command in Ireland, an invasion of that country by the French was confidently anticipated by the English Government. He used his utmost efforts to restore the discipline of an army that was utterly disorganized; and, as a first step, he anxiously endeavoured to protect the people, by re-establishing the supremacy of the civil power, and not allowing the military to be called out, except when it was indispensably necessary for the enforcement of the law and the maintenance of order. Finding that he received no adequate support from the head of the Irish Government, and that all his efforts were thwarted and opposed by those who presided in the councils of Ireland, he resigned the command. His departure from Ireland was deeply lamented by all the reflecting portion of the people, and was speedily followed by those disastrous results which he had anticipated, and which he so ardently desired to prevent.

It is known that in after life there was no part of his public conduct on which he reflected with such entire satisfaction as on those efforts which he made to protect the country from the threatened invasion. From Ireland he was called to the chief command of the forces in Scotland. When the enterprise against Holland was resolved upon, Sir Ralph Abercromby was called again to command, under his Royal Highness the Duke of York. The difficulties of the ground, the inclemency of the season, delays, though inconvenient, yet unavoidable, the disorderly movements of the Russians, and the timid duplicity of the Dutch, disappointed our hopes of that expedition. But by the Dutch, the French, the British, it was confessed, that even victory the most decisive could not have more conspicuously proved the talents of this distinguished officer. His country applauded the choice, when, in 1801, he was sent with an army to dispossess the French of Egypt. His experience in Holland and Flanders, and in the climate of the West Indies, particularly fitted him for this new command. He accomplished some of the first duties of a general, in carrying his army in health, in spirits, and with the requisite intelligence and supplies, to the destined scene of action. The landing in Egypt may be justly ranked among the most daring and brilliant exploits of the English army. The incidental capture of two English officers, who were reconnoitering the camp, indicated the point at which the attempt to land would be made. The French prepared to meet it with a body of 2000 infantry, a detachment of cavalry, and 15 pieces of artillery. The Turks were exposed to the concentrated fire of the enemy, while they were transported for a considerable distance in open boats to the coast. When they reached the shore, they had to land and form in the face of an enemy prepared to meet them, and with the additional disadvantage of sinking deep at each step in the loose sand. Sir Ralph was not discouraged by these severe difficulties, because he had been fully apprised of the very great importance which was attached even to the partial success of the enterprise, as a prelude to the negotiations for peace which were then impending; but he at the same time made arrangements for desisting, if he saw that the sacrifice of life would be greater than it was justifiable to make. The landing, the first dispositions, the attack, and the superiority over the French which the British infantry under his command evinced, all bear testimony to the high military talents of this commander. It was his fate to fall in the moment of victory. General Lord Hutchinson, who succeeded him in the command, in the dispatches with the account of his death, has given a fine eulogium on his character as a soldier, and strongly expressive of the high estimation in which he was held. "We have sustained an irreparable loss in the person of our never sufficiently to be lamented commander-in-chief, Sir Ralph Abercromby, who was mortally wounded in the action (of the 21st), and died on the 28th of March. I believe he was wounded early, but he concealed his situation from those about him, and continued in the field, giving his orders with that coolness and perspicuity which had ever marked his character, till long after the action was over, when he fainted through weakness and loss of blood. Were it permitted for a soldier to regret any one who has fallen in the service of his country, I might be excused for lamenting him more than any other person; but it is some consolation to those who tenderly loved him, that, as his life was honourable, so was his death glorious. His memory will be recorded in the annals of his country—will be sacred to every British soldier—and embalmed in the recollection of a grateful posterity." His remains were conveyed on board Admiral Lord Keith's flag-ship to Malta, attended by Colonel Sir John Dyer, and were interred in the commandery of the grand master, with the highest military honours. A monument to his memory was erected in St Paul's church, London, in pursuance of a vote of the House of Commons. His widow was created a peeress, and a pension of L.2000 a-year for her and other two lives settled on the family. For a detailed account of the military transactions in which Sir Ralph Abercromby was engaged, see BRITAIN.



ABERDARE, a parish and large village of South Wales, in the county of Glamorgan. The village is situate in a beautiful valley, watered by the river Cynon, an affluent of the Taaf, about 4½ miles south-west of Merthyr-Tydvil. In 1831, the population was only 3961; but, owing to the rapid and enormous extension of the iron-trade, the number has increased more than threefold, mostly employed in the manufacture of iron, and the raising of coal.

ABERDEEN, *Old*, is a place of great antiquity. In 1004, Malcolm II. founded a bishopric at a place called Mortlach in Banffshire, in memory of a signal victory which he there gained over the Danes: which bishopric was translated to Old Aberdeen by David I.; and in 1153, the then bishop of Aberdeen obtained a new charter from Malcolm IV. The town lies about a mile to the north of the New Town, near the mouth of the river Don, which is spanned by a fine Gothic bridge, of a single arch, resting on a rock on each side. This arch, said to have been built by a bishop of Aberdeen about the beginning of the 14th century, is 67 feet wide, and 34½ feet high above the surface of the river, which at ebb tide is here 19 feet deep. The town, which consists chiefly of one long street, was formerly the see of a bishop, and had a large cathedral dedicated to St Machar. The only remains of it are two lofty spires, and the nave, which is in a state of complete repair, and used as a church. The present cathedral, the third from the original translation of the see, was commenced about the end of the 14th century, and required 150 years for its completion, but did not remain entire above one-third of that time. It was greatly injured at the Reformation: and Cromwell's troops, time, and storms, did the rest. What remains is the oldest part, and is built chiefly of granite (*out-layer*), a remarkable, if not, as is most probable, a unique circumstance for its age. The principal structure is the King's College, on the south side of the town, which is a large and stately fabric. It is built in form of a square, with cloisters on the south side. In the chapel, which has been thoroughly repaired, and is used for public worship during session, there still remain the original fittings of the choir, of most tasteful design, and executed with a precision and delicacy not surpassed by the oak-carving of any ancient church in Europe. This was preserved by the spirit of the Principal at the time of the Reformation, who armed his people, and checked the blind zeal of the barons of the Mearns, when, after stripping the cathedral of its roof, and robbing it of the bells, they were about to violate this seat of learning. The steeple is vaulted with a double cross arch; above which is an imperial crown, supported by eight stone pillars, and closed with a globe and two gilded crosses. In the year 1631, this steeple was thrown down by a storm, but was soon after rebuilt, in a style resembling that of the cathedrals of Edinburgh and Vienna. This college was founded in 1494, by William Elphinston, bishop of Aberdeen, lord chancellor of Scotland in the reign of James III. and lord privy seal in that of James IV.; but James IV. claimed the patronage of it, and it has since been called the *King's College*. The library is considerable, and now contains upwards of 50,000 volumes. Hector Boethius was the first principal of the college, and was invited from Paris for that purpose, on an annual salary of forty merks Scots, L.2, 3s. 4d. sterling. The professorships are Divinity, Medicine, Civil Law, Moral Philosophy, Mathematics, Natural Philosophy, Greek, Humanity, and Oriental Languages. There are numerous bursaries, of which about thirty are bestowed annually by public competition, various patrons presenting to the rest, being in all about forty. (*See Marischal College, in next Article.*) The yearly amount of bursaries and prizes is about L.2000. The number of students, both at King's College and at Marischal College, but particularly the former, has been increasing of late years. In 1852, the number who graduated in arts at King's College was 35; in medicine 24; and in divinity 2. Pop. in 1853, about 2000.

Aberdeen, *New*, the capital of the county of Aberdeen. It is situate on the German Ocean, at the mouth of the river Dee, and in point of population, wealth, and commerce, ranks as the chief town and seaport in the north of Scotland. As early as 1179, it received a charter from William the Lion, who is said to have had a residence here; and it seems to have been even then a place of some importance. In 1800, an act was obtained for the general improvement of the city; and since that period its whole appearance and plan have been changed. New and spacious streets have been opened, bridges of communication have been built, and other improvements executed, ornamental as well as useful. Union street, which affords a splendid access from the south and west, extends from the market-place 1350 yards, and is 70 feet wide. The houses are built of dressed granite; and the street, being now almost filled up with handsome private dwellings, besides various public buildings, has a very imposing appearance. To facilitate the access into the town by means of this street, an elegant bridge of a single arch, the span of which is 132 feet, was erected at an expense of L.13,000. A new opening to the north has been made by King's street; and on the line of this street is a bridge over the Don, constructed at an expense of L.14,000. It consists of five arches, each with a span of 75 feet. Since 1800, numerous other new streets have been opened, and many of them completed. In consequence of these improvements, Aberdeen may be considered as a spacious, elegant, and well-built city. The public buildings are numerous. There are about 50 places for divine worship. Connected with the Established religion are the East and West churches, forming a continuous building 170 feet in length, and adorned with a spire 150 feet in height, besides four other parish churches. There are four *quoad sacra* churches; three Episcopal chapels; six connected with the United Secession; fifteen with the Free Church; eight with Congregationalists and Baptists; one with the Methodists; a Unitarian chapel; one for Roman Catholics; and a Quaker meeting-house. At the Disruption, all the Established ministers of Aberdeen seceded, carrying with them about 10,000 lay-members. The West church was planned by the architect Gibbs; the East by Mr Archibald Simpson; the North and South by Mr John Smith, all natives of Aberdeen.

The charitable institutions are numerous, and, on the whole, well managed and prosperous. The royal infirmary was lately rebuilt at an expense of nearly L.20,000, from a plan by Mr Simpson. It is large, commodious, and well-situated, and imposing in point of architectural effect. The managers were originally incorporated by royal charter in 1773; but a new charter, greatly extending the management, was obtained in 1852. The institution is supported, partly by funds invested in land, and partly by donations and contributions. The number of patients, at the end of 1852, was 134. There is a large and efficient staff of medical officers, with a numerous attendance of pupils. The lunatic asylum was opened in 1800. It is under the same management as the infirmary, and is capable of accommodating 300 patients. The average number, in 1852, was 268.

Gordon's hospital was founded by Robert Gordon (of the Straloch family) by deed of mortification, dated 1729. The president and governors were incorported by royal charter, in 1772. The institution, which was avowedly framed after the model of Heriot's hospital, is for the maintenance and education of the sons and grandsons of decayed burgesses of Aberdeen. There are at present 150 boys in the house, who are instructed in the ordinary branches of education, besides mathematics, natural philosophy, French, Latin, drawing, and music. They are admitted from 8 to 11 years of age, and may continue in the hospital until 15. On leaving, each boy is entitled to L.10, in shape of apprentice-fee, or to L.7, 10s., if allowed to go abroad. The female orphan asylum, instituted in 1840, at a cost of L.30,000, is a private endowment, for maintaining and educating orphan daughters of parents who have lived in the city of Aberdeen, and the adjoining parishes of Old Machar and Nigg, for three years previous to their decease; admitted from the age of 4 to 8, and trained chiefly for domestic service.

The other charitable institutions are,—a general dispensary, lying-in, and vaccine institution, founded in 1823, and supported by voluntary contribution; two ophthalmic institutions; an asylum for the blind, established in 1843, on the foundation of the late Miss Cruickshank; an hospital for orphan and destitute female children, endowed by the late

Aberdeen. Dr John Carnegie; the Midbeltie fund, founded in 1848, by the late James Allan, Esq. of Midbeltie, for pensions, ranging from L.5 to L.15 annually, to widows of good character and reduced circumstances. A commodious poorhouse, according to act of Parliament, was opened four years ago. The number of paupers in the house, in 1852, was 212, besides 902 on the permanent roll. The gross assessment amounted to L.6627. The cost per head of the out-door paupers was L.4, 3s. 6d. per annum; of the in-door L.7, 3s. per annum. In the four years ending 1852, the number of paupers had decreased by 231. In Old Machar parish the total number of out and in door paupers, including children and lunatics, in 1852, was 969; the average cost of each inmate of the poorhouse being L.5, 12s. per annum.

Marischal College was founded by George Keith, Earl Marischal, in 1593. It was lately rebuilt at a cost of about L.30,000,—half of which was a grant from government and the rest raised by subscription,—and has been occupied since 1840. There are professors of Humanity, Greek, Natural History, Mathematics, Natural Philosophy, Moral Philosophy, Divinity, Oriental Languages, Chemistry, Medicine, Anatomy, and Surgery, with lecturers on Materia Medica, Midwifery, Scots Law, &c. It has a good library, observatory, museum, and an excellent collection of philosophical instruments. The session commences in the first week of November, and ends in the first week of April. The curriculum of arts extends over four sessions; and a student's expenses, during each session, may be from L.35 to L.40. The fees for each of the classes are mostly from two to three guineas. Connected with the college are numerous bursaries founded for the purpose of assisting students in poor circumstances. About thirty bursaries are bestowed annually, some by competition and others by presentation, and are continued during the four sessions of the curriculum. There are sixteen competition bursaries, varying from L.16 to under L.5 each; and in the case of bursars, the fees of the session are so restricted as to be more than covered by the bursary. The annual sum expended in prizes and bursaries is about L.1500. In 1852, the number of graduates in A.M. was 21; in M.B. 7; in M.D. 12; and in LL.D. 1. In the west end of the town is the Free Church Divinity Hall. The grammar school, which is mentioned as being in existence in 1418, is a preparatory school to the colleges, and is under a rector and three masters. There are several academies, and a number of parish and other schools, including two on Dr Bell's foundation; one for boys and the other for girls. The industrial or ragged schools, which owe their establishment mainly to Sheriff Watson, are thriving, and have been the means of doing great good, as proved by the remarkable diminution of juvenile crime in the city. The average number on the roll for 1852, was 297. The average annual cost of each child, about L.3, 4s.

On the north side of Castle Street are the town-house and the old tolbooth, which is surmounted by a handsome spire 120 feet in height; and connected with it there has been erected a new court-house, which combines the advantages of elegance, convenience, and comfort; with a prison in the rear. Bridewell, now called the west prison, was built in 1809, at an expense of L.12,000. The cross, a singularly beautiful erection at the east end of Castle Street, is adorned with medallions cut in stone, in very high relief, of all the royal family of Scotland, from James I. to James VII. inclusive, with a fine column of the composite order, surmounted by the royal unicorn rampant rising from the centre. It was planned and executed about 1682, by John Montgomery, a native architect. Near it is a fine granite colossal statue of the late Duke of Gordon. The assembly-rooms, in Union Street, were built in 1821, by subscription. They are constructed of beautiful granite, handsomely ornamented. The rooms, which are ninety feet in front, and 156 feet at the back of the edifice, are splendidly finished in the interior. It has military barracks, erected in 1796, a neat theatre, and public baths. Aberdeen.

The commerce and manufactures of Aberdeen are extensive and flourishing. One of the most important branches of manufacture is the cotton, which was introduced about the year 1779, and has given rise to several large establishments, in the greater number of which steam-engines are employed. There are other smaller works, which manufacture stripes, winseys, druggets, &c. The whole, when in full work, give employment to about 4000 hands. There are two large houses engaged in the woollen trade, and four or five small ones. In these are manufactured broad and narrow cloths, blankets, serges, stockings, &c., but chiefly worsted yarns. They give employment to about 3500 persons. The manufacture of carpeting for the London, but particularly the American markets, has been carried on with success for upwards of twenty years. The linen manufacture, particularly that of thread, is carried on in all its branches to a great extent. The number of persons employed, when all the mills are on full work, is about 8000, of whom nearly one-third are engaged at the bleach-fields, or as out-door weavers. There are breweries of porter and ales, of which considerable quantities are annually exported to America and the West Indies. There are likewise several distilleries, the number of which has been increased since the reduction of the duty on spirits. Some extensive iron-works have also been established, in which are manufactured every kind of spinning machinery, and both land and marine steam-engines. Boiler-making, chain-making, and the forging of anchors employ about 1500 men. Iron ship-building was introduced about sixteen years ago, and has since been successfully carried on. The quantity of iron imported in 1852 was 3861 tons. There are also manufactories of soap, candles, leather, &c. The granite stones, so famous for their durability, which are quarried, dressed, and shipped from this port, form a staple commodity for exportation, and are a great source of wealth to the place, by giving employment to many thousands of industrious labourers. These stones are chiefly used for paving streets; for building bridges, wharfs, and docks; and for erecting lighthouses, and other works. At the extensive granite works of Messrs Macdonald and Leslie, that stone is manufactured into exquisitely polished vases, tables, chimney-pieces, fountains, funeral monuments, and columns, with a skill and elegance hitherto unrivalled in Great Britain; and in execution quite equal to the famous granite sculptures of Sweden or of Russia. Among their other works, we may mention the magnificent granite columns of St George's Hall in Liverpool, and the colossal statue of the last Duke of Gordon, that ornaments Castle Street in Aberdeen, sculptured in the same stubborn material. Comb-making has been, since 1830, an important branch of local industry, employing about 450 hands. The whale-fishery, once carried on to a great extent, has much declined. Forty years ago, it employed 17 vessels; now there are only two. Salmon-fishing formerly carried on with much spirit and remarkable success, has continued declining for a good many years. The quantity exported in 1852 was 1014 barrel-bulk. Herring-fishing has been prosecuted with considerable success for about 17 years.

There are now three paper-mills in the vicinity of Aberdeen, all in a very flourishing condition, and giving employment to between 500 and 600 hands. Another prosperous branch of local industry is ship-building, for which the city has lately become famous. Within the last 15 years many fine sailing and steam vessels have been built here. A ship of 1200 tons was lately (1852) launched, and another of 1500 is being built. There are eight banking establishments in Aberdeen, besides a savings bank, established in 1815. The amount at the credit of depositors in the savings bank on 12th February 1853 was L.133,484.

The aggregate tonnage of the vessels belonging to the port of Aberdeen in 1852 was 52,868 tons. They trade to North and South America, the West Indies, the Mediterranean, the Baltic, Davis' Straits, and most of the ports of the united kingdom. The want of a proper harbour was long a detriment to the trade of Aberdeen, and occasioned the loss of many lives and of much property. To remedy this defect a pier was built in 1776, by Smeaton, on the north side of the old harbour, extending a considerable way into the German Ocean; and by an act obtained in 1810, it was still farther enlarged. This extensive work is built of large masses of dressed granite, and measures in length 2300 feet. In consequence of this improvement the depth of water on the bar is at spring-tides upwards of nineteen feet, and at neap-tides fourteen feet, where there was formerly only a few feet. The flood-gates, and other works necessary for the completion of Telford's plan of 1810, were completed in 1848. The wet dock, where the largest vessels may float in safety, has a surface of nearly 40 acres, and about 9000 feet of quay-room. It is called the Victoria Dock, in honour of her Majesty's visit in 1848. The harbour dues which, in 1765, produced only L.126—amounted in 1800 to L.1300. The shore-dues for the year ending 30th Sept. 1852, were L.15,236; revenue, L.19,953; expenditure, L.18,376; debt, L.282,263. The registered tonnage charged inwards, was 298,418 tons; outwards 33,343 tons; for wintering, 16,106 tons. Commodious steam-vessels sail statedly to London, Leith, Inverness, &c. The introduction of steam-navigation in 1821 effected a complete and beneficial revolution in various branches of industry, more especially in the cattle-trade; and the benefits have been greatly increased by the recent introduction of railways. The bay affords safe anchorage with off-shore winds, but not with those from E. or N.E. A lighthouse has been erected on Girdleness, the south point of the bay, having two fixed lights, one above the other, 115 and 185 feet above high-water spring-tides, in Lat. 57. 8. N. Long. 2. 3. W. On the north pier head, there is also a tidal fixed red light, seen at the distance of four miles, and two leading lights further up the harbour on its south side. The affairs of the harbour are managed by a board of Commissioners.

No place in the empire is better supplied with water and gas. The former is brought from the Dee, a little above the bridge. It is filtered through a bed of gravel, conveyed in a tunnel to a well, whence it is pumped by steam, and propelled into a reservoir at the west end of Union Place. The quantity of water raised in twenty-four hours is about 900,000 gallons.

Aberdeen possesses a very complete public market, built by a company established by act of parliament in 1839. The building was designed by Mr Archibald Simpson, and consists of two floors of about 300 by 100 feet, with galleries going round the whole building. The upper and lower floors are fitted up with shops for the sale of butcher-meat, fish, fowls, &c. On the upper floor is a fountain of polished granite, the principal basin of which is 7 feet 3 inches diameter, cut out of a single block of stone. Connected with this undertaking was the laying out of a new street leading from Union Street to the quay, an improvement of great importance. In this street are the Post-Office and Mechanics' Hall, both handsome buildings of recent erection. The Aberdeen Railway Company was incorporated in 1845, with a capital (including additions) of L.1,256,000; the total number of shares being 78,600. The main line is 65 miles in length, with 7 miles of branches. The total receipts for the week ending 1st January 1853, were L.1647: and for the corresponding week of 1852, L.1560. In 1846, the Great North of Scotland Railway Company was incorporated, with a capital of L.1,107,440, divided into 110,744 shares. The works were not commenced until last year (1852), but are now in steady progress, with every prospect of early completion. The line will reach from Aberdeen to Elgin, in the first instance, and will be of immense importance to the northern counties. A railway, reaching from Aberdeen to Banchory-Ternan, along the north side of the river Dee, has also been recently commenced.



The oldest charter extant held by Aberdeen is from William the Lion, and of the probable date of 1178. Reference, however, is made in it to certain privileges conferred on the burgesses of Aberdeen, in common with all those north of the "mounth," by David I. The records of the burgh commence in 1398, and are complete to the present time, with the exception of a short break about the beginning of the 15th century. An interesting selection from these records has been published by the Spalding Club, the establishment of which has been the means of amply illustrating many other matters of local antiquity. The town is governed by a magistracy, consisting of a provost, four bailies, a dean of guild, and a treasurer. The other members of the council amount to twelve, all being chosen by the electors within the parliamentary bounds. In 1333 and 1336 the town was burnt by a fleet of Edward III.; but it was speedily afterwards rebuilt, and was thereafter known by the name of New Aberdeen. The total revenue of the burgh for 1852 was L.19,780; the total expenditure, for the same period, L.18,100; surplus, L.1680. In 1817, the affairs of the burgh became embarrassed to a great extent, and were placed under trust. By prudent management, however, they gradually recovered, and all liabilities were paid in full. The population of Aberdeen, in 1396, was about 3000; in 1643, 8750; in 1708, 5556; in 1801, 27,608; in 1831, 58,019; in 1841, 63,262; and in 1851, 71,945. The number of parliamentary electors is 2947; of municipal electors, 2413. It returns one member to parliament. Aberdeen is distant 108 miles north of Edinburgh, and 118 from Inverness. Long. 2. 5. 42. W. Lat. 57. 8. 58. N.

ABERDEENSHIRE, a county in Scotland, situate in the north-east, between 56. 52. and 57. 42. north latitude, and between 1. 49. and 3. 48. of longitude west from Greenwich. It is bounded by the German Ocean on the north and east; by the counties of Kincardine, Forfar, and Perth, on the south; and by those of Inverness and Banff on the west. Its greatest length is 87, and breadth 36 miles; with a circuit of about 200 miles, of which 60 are on the sea-coast. It has an area of 1985 square miles, or 1,270,740 acres, of which somewhat more than one-third is under cultivation; and contains 83 parishes, with parts of six others. This county is popularly divided into five districts. First, *Marr*, which is a mountainous district, particularly Braemar, the highland part of it; and is much frequented by tourists, on account of its wild and majestic beauties. Ben Macdhui, the highest mountain in Scotland, rises here to the height of 4299 feet, and in the vicinity are Cairntoul, Ben Avon, and Cairngorum, which attain respectively the height of 4245, 3967, and 4050 feet. The last is famous for a peculiar kind of rock crystals, known as *Cairngorum stones.* A few miles below Braemar is "dark Lochnagar," which rises to the height of 3800 feet. Second, *Formartin*, of which the land on the sea-coast is low and fertile; but hills and mosses are spread over the interior. Third, *Buchan*, the most extensive division next to Marr, having a bold precipitous shore of 50 miles, but generally a flat surface, the soil of which has been greatly improved. The Bullers of Buchan, about 6 miles south from Peterhead, is a natural curiosity, which has been often described by tourists. Fourth, *Garioch*, a large and beautiful valley, naturally very fertile. Before the introduction of modern husbandry, it was termed the granary of Aberdeen. Fifth, *Strathbogie*, the greater part of which consists of hills, mosses, and moors. On a comprehensive review, it may be said, that, with the exception of the low grounds of Buchan, and the highlands of the south-west division, Aberdeenshire consists for the most part of tracts nearly level, but often bleak, naked and unfertile, though interspersed with many rich spots in a high state of cultivation. In extent, it is very nearly one-sixteenth part of Scotland.

The chief mineral wealth of the county is its granite, for which it has long been famous, and which has brought considerable sums into the county, besides supplying the inhabitants with excellent stones for building and other purposes. As many stones have been raised from an acre of land under preparation for tillage, as brought from L.30 to L.50, for paving the streets of London. The exportation of granite to the capital employed at one time about 70 vessels of 7000 tons, and 400 men; and the value of all the stones exported yearly was stated at L40,000. The quantity exported in 1852, was 38,595 tons. Gneiss, grauwackè, and old red sandstone, are also abundant; limestone, basalt, trap, and clay-slate, are found in various parts; sandstone, and millstone are quarried at Aberdour, slate at Culsalmond and Lambhills; blacklead has been found near Huntly; and there is a manganese quarry in the vicinity of Aberdeen.

The principal rivers are the Dee and the Don. The Ythan and Ugie within the county, and the Deveron and Bogie on its boundaries, are also considerable streams. Mussels are plentiful near the mouth of the Ythan; and pearl mussels have been sometimes discovered at its lower extremity. One of the jewels of the ancient crown of Scotland, a valuable pearl, is said to have been found here. There are also several lakes well stored with pike, trout, eels, and other kinds of fish. The county is noted for its chalybeate springs at Peterhead, Fraserburgh, and at Pananich on the Dee, near Ballater.

The climate of Aberdeenshire, except in the mountainous districts, is rendered comparatively mild by its being bounded on two sides by the sea. The winters are not so severe as in some of the southern counties, but the springs are late, owing to the prevalence of easterly winds; and in autumn the weather is often wet and stormy. Wheat, however, and all the other crops cultivated in Scotland, come to perfection; and the inhabitants, who are not subject to any organic diseases, sometimes live to a great age.

The district of Marr, containing almost half the county, abounds in natural woods, which are a source of wealth to their proprietors, and of profitable employment to the inhabitants. This county is so well adapted to the growth of trees, that it is only necessary to shut out the cattle by inclosures, and the birds and winds supply it with seeds that soon rise into vigorous plants. These woods consist chiefly of Scotch fir; and the timber, especially what grows in the forests of Braemar, has been thought superior to any that Scotland has imported from the north of Europe. About a tenth part of the whole surface of the county is under wood; and the trees found in the peat mosses indicate the existence of still more extensive forests in former ages. The forests abound in deer and grouse; and partridges, and other kinds of game, are plentiful in all the higher parts of the county.

Ruins of ancient edifices are seen in different parts of the county. In the Garioch district, on the summit of a conical hill called Dun-i-deer, are the remains of a castle, supposed to be about 700 years old. They stand within a still older vitrified wall, which encircles the summit of the hill, and formed a British fort of unascertainable antiquity. Such forts would seem to have been rather places of temporary refuge than of permanent residence. The ruins of two buildings, supposed to have belonged to Malcolm Canmore, King of Scotland, are still pointed out. One of them, situate at Castletown of Braemar, was his hunting seat; the other stands in a small island in the Loch of Kinnoir. A wooden bridge, which connected it with the land, has been found in the lake. The castle of Kildrummy, which in 1150 was the property of David Earl of Huntingdon, must have been a princely edifice, covering nearly an acre of ground; and its venerable remains still show the power and grandeur of the chieftains by whom it was inhabited. In the same district are some ancient subterraneous retreats, supposed to have been used by the Picts as places of refuge from an invading enemy.

The agriculture of Aberdeenshire has been very greatly improved of late years: potatoes, turnips, and clover, as well as wheat and other crops, are now cultivated according to the best courses of modern husbandry. Farms, however, are still generally of a small size, compared with those of the south-eastern counties; and the buildings, though much improved, are for the most part less convenient and comfortable. Here, as in every other part of Scotland, a lease for nineteen years is the most common bond of connection between the landholder and farmer.

In most parts of Aberdeenshire, cattle are a more important object to the tenantry than corn. Great numbers of cattle are now sent to London, the annual value of which is estimated at L360,000. The whole value of agricultural exports is estimated at L.750,000 a-year. The productive qualities of the county have been greatly enhanced by general drainage, and the introduction of bone-dust and guano. Of the former, there were imported in 1852, 3861 tons, and of the latter, 5508 tons. During the same year, there were exported, of oats, barley, and bear, 56,132 quarters; of butter, 2568 cwt.; eggs, 7273 barrel-bulk; pork, 6950 cwt.; sheep and lambs, 5240. About two-thirds of the population depend entirely on agriculture; oatmeal, prepared in different ways, is the principal food of the labouring classes.

The sea-fishing employs a number of hands. The Greenland whale-fishery is carried on by ships fitted out from Peterhead and Aberdeen.

The old staple manufacture, the knitting of stockings, has declined greatly for many years; but those in wool, cotton, and flax, are upon an extensive scale, and employ a large proportion of the inhabitants. There are also establishments for making sail-cloth, twine, paper, &c.; and, from the characteristic ingenuity and enterprise of the people, Aberdeenshire has been gradually assuming a high rank among the manufacturing counties of Britain.

A share of our foreign trade, chiefly with the north of Europe, has been long enjoyed by this county; and the recent improvements on the harbour of Aberdeen must contribute essentially to the extension of its commerce. In 1807 a canal was opened from the harbour of Aberdeen to the town of Inverury, a distance of 18¼ miles, the expense of which was about L.44,000. The facilities which this canal affords for the conveyance of coal, lime, and the excellent stone so abundant in the tract of country through which it is cut, have already proved highly beneficial to the agriculture of the county, as also to the prosperity of Aberdeen; but it will be superseded by the North of Scotland Railway.

The *valued rent* of the county is L.235,665, 8s. 11d. Scots; but the *real rent* for the lands and houses is probably not less than L.800,000 sterling.

The principal seats in Aberdeenshire are, Aboyne Castle, the Earl of Aboyne; Haddo House, the Earl of Aberdeen; Huntly Lodge, the Duke of Richmond; Keith Hall, the

Earl of Kintore; Marr Lodge, the Earl of Fife; Philorth House, Lord Saltoun; Strichen, Lord Lovat; Castle Forbes, Lord Forbes; Skene House, Duff; Slaines Castle, the Earl of Errol. Her Majesty has lately purchased, from the Fife trustees, the lands and house of Balmoral, in the parish of Crathie, Braemar, which is the residence of the Court for a few weeks towards the end of summer. This year (1853) will see the commencement of a palace, every way suitable for "the royal dwelling." The prevailing names among the proprietors are, Gordon, Forbes, Grant, Fraser, Duff, and Farquharson. The county has four parliamentary burghs, which, with their respective populations in 1851, are as follows: Aberdeen, 71,945; Peterhead, 7242; Inverury, 2264; and Kintore, 476. The first returns a member to parliament, and the other three are contributory burghs to Elgin. The county also sends a member to parliament. The parliamentary constituency is 4022. Besides a sheriff, the county has two sheriffs-substitute, one at Aberdeen, the other at Peterhead; and circuit courts are held at Tarland, Inverury, Huntly, Turriff, Old Deer, and Fraserburgh. There are about 450 schools in the county, and, along with Banff and Elgin, it participates in Dick's bequest for parish schools. Five miles from Aberdeen, on the river Dee, is the Roman Catholic College of Blairs. By the census of 1851, there were 32,110 inhabited houses, 768 uninhabited, and 179 building. In that census the county is divided into eight districts, with populations as under.

| DISTRICTS. | 1851. | | |
|---|---|---|---|
| | MALES. | FEMALES. | TOTAL. |
| Aberdeen, | 38,645 | 47,582 | 86,227 |
| Alford, | 6,368 | 6,293 | 12,661 |
| Deer, | 19,166 | 22,004 | 41,170 |
| Ellon, | 7,701 | 7,671 | 15,372 |
| Garioch, | 9,082 | 9,072 | 18,154 |
| Kincardine O'Neil, | 7,966 | 7,963 | 15,929 |
| Strathbogie, | 5,131 | 5,620 | 10,751 |
| Turriff, | 6,998 | 7,396 | 14,394 |
| Total Population of the County of Aberdeen, (exclusive of absent Seamen), | | | 214,658 |
| Population in 1841, | | | 192,387 |
| Increase, | | | 22,271 |

ABERDOUR, a small town in Fifeshire, Scotland, on the northern shore of the Firth of Forth, about ten miles north-west of Edinburgh, with which there is now a frequent and easy communication by steam-boats. In old times it belonged to the Viponts; in 1126 it was transferred to the Mortimers by marriage, and afterwards to the Douglases. William, lord of Liddesdale, surnamed the *Flower of Chivalry*, in the reign of David II. conveyed it by charter to James Douglas, ancestor of the present noble owner, the Earl of Morton. The monks of Inchcolm had a grant for a burial-place here from Allen de Mortimer, in the reign of Alexander III. It is a pleasantly situated town, and is greatly resorted to in summer for sea-bathing. Coarse cloths are manufactured to a small extent in the village. Pop. in 1851, 1945.

Aberdour is also the name of a parish in Aberdeenshire, containing 1857 inhabitants. It lies six miles west of Fraserburgh.

ABERFELDIE, a village in Perthshire, celebrated in Scottish song, one mile from the falls of Moness.

ABERFFRAU, a small seaport and parish in Anglesey, in Wales, with a population of 1336, chiefly engaged in fisheries.



ABERFORD, a market-town in the west riding of Yorkshire, about a mile in length, and pretty well built. In the vicinity is a Roman road, considerably elevated; and not far off flows the river Cock, between which and the town the foundation of an old castle is still visible. It is 181 miles north by west from London. Pop. in 1851, 996.

ABERFOYLE, a village and parish, eight miles S.W. of Callender, on one of the gorges leading into the highlands of Perthshire.

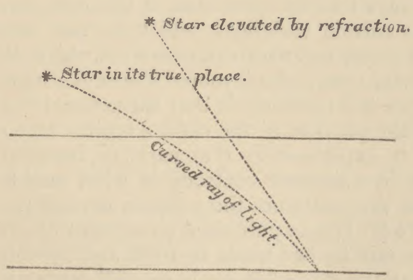
ABERGAVENNY, a decayed corporate town in Monmouthshire, 14 miles west of Monmouth, at the confluence of the Usk and Gavenny. It was once a walled town, and has the remains of a castle built at the time of the Conquest. The river Usk is here spanned by a noble stone bridge of fifteen arches. It has a town-hall, two banks, gas-works, and a free grammar school, with a fellowship and exhibitions at Jesus College, Oxford. The rich coal and iron mines in the vicinity afford employment to the people, who also engage in the weaving of flannel, &c. Abergavenny appears to have been the *Gobannium* of Antoninus, and the town of Usk his *Burrium*. Pop. in 1851, 4797.

ABERNETHY, John, an eminent dissenting minister, was the son of Mr John Abernethy, a dissenting minister in Coleraine, where he was born on the 19th of October 1680. When about nine years of age he was separated from his parents, his father being obliged to attend some public affairs in London; and his mother, to shelter herself from the fury of the Irish rebels, retiring to Derry, a relation who had him under his care, having had no opportunity of conveying him to her, carried him to Scotland; and thus he escaped the hardships and dangers of the siege of Derry, in which Mrs Abernethy lost all her other children. He afterwards studied at the University of Glasgow, where he remained till he took the degree of master of arts; and, in 1708, he was chosen minister of a dissenting congregation at Antrim, in which situation he continued above 20 years. About the time of the Bangorian controversy (for which see Hoadly), a dissension arose among his brethren in the ministry at Belfast, on the subject of subscription to the Westminster Confession of Faith. In this controversy he became a leader on the negative side, and incurred the censure of a general synod. The agitation of parties on this occasion induced him to accept of an invitation to settle in Dublin, where his preaching was much admired. Here he continued for ten years, respected and esteemed; and died in December 1740, in the 61st year of his age. His writings, like his character, are distinguished for candour, liberality, and manly sentiment. He published a volume of sermons on the Divine Attributes; after his death a second volume was published by his friends; and these were succeeded by four other volumes on different subjects.

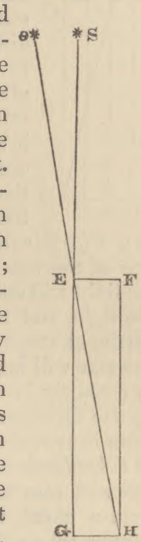
Abernethy, *John*, an eminent surgeon, was born in London in 1765. His professional studies and career began and terminated in the metropolis, where he obtained a high reputation. He was an apprentice to Sir Charles Blick; and succeeded the celebrated Mr Pott in 1787, as assistant-surgeon in St Bartholomew's Hospital. Not long after, Abernethy was also his successor as Lecturer on Anatomy and Surgery; an office in which he acquired just celebrity, from an easy, impressive manner, and a style of illustration at once amusing and instructive. On the death of Blick, he was elected surgeon to St Bartholomew's Hospital, of which he was long a distinguished member. His reputation began with his success as a teacher; but it rested on the more solid foundation of his efforts for the practical improvement of surgery. The philosophic views developed in his work entitled "The Constitutional Origin and Treatment of Local Diseases," are of great practical importance, and are founded on two general principles;—1st, That topical diseases are often mere symptons of constitutional maladies, and then can only be removed by general remedies; 2d, That the disordered state of the constitution very often originates in, or is closely allied to deranged states of the stomach and bowels; and can only be remedied by means that beneficially affect the functions of those organs. Besides these essays, we are indebted to Mr Abernethy for the original suggestion and practice of the daring operation of securing by ligature the carotid and external iliac arteries. This eminent surgeon had one peculiar eccentricity, which candour compels us to notice. In the private circle of his family and of his friends he was kind, courteous, and affectionate, was just and honourable in his intercourse with all; but, in his latter days, especially with his patients, he was often rude and capricious, and sometimes assumed an offensive coarseness, at variance with a character otherwise estimable. (T.S.T.)

Abernethy, a town in Scotland, in Perthshire, situated at a short distance to the southward of the right bank of the river Tay, a little above the mouth of the Earne. It is of very ancient date, and is said to have been the seat of the Pictish kings; and there are some uncertain traditions of its existence prior to this period. It is distinguished by a curious piece of antiquity, a circular tower, 74 feet high and 16 feet in diameter, consisting of 64 courses of hewn stone. It continued long to be the see of an archbishop, which was afterwards transferred to St Andrews. The inhabitants are engaged in the manufacture of linen. The population in 1851, 2026. Abernethy is seven miles from Perth.

ABERRATION, in *Astronomy*, a remarkable phenomenon, by which all the stars appear, at certain seasons of the year, to deviate in a slight degree from their true situation in the heavens, in consequence, as is now ascertained, of the motion of the light from every star combining itself with the motion in the eye of the observer, caused by the earth's annual revolution round the sun. All vision, it is well known, is performed by the particles or rays of light from any object striking against the eye, and the object invariably appears in that direction in which the rays finally impinge. Hence, for example, arise the effects of refraction, by which the heavenly bodies appear more elevated in the horizon than they really are; the rays of light, as they penetrate the atmosphere, bending gradually downwards towards the surface of the earth, so as at last to reach the eye of the spectator in a direction more inclined from the horizon than that in which they issue from the object: and thus the latter appears more elevated in the sky than it really is, as in the annexed sketch.




In a similar manner the rays of light which fall directly from the stars, in certain circumstances, owing to the motion of the earth, really impinge on the eye of a spectator in a direction somewhat oblique, so that they appear on this account in a situation different from what they really occupy; and this constitutes the aberration. Suppose, for example, the earth is moving in a direction at right angles to that of the light from any star, then it is evident there will be a mutual collision between them; the light will not only strike the eye of a spectator, but the eye will also strike the light; the effect will be exactly the same as if the eye had been at rest, and the light had been endowed with an equal motion in the contrary direction; so that in addition to its direct motion, it has also a slight motion laterally; and the true direction of the impact, therefore, or of the compound motion of the light, according to the well-known laws of the composition of forces, will be the diagonal of the rectangle, the sides of which represent the directions and velocities of the light and of the eye, as in the annexed sketch, where S E represents the direction and velocity of the light, F E the direction and velocity of the motion of the earth, and E F, therefore, the direction and velocity of the contrary motion in the light, the earth being supposed at rest. When the light arrives at the eye therefore at E, it has not only the direct motion S E or E G, which is made by construction equal to S E, but also a lateral motion E F; so that the compound motion will be represented by the diagonal E H, which is the true direction in which the light will really impinge on the eye; so that the star, instead of appearing at S, will appear at *s*, as far in advance of its true position as the earth has moved in the time the light travels from the star to the eye. To determine the amount of this aberration, therefore, we have only to compare the motion of light with that of the earth in its orbit. Now, from the celebrated discovery of the Danish astronomer Roemer, regarding the successive propagation of light, as found by the observations of the eclipses of Jupiter's satellites at different seasons of the year, it appears that light actually employs about 15 minutes to travel from the one circumference to the other of the earth's orbit; and from other still more accurate observations, its velocity has been determined at about 194,000 miles per second, while the mean velocity of the earth in her orbit does not exceed 19 miles. Hence it is easy to calculate that the aberration in this case will amount to an angle of about 20″ of a degree; and this case in which the earth's motion is perpendicular to that of the light is that in which the aberration is the greatest of all; for, as the motion of the earth becomes oblique to that of the light, the aberration gradually diminishes, until at last it disappears altogether, when the two motions become in one straight line, that is, when the earth is moving either directly from or directly towards the stars. In all cases the apparent direction of the stars will be in the diagonal of the parallelogram, the sides of which represent the direction and the relative motions of the light and of the earth.




The aberration of light having been discovered by means of the telescope, this has given rise to a familiar illustration of the subject, which it may be proper to state. It is evident, that before the star can be visible in the telescope, the light in its progress through it must be continually in the axis. Were the telescope, therefore, affected with any considerable lateral motion, this could not take place if the telescope were held directly up to the star; because, though the light might enter the telescope in the axis, the lateral motion would quickly withdraw the axis from the line of the light, which would strike against the side of the telescope and never reach the eye. If, for example, the light moved successively to the points A, B, C, D, E, while the telescope or tube moved successively parallel to itself into the positions E A, F *f*, G *g*, H *h*, I *i*; then the light entering at A, by the time it reaches B the tube is off into the position F *f*, and by the time it could reach E the tube is removed to I *i*; so that it is evident the star will not be visible at all in the true direction of the light. In order that this may always remain in the telescope, and traverse it from end to end, this must be set in the position E *i*, oblique to E A; then the light entering at *i*, *Fig.* 2. will advance to *b* in the same time that the axis of the tube advances parallel to itself to F *f*; so that the light will still remain in the axis. In the same manner the light and the tube will continue to advance by proportional steps till the former reaches the eye, where the star will appear in the direction of the tube, and that as formerly in the diagonal of the parallelogram formed by the directions and velocities of the two motions. Another illustration was suggested by Clairaut in the *Mémoires de l'Académie des Sciences* for the year 1746, by supposing drops of rain to fall rapidly and quickly after each other from a cloud, under which a person moves with a very narrow tube; in which case, it is evident that the tube must have a certain inclination, in order that a drop which enters at the top may fall freely through the axis of the tube, without touching the sides of it; which inclination must be more or less, according to the velocity of the drops in respect to that of the tube: then the angle made by the direction of the tube and of the falling drops is the aberration arising from the combination of those two motions.

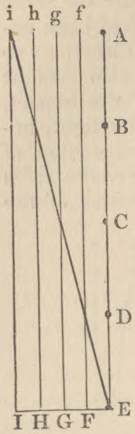
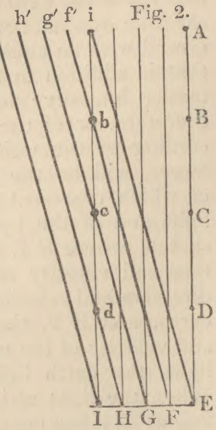
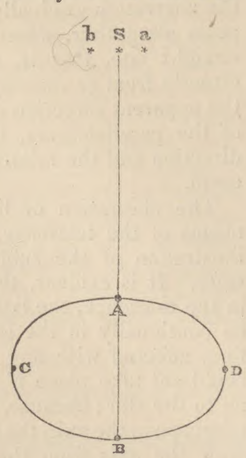



Fig. 2.




In all cases it will be observed the aberration takes place in the direction of the earth's motion. Hence it is easy to deduce, from what we have stated, the effects on the different stars. Consider, for example, those situated in the pole of the ecliptic. To the rays of light from these, the earth's motion will always be at right angles; the aberration on them, therefore, will always be of the same amount, viz. about 20″; but as the earth changes the direction of its motion along the ecliptic, the aberration will change its direction also, so that the star will appear to move in a little orbit, similar to, and parallel with the ecliptic; the apparent situation of the star revolving annually round the true place, as the earth revolves round the sun. Consider again the stars situated in the plane of the ecliptic. To the rays of light from these, the earth's motion will be at one time at right angles, as at A and B in the annexed sketch, and at another in the same direction, as at C and D; for in all these cases we may hold the dimensions of the earth's orbit as nothing compared with the distance of the star. At A, therefore, the earth being supposed to move in the direction A D B, so as to make the star appear at *a*, the aberration will be 20″ in the direction S *a*, and at B 20″ in the direction S *b*, so as to make the star appear at *b*, while at C and D it will be nothing, and the star will appear in its true place at S. The apparent situation will, therefore, appear annually to oscillate on each side of the true, to the extent of 20″. Between the two extremes therefore, namely, the *pole* of the ecliptic, where the aberration causes the star to revolve in a circle, and the *plane* of the ecliptic, where it causes it to oscillate in a straight line, the stars will all describe elliptic curves, elongated 40″ in a direction parallel to the plane of the ecliptic, and the breadth or lesser axis diminishing continually from the pole towards the plane of the ecliptic, where the curve passes into a straight line. These motions in the stars are confirmed by the observations of astronomers, (see ASTRONOMY,) and they furnish one among many other beautiful examples of that remarkable and perfect accordance which in this science subsists everywhere between theory and fact. The effects of aberration also present a striking, and one of the few direct proofs which astronomy furnishes of the motion of the earth, these being quite unaccountable on any other hypothesis.






Such are the principal phenomena of aberration. This great discovery, one of the finest in modern astronomy, we owe to the accuracy and ingenuity of the distinguished astronomer Dr Bradley, who was led to it in the year 1727, by the result of some observations which he made, with a view of determining the annual parallax of the fixed stars. See PARALLAX.

The annual motion of the earth about the sun had been much doubted and warmly contested. The defenders of that motion, among other proofs of the reality of it, conceived the idea of adducing an incontestible one from the annual parallax of the fixed stars, if the stars should be within such a distance, or if instruments and observations could be made with such accuracy, as to render that parallax sensible. And with this view various attempts have been made. Before the observations of M. Picard, made in 1672, it was the general opinion that the stars did not change their position during the course of a year. Tycho Brahe and Ricciolus fancied that they had assured themselves of it from their observations; and from thence they concluded that the earth did not move round the sun, and that there was no annual parallax in the fixed stars. M. Picard, in the account of his *Voyage d'Uranibourg*, made in 1672, says that the pole star, at different times of the year, has certain variations, which he had observed for about 10 years, and which amounted to about 40″ a year: from whence some, who favoured the annual motion of the earth, were led to conclude that these variations were the effect of the parallax of the earth's orbit. But it was impossible to explain it by that parallax, because this motion was in a manner contrary to what ought to follow only from the motion of the earth in her orbit.

In 1674 Dr Hooke published an account of observations which he said he had made in 1669, and by which he had found that the star $\gamma$ Draconis was 23″ more northerly in July than in October; observations which, for the present, seemed to favour the opinion of the earth's motion, although it be now known that there could not be any truth or accuracy in them.

Flamsteed having observed the pole star with his mural quadrant, in 1680 and the following years, found that its declination was 40″ less in July than in December; which observations, although very just, were yet, however, improper for proving the annual parallax; and he recommended the making of an instrument of 15 or 20 feet radius, to be firmly fixed on a strong foundation, for deciding a doubt which was otherwise not soon likely to be brought to a conclusion.

In this state of uncertainty and doubt, then, Dr Bradley, in conjunction with Mr Samuel Molineux, in the year 1725, formed the project of verifying, by a series of new observations, those which Dr Hook had communicated to the public almost 50 years before. And as it was his attempt that chiefly gave rise to this, so it was his method in making the observations, in some measure, that they followed; for they made choice of the same star, and their instrument was constructed upon nearly the same principles: but had it not greatly exceeded the former in exactness, they might still have continued in great uncertainty as to the parallax of the fixed stars. For this, and many other convenient and useful astronomical instruments, philosophers are indebted to the ingenuity and accuracy of Mr Graham.

The success of the experiment evidently depending so much on the accuracy of the instrument, this became a leading object of consideration. Mr Molineux's apparatus then having been completed, and fitted for observing, about the end of November 1725, on the third day of December following, the bright star in the head of Draco, marked $\gamma$ by Bayer, was for the first time observed, as it passed near the zenith, and its situation carefully taken with the instrument. The like observations were made on the fifth, eleventh, and twelfth days of the same month; and there appearing no material difference in the place of the star, a further repetition of them, at that season, seemed needless, it being a time of the year in which no sensible alteration of parallax, in this star, could soon be expected. It was therefore curiosity that chiefly urged Dr Bradley, who was then at Kew, where the instrument was fixed, to prepare for observing the star again on the 17th of the same month; when, having adjusted the instrument as usual, he perceived that it passed a little more southerly this day than it had done before. Not suspecting any other cause of this appearance, it was ascribed to the uncertainty of the observations, and that either this or the foregoing was not so exact as had been supposed. For which reason they proposed to repeat the observation again, to determine from what cause this difference might proceed: and upon doing it, on the 20th of December, the doctor found that the star passed still more southerly than at the preceding observation. This sensible alteration surprised them the more, as it was the contrary way from what it would have been had it proceeded from an annual parallax of the star. But being now pretty well satisfied that it could not be entirely owing to the want of accuracy in the observations, and having no notion of any thing else that could cause such an apparent motion as this in the star, they began to suspect that some change in the materials or fabric of the instrument itself might have occasioned it. Under these uncertainties they remained for some time; but being at length fully convinced, by several trials, of the great exactness of the instrument, and finding, by the gradual increase of the star's distance from the pole, that there must be some regular cause that produced it, they took care to examine very nicely, at the time of each observation, how much the variation was; till about the beginning of March 1726, the star was found to be 20″ more southerly than at the time of the first observation: it now indeed seemed to have arrived at its utmost limit southward, as in several trials, made about this time, no sensible difference was observed in its situation. By the middle of April it appeared to be returning back again towards the north; and about the beginning of June it passed at the same distance from the zenith as it had done in December, when it was first observed.

From the quick alteration in the declination of the star at this time, increasing about one second in three days, it was conjectured that it would now proceed northward, as it had before gone southward, of its present situation; and it happened accordingly; for the star continued to move northward till September following, when it again became stationary; being then near 20″ more northerly than in June, and upwards of 39″ more northerly than it had been in March. From September the star again returned towards the south, till, in December, it arrived at the same situation in which it had been observed twelve months before, allowing for the difference of declination on account of the precession of the equinox.

This was a sufficient proof that the instrument had not been the cause of this apparent motion of the star; and yet it seemed difficult to devise one that should be adequate to such an unusual effect. A nutation of the earth's axis was one of the first things that offered itself on this occasion; but it was soon found to be insufficient; for though it might have accounted for the change of declination in $\gamma$ Draconis, yet it would not at the same time accord with the phenomena observed in the other stars, particularly in a small one almost opposite in right ascension to $\gamma$ Draconis, and at about the same distance from the north pole of the equator: for though this star seemed to move the same way as a nutation of the earth's axis would have made it, yet changing its declination but about half as much as $\gamma$ Draconis in the same time, as appeared on comparing the observations of both made on the same days, at different seasons of the year, this plainly proved that the apparent motion of the star was not occasioned by a real nutation; for had this been the case, the alteration in both stars would have been nearly equal.

The great regularity of the observations left no room to doubt, but that there was some uniform cause by which this unexpected motion was produced, and which did not depend on the uncertainty or variety of the seasons of the year. Upon comparing the observations with each other, it was discovered that, in both the stars above mentioned, the apparent difference of declination from the *maxima* was always nearly proportional to the versed sine of the sun's distance from the equinoctial points. This was an inducement to think that the cause, whatever it was, had some relation to the sun's situation with respect to those points. But not being able to frame any hypothesis sufficient to account for all the phenomena, and being very desirous to search a little further into this matter, Dr Bradley began to think of erecting an instrument for himself at Wanstead; that, having it always at hand, he might with the more ease and certainty inquire into the laws of this new motion. The consideration likewise of being able, by another instrument, to conform the truth of the observations hitherto made with that of Mr Molineux, was no small inducement to the undertaking; but the chief of all was, the opportunity he should thereby have of trying in what manner other stars should be affected by the same cause, whatever it might be. For Mr Molineux's instrument being originally designed for observing $\gamma$ Draconis, to try whether it had any sensible parallax, it was so contrived as to be capable of but little alteration in its direction; not above seven or eight minutes of a degree: and there being but few stars within half that distance from the zenith of Kew bright enough to be well observed, he could not, with his instrument, thoroughly examine how this cause affected stars that were differently situated with respect to the equinoctial and solstitial points of the ecliptic.

These considerations determined him; and by the contrivance and direction of the same ingenious person, Mr Graham, his instrument was fixed up the 19th of August 1727. As he had no convenient place where he could make use of so long a telescope as Mr Molineux's, he contented himself with one of but little more than half the length, namely of 12 feet and a half, the other being 24 feet and a half long, judging from the experience he had already had, that this radius would be long enough to adjust the instrument to a sufficient degree of exactness: and he had no reason afterwards to change his opinion; for by all his trials he was very well satisfied, that when it was carefully rectified, its situation might be securely depended on to half a second. As the place where his instrument was hung in some measure determined its radius, so did it also the length of the arc or limb, on which the divisions were made, to adjust it; for the arc could not conveniently be extended farther, than to reach to about $6\frac{1}{4}$ degrees on each side of the zenith. This however was sufficient, as it gave him an opportunity of making choice of several stars, very different both in magnitude and situation; there being more than two hundred, inserted in the British Catalogue, that might be observed with it. He needed not, indeed, to have extended the limb so far, but that he was willing to take in *Capella*, the only star of the first magnitude that came so near his zenith.

His instrument being fixed, he immediately began to observe such stars as he judged most proper to give him any light into the cause of the motion already mentioned. There was a sufficient variety of small ones, and not less than twelve that he could observe through all seasons of the year, as they were bright enough to be seen in the day-time, when nearest the sun. He had not been long observing, before he perceived that the notion they had before entertained, that the stars were farthest north and south when the sun was near the equinoxes, was only true of those stars which are near the solstitial colure. And after continuing his observations a few months, he discovered what he then apprehended to be a general law observed by all the stars, namely, that each of them became stationary, or was farthest north or south, when it passed over his zenith at six of the clock, either in the evening or morning. He perceived also, that whatever situation the stars were in with respect to the cardinal points of the ecliptic, the apparent motion of every one of them tended the same way when they passed his instrument about the same hour of the day or night; for they all moved southward when they passed in the day, and northward when in the night: so that each of them was farthest north when it came in the evening about six of the clock, and farthest south when it came about six in the morning.

Though he afterwards discovered that the maxima, in most of these stars, do not happen exactly when they pass at those hours; yet, not being able at that time to prove the contrary, and supposing that they did, he endeavoured to find out what proportion the greatest alterations of declination, in different stars, bore to each other; it being very evident that they did not all change their inclination equally. It has been before noticed, that it appeared from Mr Molineux's observations, that $\gamma$ *Draconis* changed its declination above twice as much as the before-mentioned small star that was nearly opposite to it; but examining the matter more nicely, he found that the greatest change in the declination of these stars was as the sine of the latitude of each star respectively. This led him to suspect that there might be the like proportion between the *maxima* of other stars; but finding that the observations of some of them would not perfectly correspond with such an hypothesis, and not knowing whether the small difference he met with might not be owing to the uncertainty and error of the observations, he deferred the further examination into the truth of this hypothesis till he should be furnished with a series of observations made in all parts of the year; which would enable him not only to determine what errors the observations might be liable to, or how far they might safely be depended on, but also to judge whether there had been any sensible change in the parts of the instrument itself.

When the year was completed, he began to examine and compare his observations; and having satisfied himself as to the general laws of the phenomena, he then endeavoured to find out the cause of them. He was already convinced that the apparent motion of the stars was not owing to a nutation of the earth's axis. The next circumstance which occurred to him, was an alteration in the direction of the plumb-line, by which the instrument was constantly adjusted; but this, upon trial, proved insufficient. Then he considered what refraction might do; but here also he met with no satisfaction. At last, in a state of great perplexity, the discovery of Roëmer occurred to him, that the motion of light, however incredibly swift, was not altogether instantaneous, but took a certain interval in passing from the sun to the earth; and then the truth flashed on his mind. He immediately perceived that the motion of the earth being also extremely rapid, might have though a small yet a perceptible relation to that of light. and might thus come by combining its influence to affect the direction of the visual rays, and with them the apparent situation of the stars, in the manner above explained. Pursuing this happy idea, he calculated the aberration from the relative velocities of the earth and of light, and comparing it with his own observations, was delighted to find them agree in every particular; so that no doubt could remain of the truth of his discovery. For further information on this subject, see ASTRONOMY, in this Encyclopædia; and also the following works, *Phil. Transactions*, vol. xxxv.; vol. lxxii. *Mem. Acad. Paris*, 1737; *Mem. Acad. Berlin*, tom. ii.; *Nov. Acad. Petrop.* tom. i.; *Connoissances des Temps*, 1788; T. Simpson's *Essays on Several Subjects*, 1740; *Boscovichii Opera*, tom. v. 1785; *Traité sur l'Aberration*, par Fontaines des Crutes; Cagnoli's *Trigonometrie;* Vince's *Astronomy*, vol. i.; Delambre, *Astronomie;* Woodhouse's *Astronomy.* (G. B.)

ABERRATION *of the Planets.* This is quite of the same nature with that of the stars, only that its amount and direction are greatly affected by the motion of the planet itself combining itself with that of the earth, and producing on the whole a more complex result. When the planet is stationary, the aberration disappears altogether, because the light itself, participating of the motion of the planet, strikes the earth not only with its usual direct motion, but also with a lateral motion exactly the same as that of the earth itself. The eye of the spectator, therefore, and the light have the same motion laterally; and thus the effect is quite the same as if they had relatively no lateral motion at all. It is the same as if both the earth and the planet were at rest, and therefore there cannot be any aberration. In every other case, the aberration is determined by combining the motion of light not only with the earth's, but with the planet's motion also; and doing this it is found, that in every case the aberration is equal to the motion of the planet about the earth or its geocentric motion, during the interval that light employs in passing from the planet to the earth. Thus, in the sun, the aberration in longitude is constantly 20″, that being the space moved by the sun, or, what is the same thing, by the earth, in 8′ 7″, the time in which light passes from the sun to the earth. In like manner, knowing the distance of any planet from the earth, by proportion it will be, as the distance of the sun is to the distance of the planet, so is 8′ 7″ to the time of light passing from the planet to the earth: then computing the planet's geocentric motion in this time, that will be the aberration of the planet, whether it be in longitude, latitude, right ascension, or declination.

Since the motion of the planets affects so much the aberration, ought not the motion of the fixed stars relatively to our system, if they have any, as some have suspected, be rendered sensible in this manner? Their prodigious distance has hitherto rendered these motions, if they do exist, almost insensible. But this would not affect the motion of light. This element flies through the remotest parts of the system; and if it be really material, the motion with which it is propelled from one point must continue for ever afterwards to affect it, unless opposed or modified by extraneous influence. If the stars, therefore, have any motion laterally in respect of the earth, so will the light which issues from them, and which, preserving undiminished its original impulse, must strike the eye of a spectator on the earth not only with a direct motion, but also with one to the right or left similar to that of the star; and this ought to affect the aberration just in the same manner as if the star were no farther off than any of the planets. The same thing would be observed if the earth, along with the whole solar system, as the late Dr Herschel and other astronomers have attempted to prove, be advancing forward among the stars. Since, however, no such effect has ever been noticed, it would seem to follow, that the stars, as well as the sun, are really at rest; or if they have any motion, it is but a slow one, even compared with that of the earth or the planets round the sun. This is certainly a curious speculation, which we have never seen discussed by astronomers. See ASTRONOMY. (G. B.)

ABERRATION, in *Optics*, a certain deviation in the rays of light, from the true or geometrical focus of reflection or refraction in curved specula or lenses, arising from two causes, viz. 1*st*, the figure of the speculum or lens, giving rise to what is called the *spherical* aberration; and, 2*d*, the unequal refrangibility of the rays of light giving rise, in lenses only however, to a far more material, and in other respects inconvenient aberration, termed the *chromatic*, or the aberration of *colour*, or of *refrangibility*. The object of all specula or lenses, is to collect the rays of light proceeding from any object into a single point, so as to form there a distinct image of the object, either enlarged or diminished, according as our purposes may require: and on this principle depends the whole operation of the telescope, the microscope, and other optical instruments. The more completely the rays can be collected into a focus, so much the more distinctly, in every case, does the image of the object appear at that point, and so much the more perfect is the operation of the instrument. But there are certain curves or figures in the speculum or lens, which are necessary to produce this effect. Parallel rays, for example, can only be collected into one focus by a reflecting speculum of a parabolic form, or by a refracting lens of parabolic or hyperbolic, combined with spherical curves: all other forms cause more or less a dispersion or aberration of the rays from the focus. In practice, however, it is extremely difficult to form the lenses into these complex curves; and as the spherical form is much more easily constructed, and as the aberration from it is not generally attended with serious inconvenience, this form has been universally adopted. The amount of the aberration is measured either by the distance *longitudinally* at which the rays meet from the true focus, or by the distance *laterally* by which they are dispersed from it. In all double convex lenses of equal spheres, the longitudinal aberration of the extreme ray is $1\frac{2}{3}$ of the thickness of the lens. The smallest aberration takes place when the radii of the spheres are as 1 to 6, the more convex surface being exposed to the rays; in that case, it is only $1\frac{1}{14}$th of the thickness of the lens. See OPTICS.



The aberration of refrangibility is of far more importance. It arises from this circumstance, that in a homogeneous lens of glass the violet rays are greatly more refracted than the red. The latter are therefore thrown to a greater distance, and the others in proportion almost all deviating from the true focus: hence arises that confusion of images, and that fringe of extraneous colour with which objects are surrounded when seen through glasses of this description, which has ever formed the great obstacle to the perfection of the refracting telescope; so much so, that Sir Isaac Newton, misled at the time by a partial view of the subject, and others after him, were led to despair of success in correcting this defect, and thus directed their chief attention to those of the *reflecting* kind. Subsequent discoveries, however, led to the invention of *achromatic* glasses, by which the refracting telescope has been wonderfully improved; and some important experiments, we understand, are now going on at the Royal Institution in London, by M. Faraday, under the direction of the Board of Longitude, in the manufacture of a more perfect glass than has hitherto been used, from which we may hope to see these instruments carried to a yet higher degree of perfection. See ACHROMATIC GLASSES; also *Phil. Trans.* vols. xxxv. xlviii., and from l. to lv.; *Mem. Acad. Par.* from 1737 to 1770; *Mem. Acad. Berlin*, from 1746 to 1798; *Nov. Comment. Petrop.* 1762; *Mem. Irish Academy*, vol. iv.; *Edinb. Trans.* vol. iii.; *Comment. Gottingen*, vol. xiii.; *Huygenii Dioptrica; Boscovichii Opera; Klingensteirna de Aberrationibus Luminis*, &c. (G. B.)

ABERYSTWITH, a market-town of Cardiganshire, in Wales, seated on the Rheidol, near its confluence with the Ystwith, where it falls into the sea. It has a considerable trade in lead, flannels, oak bark (which is mostly sent to Liverpool); and the fishery of whiting, cod, and herrings is valuable. It was formerly surrounded with walls, and fortified with a castle of great strength, the ruins of which occupy the summit of a *bluff* promontory on the S.W. of the town. The harbour has been of late much improved; and the picturesque situation of the place draws many visitors, especially for sea-bathing. The municipal government consists of a mayor, four aldermen, and twelve councillors. Pop. in 1841, 4916; in 1851, 5231.

ABESTA, or AVESTA, the name of one of the sacred books of the Persian magi, which they ascribe to their great founder Zoroaster. The Abesta is a commentary on two others of their religious books, called *Zend* and *Pazend;* the three together including the whole system of the Ignicolæ or worshippers of fire.

ABETTOR, a law term implying one who encourages another to the performance of some criminal action, or assists in the performance itself. Treason is the only crime in which abettors are excluded by law, every individual concerned being considered as a principal. It is the same with *art-and-part* in the Scottish law.

ABEX, a country of Africa, bordering on the Red Sea, by which it is bounded on the east. It has Nubia or Sennaar on the north; Sennaar and Abyssinia on the west; and Abyssinia on the south. Its principal towns are Suakim and Arkeko. It is subject to the sheriffe of Mea, and has the name of the beglerbeglik of Habeleth. It is about 500 miles in length and 100 in breadth; is a mountainous country, sandy, barren, and unhealthy, much infested with wild beasts; and the forests abound with ebony trees.

ABEYANCE, in *Law*, the expectancy of an estate. Thus, if lands be leased to one person for life, with reversion to another for years, the remainder for years is in abeyance till the death of the lessee.

ABGAR, or Abgarus, a name given to several of the kings of Edessa in Syria. The most celebrated of them was one, who, it is said, was contemporary with Jesus Christ; and who, having a distemper in his feet, and hearing of Jesus's miraculous cures, requested him by letter to come and cure him. Eusebius,[1] who believed that this letter was genuine, and also an answer our Saviour is said to have returned to it, has translated them both from the Syriac, and asserts that they were taken out of the archives of the city of Edessa. The first is as follows:—"Abgarus, prince of Edessa, to Jesus the holy Saviour, who hath appeared in the flesh in the confines of Jerusalem, greeting. I have heard of thee, and of the cures thou hast wrought without medicines or herbs. For it is reported thou makest the blind to see, the lame to walk, lepers to be clean, devils and unclean spirits to be expelled, such as have been long diseased to be healed, and the dead to be raised; all which when I heard concerning thee, I concluded with myself, that either thou wast a God come down from heaven, or the Son of God sent to do these things. I have therefore written to thee, beseeching thee to vouchsafe to come unto me and cure my disease. For I have also heard that the Jews use thee ill, and lay snares to destroy thee. I have here a little city, pleasantly situated, and sufficient for us both. Abgarus." To this letter Jesus, it is said, returned an answer by Ananias, Abgarus's courier, which was as follows:—"Blessed art thou, O Abgarus! who hast believed in me whom thou hast not seen; for the Scriptures say of me, 'They who have seen me have not believed in me, that they who have not seen may, by believing, have life.' But whereas thou writest to have me come to thee, it is of necessity that I fulfil all things here for which I am sent; and having finished them, to return to Him that sent me: but when I am returned to Him, I will then send one of my disciples to thee, who shall cure thy malady, and give life to thee and thine. Jesus." After Christ's ascension, Judas, who is also named Thomas, sent Thaddeus, one of the seventy, to Abgarus; who preached the gospel to him and his people, cured him of his disorder, and wrought many other miracles: which was done, says Eusebius, A.D. 43.—Though the above letters are acknowledged to be spurious by the candid writers of the church of Rome, several Protestant authors, as Dr Parker, Dr Cave, and Dr Grabe, have maintained that they are genuine, and ought not to be rejected.

[1] *Hist. Eccl.* lib. i. cap. 13.

ABGILLUS, John, surnamed Prester John, was son to a king of the Friscii; and, from the austerity of his life, obtained the name of *Prester*, or Priest. He attended Charlemagne in his expedition to the Holy Land; but instead of returning with that monarch to Europe, it is pretended that he gained mighty conquests, and founded the empire of the Abyssines, called, from his name, the empire of Prester John. He is said to have written the history of Charlemagne's journey into the Holy Land, and his own into the Indies; but they are more probably trifling romances, written in the ages of ignorance.

ABHEBBAD, or the Lake of Ausa, in the country of Adel, is the receptacle of the great river Hawash, which drains the eastern regions of Abyssinia. During the rains the lake acquires a superficial extent of about 50 leagues in circumference. It has no outlet.



ABIA, in *Ancient Geography*, a town of Messenia, on the Messenian Gulf, supposed to be the Ire of Homer, *Il.* ix. 292.

ABIAD, Bahr el, a great river of interior Africa, which, at Halfaia, below Sennaar, joins the Bahr-el-Azrek, or river of Abyssinia; and these unite at Khartoum and form the true Nile. The Abyssinian river was long considered by Europeans as the main stream; but more accurate observation has now clearly determined, that the Abiad, both as to magnitude and length of course, is entitled to the pre-eminence. Its sources, however, and the upper part of its course, have not been reached by any European. The nearest approaches to the source that have been made were in 1842, when an expedition from Egypt reached so far south as 4. 42. N. Lat., nearly in the meridian of Cairo; and in January 1850, when Dr Knoblicher, the Pope's vicar-general in Central Africa, reached about six miles farther south. The former saw no mountains, though they had passed the latitude commonly assigned to the Mountains of the Moon; on the contrary, they observed immense marshes and large islands. Dr Knoblicher twice ascended a mountain in the latitude above mentioned, and saw the river trending away in a southerly direction, till it vanished between two mountains. The last natives he met with, the Bary negroes, informed him that beyond those mountains the river came straight from the south.

ABIANUS, a river of ancient Scythia, falling into the Euxine; on which the Abii dwelt, a nation who subsisted on milk, and the flesh of their herds and flocks.

ABIATHAR, (*the Father of abundance*,) high priest of the Jews, son to Ahimelech, who had borne the same office, and received David into his house. This so enraged Saul, who hated David, that he put Ahimelech to death, and 81 priests; Abiathar alone escaped the massacre. He afterwards was high priest, and often gave King David testimonies of his fidelity, particularly during Absalom's conspiracy, at which time Abiathar followed David, and bore away the ark. But after this he conspired with Adonijah, in order to raise him to the throne of King David his father; which so exasperated Solomon against him, that he divested him of the priesthood, and banished him, A.M. 3021, before Christ 1014.

ABIB, signifying an ear of corn, a name given by the Jews to the first month of their ecclesiastical year, afterwards called *Nisan*. It commenced at the vernal equinox; and according to the course of the moon, by which their months were regulated, answered to the latter part of our March and beginning of April.

ABIES, the Fir-Tree. See Planting.

ABIGAIL, the wife of Nabal, on whose death she became the wife of King David, to whom she bare a son named both Chileab and Daniel, which has given rise to the idea that she had two sons by David. 2 Sam. iii. 3; 1 Chron. iii. 1.

ABIHU, (*the Father of Him*,) the second son of Aaron, with his brothers consecrated for the priesthood; but who with his brother Nadab, disregarding the divine injunction as to offering incense, and kindling their censers with unhallowed fire, were struck dead by lightning before the altar they had profaned.

ABILA, a city of ancient Syria, the capital of the tetrarchy of Abilene. Its site is indicated by some ruins and inscriptions, near the village of Souk, on the banks of the river Barrada, on the road between Baalbec and Damascus, a little to the east of the range of Esh Sharki, or Anti-libanus, 33. 40. N. Lat., 36. 91. E. Long. It was the capital of the Abilene of which Lysanias was tetrarch in the time of John the Baptist (Luke iii. 1). From the tradition of this being the scene of Abel's murder, it is now called Nebi-Abel. It lies between Baalbec and Damascus, in Lat. 33. 38. N., Long. 36. 18. E.

ABILDGAARD, Nicolas, a modern Danish historical painter, and a writer on art. Born in 1744, died in 1809. Thorwaldsen was one of his pupils.

ABIMELECH, signifying *Father of the King,* the name of the Philistine king of Gerar, in the time of Abraham; but from its recurrence among that people it was perhaps rather a titular distinction than a proper name, like *Pharaoh* among the Egyptians. After the destruction of "the cities of the plain," Abraham removed into his territory; and fearing that the beauty of Sarah might bring him into difficulties, he declared her to be his sister: whereupon Abimelech, in virtue of the royal prerogative to appropriate any unmarried female that pleased him, placed Sarah in his harem. But, in obedience to a divine warning, he forthwith restored her to her husband, with a strong and merited reproof for the deceit he had practised. Abimelech, however, made a league of peace and amity with Abraham, the first recorded in the Scriptures, and confirmed by a mutual oath. (Gen. xx.)

Abimelech, another king of Gerar, probably the son of the former, in the time of Isaac. During a famine Isaac sought refuge in this king's territories; and Rebekah's beauty induced her husband to employ the same subterfuge as his father had done in the case of Sarah; which deceit met with a similar rebuke from the king.

In that country, wells were of such vast importance, that the digging of them conferred a proprictary right to the soil not previously appropriated. During his sojourn there Abraham had dug wells, which were again cleared out by Isaac, who proceeded to cultivate the ground to which they gave him a right. This gave rise to disputes between the herdsmen of Isaac and Abimelech, which ended in the removal of the patriarch to Beersheba, where he concluded a treaty of amity with the king. (Gen. xxvi.)

Abimelech, the natural son of Gideon, by his concubine. His violent acts and death (A.M. 2769) are recorded in Judges, chap. ix.

ABINGDON, a market-town in Berkshire, on a branch of the Thames, derives its name from an ancient abbey. The streets, which are well paved, terminate in a spacious area, in which the market is held. In the centre of this area stands the market-house, supported on lofty pillars, with a large hall of freestone above, appropriated to the summer assizes for the county, and the transaction of other public business; the Lent assizes being held at Reading. It has two churches, which are said to have been erected by the abbots of Abingdon, one dedicated to St Nicholas, and the other to St Helena, the latter adorned with a spire: two hospitals, one for six, and the other for thirteen poor men, and as many poor women; a free grammar school, with ten scholarships at Pembroke College, Oxford; charity schools; a mechanics' institution, &c., and two banks. The town was incorporated by Queen Mary. It sends one member to parliament, and is governed by a mayor, four aldermen, and twelve councillors. During the war it manufactured much sail-cloth and sacking; but its chief trade now is in corn and malt, with a few carpets and coarse linen. It is seven miles south of Oxford, 47 east of Gloucester, and 55 W.N.W. of London. This town is supposed by Bishop Gibson to be the place called in the Saxon annals *Cloveshoo.* Population in 1841, 5585; in 1851, 5954.

ABINTESTATE, in *Law,* is applied to a person who inherits the right of one who died intestate, or without making a will.

ABIPONIANS, a tribe of American Indians, who formerly inhabited the district of *Chaks* in Paraguay; but the hostilities of the Spaniards have now obliged them to remove southward into the territory lying between Santa Fe and St Jago. M. Dobrizhoffer, who lived seven years in their country, informs us, in his account of them published in 1785, that they are not numerous, the whole nation not much exceeding 5000; for which he assigns as a reason an unnatural custom among their women of sometimes destroying their own children, from motives of jealousy lest their husbands should take other mates during the long time they give suck, which is not less than two years. They are naturally white, but, by exposure to the air and smoke, become of a brown colour. They are a strong and hardy race of people, which our author attributes to their marrying so late, an Abiponian seldom or never thinking of marriage till 30 years of age. They are greatly celebrated on account of their chastity and other virtues; though, according to our author, they have no knowledge of a Deity. They make frequent incursions into the territories of the Spaniards, mounted on the horses which run wild in those parts. They have a kind of order of chivalry for their warriors; and are so formidable, that 100 of their enemies will fly before ten of these horsemen. The hatred which these savages, whose manners, though rude and uncultivated, are in many respects pure and virtuous, bear to the Spaniards, is invincible. "These pretended Christians," says our author, "who are the scum of the Spanish nation, practise every kind of fraud and villany among these poor barbarians; and their corrupt and vicious morals are so adapted to prejudice the Abiponians against the Christian religion, that the Jesuit missionaries have, by a severe law, prohibited any Spaniard from coming, without a formal permission, into any of their colonies." From his account of the success of the Jesuits in converting them to Christianity, however, it does not appear that they have been able to do more than bribe them to a compliance with the ceremonies of the Popish religion; so that in general they are quite ignorant and uncivilized; a most striking instance of which is, that in counting they can go no further than three; and all the art of the Jesuits to teach them the simplest use and expression of numbers has proved unsuccessful. Dobrizhoffer's account of this people was translated into English by Mr Southey, and published in 1822, in 3 vols. 8vo.



ABIRAM, a seditious Reubenite, who, in concert with Korah and Dathan, rebelled against Moses and Aaron, in order to share with them in the government of the people; when Moses ordering them to come with their censers before the altar of the Lord, the earth suddenly opened under their feet, and swallowed up them and their tents; and at the same instant fire came from heaven and consumed 250 of their followers. (Numb. xvi.)

ABISHAI, son of Zeruiah, and brother to Joab, was one of the celebrated warriors who flourished in the reign of David: he killed with his own hand 300 men, with no other weapon but his lance; and slew a Philistine giant, the iron of whose spear weighed 300 shekels. (1 Sam. xxvi.; 2 Sam. xxiii.)

ABJURATION, in our ancient customs, implied an oath taken by a person guilty of felony, and who had fled to a place of sanctuary, whereby he solemnly engaged to leave the kingdom for ever.

Abjuration was used also to signify the renouncing, disclaiming, and denying upon oath, the Pretender to have any kind of right to the crown of these kingdoms.

*Abjuration of Heresy,* the solemn recantation of any doctrine as false and wicked.

ABLACTATION, (*ab* and *lacto,* I suck,) the ancient term for what is now called *Grafting by approach,* a method of ingrafting, by which the scion of one tree being for some time united to the stock of another, is afterwards cut off, and, as it were, weaned from the parent tree.

ABLAIKET, in the government of Orel. It is situated on a river of the same name which flows into the Irtysch, and contains the remains of a temple built in the 17th century, by the Kalmuck Prince Ablai.

ABLAQUEATION, (*ab* and *laquear,* a roof or covering,) an old term in *Gardening*, signifies the operation of removing the earth, and baring the roots of trees in winter, to expose them more freely to the air, rain, snow, &c.

ABLATIVE, in *Grammar*, the sixth case of Latin nouns. The word is formed from *ablatus*, the participle of *auferre*, "to take away." Priscian calls it also the *comparative case;* as serving among the Latins for comparing, as well as taking away.

The ABLATIVE is opposite to the DATIVE; the first expressing the action of taking away, and the latter that of giving.

In English, French, &c., there is no precise mark whereby to distinguish the ablative from other cases; and we only use the term from analogy to the Latin.

The question concerning the Greek ablative has been the subject of a famous literary war between two great grammarians, Frischlin and Crusius; the former maintaining, and the latter opposing, its existence. The dispute still subsists among their respective followers. The chief reason alleged by the former is, that the Roman writers often joined Greek words with the Latin prepositions which govern ablative cases, as well as with nouns of the same case. To which their opponents answer, that the Latins anciently had no ablative themselves, but instead thereof made use, like the Greeks, of the dative case; till at length they formed an ablative, governed by prepositions, which were not put before the dative: that, at first, the two cases had always the same termination, as they still have in many instances; but that this was afterwards changed in certain words. It is no wonder, then, that the Latins sometimes join prepositions which govern an ablative case, or nouns in the ablative case, with Greek datives, since they were originally the same; and that the Greek dative has the same effect as the Latin ablative.

ABLATIVE ABSOLUTE, in *Grammar*, is applied to a noun with a participle in the ablative case detached or independent of the other parts of a sentence or discourse. In the Latin language it is frequent, and it has been adopted by the moderns.

ABLAVIUS, a Roman who wrote a history of the Goths, quoted by Jornandes, *De Reb. Getic.* iv. 14. 23.

ABLAY, a country of Great Tartary, governed by a Kalmuck chief, but subject to Russia, in return for its protection. It lies east of the river Irtysch, and extends 400 leagues along the southern frontiers of Siberia.

ABLE, or ABEL, THOMAS, chaplain to Queen Catherine, consort to Henry VIII., distinguished himself by his zeal in opposing the proceedings against that unfortunate princess for a divorce. For this purpose he wrote a piece entitled *Tractatus de non dissolvendo Henrici et Catharinæ matrimonio.* But the title of the book, according to Bishop Tanner, was *Invicta Veritas.* He took the degree of bachelor of arts at Oxford on the 4th of July 1513, and that of master of arts on the 27th July 1516. In 1534 he fell under a prosecution for being concerned in the affair of Elizabeth Barton, called the *Holy Maid of Kent.* This was an infamous impostor, suborned by the monks to use strange gesticulations, exhibit fictitious miracles, and to feign the gift of prophecy; and so well did she act her part, that she drew some persons of respectability to her interest: but being detected, she was condemned and executed, after discovering the names of her principal accomplices and instigators. On her account Able was charged with misprision of treason; and being also one of those who denied the king's supremacy over the church, he was apprehended and imprisoned. He was afterwards hanged, drawn, and quartered, at Smithfield, in 1540.

ABLECTI, in Roman antiquity, a select body of soldiers chosen from among those called EXTRAORDINARII.

ABLEGMINA, in Roman antiquity, those choice parts of the entrails of victims which were offered in sacrifice to the gods. They were sprinkled with flour, and burnt upon the altar; the priests pouring some wine on them.



ABLUTION, a ceremony in use among the ancients, and still practised in several parts of the world: it consisted in washing the body, which was always done before sacrificing, or even entering their houses. Ablutions appear to be as old as any ceremonies, or as external worship itself. Moses enjoined them, the heathens adopted them, and Mahomet and his followers have continued them; thus they have got footing among most nations, and make a considerable part of many established religions. The ceremony of ablution, the symbol of spiritual purity, was at first, perhaps, graciously designed as an incitement to personal cleanliness; and there can scarce be a doubt that this salutary end chiefly was proposed in its adoption by the legislators of succeeding times. In the desert, when no water is to be found, the Arabs perform this rite, according to Mohammedan law, with sand.

ABNER, the cousin of Saul (being the son of his uncle Ner), and the commander-in-chief of his army. When Saul was slain in the battle of Gilboa, David was made king over his own tribe of Judah, and reigned in Hebron. In the other tribes an influence adverse to Judah existed, and was controlled chiefly by the tribe of Ephraim. Abner availed himself of this state of feeling, and took Ishbosheth, a surviving son of Saul, whose known imbecility had excused his absence from the fatal fight in which his father and brothers perished, and made him king over the tribes, and ruled in his name. A sort of desultory warfare arose between them, in which the advantage appears to have been always on the side of David. In one of the engagements, Abner was beaten and fled for his life; and when pursued by Asahel, the brother of Joab, slew him by a back thrust with the pointed heel of his spear (2 Sam. ii. 8-32). This put a strife of blood between Abner and Joab; for the law of honour which in early times existed among the Hebrews, and which still prevails in Arabia, rendered it the conventional duty of Joab to avenge the blood of his brother upon the person by whom he had been slain.

As time went on, Abner had occasion to feel more strongly that he was himself not only the chief, but the only remaining prop of the house of Saul: and this conviction, acting upon a proud and arrogant spirit, led him to more presumptuous conduct than even the mildness of the feeble Ishbosheth could suffer to pass without question. Abner having taken into his harem a woman who had been a concubine-wife of Saul, was rebuked by the nominal king for his presumption. Being offended by the language of Ishbosheth, Abner resolved to abandon his cause and transfer his allegiance to the son of Jesse. He repaired to Hebron where he made certain overtures to David, which were gladly received, and David in return agreed that he should have the command of the combined armies on the union of the kingdoms. Abner had just left Hebron as Joab who had been absent returned to it, and learning what had taken place between Abner and David, he determined, under the influence of revenge and jealousy, to avenge himself of his adversary. Without the knowledge of the king, he treacherously sent a messenger to call Abner back, under the pretence that he wanted to confer peaceably with him, and while engaged in this conference, Joab led him aside and suddenly plunged his sword into his side. This assassination of Abner might have been dangerous to David, but his deep and genuine grief and lamentation over the cruel and treacherous act of Joab obviated the dangers which it might have produced.

ABNOBA, now ABENAU, in *Geography*, a long range of mountains in Germany, extending from the Rhine to the Neckar, having different names in the different countries through which they stretch. About the river Maine they are called the *Oden* or *Otenwald;* between Hesse and Franconia, the *Spessart;* and about the duchy of Wirtemberg, where the Danube takes its rise, they receive the name of *Baar.*

ABNORMAL, (*ab* and *norma*, a rule or pattern,) is employed, in physical science, to denote any state of irregularity or deviation from the general form, or law, of nature.

ÅBO, a district in the province of Finland, in 1809 transferred to Russia from Sweden. By the new division, it extends over 12,145 square miles, between Lat. 59. 50. and 62. 20. N., and Long. 19. 10. and 23. 46. E. It is bounded on the north by the circle of Wasa; on the east by Tavastehus; on the south by the Gulf of Finland; on the south-east by the Baltic Sea; and on the west by the Gulf of Bothnia, in which the Aland group of islands comprehended in this circle are situated. It contains 6 cities, and 4980 hamlets. The number of inhabitants may be estimated at 208,000; of whom about 20,000 live in cities, and the remainder in the country places. On the sea-coast, and on the eastern side of the circle, it is rather hilly; but the centre is chiefly a level country. The land is of medium fertility, producing rye, potatoes, hemp, flax, hops, and tobacco. The forests produce plants, pitch, and tar, and some potash. The coasts yield abundance of fish. It is divided into nine horads or baronies.

Åbo, a city in the Russian province of Finland, and chief town of the circle of the same name. It is situated near the extremity of the promontory, formed by the gulfs of Bothnia and Finland, and is divided into two parts by the river Aurajoki. Åbo is the seat of a Lutheran archbishop, and of the supreme court of justice for South Finland; and was the chief place of export from Finland to Sweden. It has a bank and gymnasium, carries on several manufactures of sailcloth, linen, glass, leather, tobacco, &c.; and its ship-building is considerable. Previous to 1819, Åbo was the capital of Finland; in 1743, the peace between Russia and Sweden was concluded here. By a most extensive fire in November 1827, nearly the whole city was destroyed, including the university and its valuable library. Immediately before this calamity, Åbo contained 1100 houses, and 13,000 inhabitants; and its university had 40 professors, more than 500 students, and a library of upwards of 30,000 volumes, together with a botanical garden, an observatory, a chemical laboratory, &c. The university has since been removed to Helsingfors. The entrance of the Aurajoki is defended by a castle. Vessels drawing 9 or 10 feet water go up to the town; but those drawing more, anchor 3 miles south-west of the river, where there is a good harbour; and thence the goods are sent by small craft to Åbo. Population in 1846, 12,000. The great church is in Lat. 60. 27. 14. N. and in Long. 22. 18. 10. E.

ABOARD, the inside of a ship. Hence any person who enters a ship is said to *go aboard:* but when an enemy enters in the time of battle, he is said to *board;* a phrase which always implies hostility.—To *fall aboard of*, is to strike or *encounter* another ship when one or both are in motion, or to be driven upon a ship by the force of the wind or current. —*Aboard-main-tack*, the order to draw the main-tack, *i.e.* the lower corner of the mainsail, down to the CHESS-TREE.

ABOLITION, the act of abolishing or annulling, abrogation. The putting an end to slavery; emancipation.

ABOLITIONIST, a person who favours abolition of slavery, or the immediate emancipation of slaves.

This term is usually applied to the members of the American Anti-Slavery Society. The condition of the negro population of the United States had, at an early period, attracted the attention of some of its philanthropic citizens, and a society was organized for the purpose of planting colonies of liberated American slaves on the western coast of Africa, where it was anticipated they would open the way for the introduction of Christianity, and operate as an effectual check upon the slave-trade. The spirit and tendency of this colonization scheme, however, soon began to be viewed with suspicion and dislike by the more earnest and uncompromising opponents of slavery, and on the 1st of January 1832, William Lloyd Garrison, and a few other ardent emancipationists, formed themselves at Boston into a society, which became the nucleus of a larger and more influential association, subsequently organized at Philadelphia, under the name of the "American Anti-Slavery Society;" on the principle of immediate and unconditional emancipation. Its members include persons of both sexes, and of all diversities of sentiment on religious and political questions, who agree in the opinion that slavery is a sin, and should be immediately abandoned. The measures adopted by the Abolitionists to promote the object which they have in view, have been prosecuted with untiring energy and zeal, in the face of the most virulent opposition; and the question which they have stirred has awakened great excitement, not only in the United States, but also in Great Britain. Their movements, however, have been weakened by divisions in their own ranks. In 1839, what is called the "Women's Rights Question" was raised, and a large majority of the members of the Anti-Slavery Society having decided that females as well as males should sit on the Committee, the minority immediately seceded, and organized a new association, under the name of the "American and Foreign Anti-slavery Society." In connection with this movement, another element of discord arose. The new society is composed of persons holding evangelical sentiments, and they have made it matter of charge against the original association that many of its members and most prominent office-bearers are the enemies of Christianity, and have mingled infidel arguments and appeals with their advocacy of emancipation.

Mr Garrison and his friends decline to vote or hold office under the present constitution of the United States, on the ground that it sanctions slavery—ordains that fugitive slaves shall be returned to their masters, on proof of their condition; that slave insurrections shall be suppressed by the strong arm of the nation; and that the slaveholders shall virtually have three votes for every five slaves they hold. A preliminary oath to support the constitution is required of every person holding public office in the country, and as the members of the Anti-Slavery Society do not mean to support the constitution in these particulars, they refuse to hold office under such an oath, or to appoint others by their votes to do so.

There are several other Anti-Slavery Societies in the United States, such as the "Liberty Party;" the "Free Soil Party;" and the "Christian Anti-Slavery Association." The "Liberty Party" had its origin in the unconquerable passion of the Americans for political action. Its members aim to be "a Third Party" with the abolition of slavery for their gathering cry. They enter into direct competition with the Whigs and Democrats, they nominate candidates for office, and adopt the usual tactics of party warfare to carry the election of their nominees. The object of the "Free Soil Party" is chiefly to maintain the balance of power in favour of the free states, by preventing the intrusion of slavery into the territories of the union which may eventually become States, and as such, exercise an influence on Congress in favour of the North or the South, as they happen to reject or retain the institution of slavery. The "Christian Anti-Slavery Association" was established at a convention held in Chicago in July 1851. Its name sufficiently explains its constitutional object. (J. T.)

Abolla || Abortion.

ABOLLA, in antiquity, a warm kind of garment, lined or doubled, worn by the Greeks and Romans, chiefly out of the city, in following the camp. Critics and antiquaries are greatly divided as to the form, use, kinds, &c. of this garment.

ABOMEY, capital of the kingdom of Dahomey, 7. 30. N. Lat. 2. 17. E. Long.

ABON, Abona, or Abonis, in *Ancient Geography*, a town and river of Albion, probably Abingdon.

ABONI-TEICHOS, afterwards Ionopolis, now Ineboli, a town of Paphlagonia, on the Black Sea, the birth-place of the impostor Alexander, of whom Lucian gives an amusing account.—(Lucian. *Alex.*)

ABOO, (Abu, Abuje, Abughad,) a celebrated mountain of Rajpootana, in India, rising from a very broad base, to an elevation of 5000 feet above the level of the sea, N. Lat. 42. 40. E. Long. 72. 48. Its elevations and platforms are covered with shrines, temples, castles, and tombs, adorned with sculptures and statues, relieved at intervals by wild and beautiful scenery. On the very top is a small round platform containing a cavern, with a block of granite, bearing the impression of the feet of Data-Briga, (an incarnation of Vishnu,) which is the grand object of pilgrimage to the Jains, Shrawaks, and Banians. But in that part of the mountain called Dailwarra, or Dewulwarra, (the region of temples,) are four Jain temples, all of marble, and two of them of the richest kind. One of these, indeed, is considered the most superb of all the temples of India, to which no edifice but the Taj-Mahal, at Agra, can be compared. It is sacred to Vrishabdeva, the first of the Jains, was erected by Bimul Sal, a merchant of Auhulwarra, and attracts pilgrims from every part of India. The principal building is surrounded by numerous smaller temples, the chief features of which are not mere vastness and solidity. Their merits consist rather in the proportions, the endless variety and richness of their sculptures, their long colonnades and vaulted roofs, which bear evidence not only of unbounded wealth in the founders, but also of high refinement in the arts.—*Colonel Todd's Travels in Western India.*

ABORIGINES, in *History*, originally a proper name, given to a certain people in Italy, who inhabited the ancient Latium, or country now called *Campagna di Roma*. Whence this people came by the appellation is much disputed. St Jerome says, they were so called, as being *absque origine*, the primitive planters of the country after the flood: Dionysius of Halicarnassus accounts for the name, as denoting them the founders of the race of inhabitants of that country: others think them so called as being originally Arcadians, who claimed to be earth-born, and not descended from any people. The term *Aborigines*, in modern geography, is applied to the primitive inhabitants of a country, in contradistinction to colonies, or new races of people.

ABORRHAS, in *Ancient Geography*, a branch of the Euphrates which joins that river on the east side, near Arcesium. It is called Araxes by Xenophon. Its modern name is Khabur. Xen. *Anab.* i.; Strabo, xvi.

ABORTION, in *Midwifery*, the premature exclusion of a fœtus. It has sometimes been doubted whether this unnatural practice was ranked as a crime in the laws of Greece and Rome. This question has been revived, and elaborately discussed in France, by some members of the Institute. The subject, it seems, had been incidentally alluded to in a discourse of Gregoire's upon the influence of Christianity on the condition of the female sex, read in the early part of 1814. This produced two dissertations, one by M. Clavier, and the other by M. Boissonade; the first maintaining the impunity of the practice among the ancients, the last, that it was on the contrary viewed as a penal office.

We find, says M. Clavier, that in one of Plato's dialogues (*Theæt.*) Socrates is made to speak of artificial abortion, as a practice not only common, but allowable; and Plato himself authorises it in his *Republic*, (lib. v.). Aristotle (*Polit.* lib. vii. c. 17) gives it as his opinion, that no child ought to be suffered to come into the world, the mother being above forty, or the father above fifty-five years of age. Lysias maintained, in one of his pleadings quoted by Harpocration, that forced abortion could not be considered homicide, because a child *in utero* was not an animal, or separate existence. M. Clavier admits, that, in a treatise ascribed to Galen, (*An animal sit quod in utero est?*) there is mention made of enactments by Solon and Lycurgus against this crime; but he maintains that this is a spurious production, and that, at any rate, his testimony cannot be opposed to that of so many writers who lived long before his age. Among the Romans, Ovid (*Amor.* lib. ii), Juvenal (*Sat.* vi. 594), and Seneca (*Consol. ad Helv.* 16), though they lament in strong terms the frequency of this enormity, yet they never allude to any laws by which it might be suppressed. Various other writers, it is said, preserve the same silence on this point whilst joining in general reprobation of the crime.

Abortion.

On the other hand, M. Boissonade appeals not only to the authority of Galen, but of Cicero (*Pro Cluentio*), as placing it beyond a doubt, that, so far from being allowed to pass with impunity, the offence in question was sometimes punished with death. With regard to the authority of Lysias, he states, that the pleading referred to is quoted by Harpocration himself as of dubious authenticity; and, as to Plato and Aristotle, he observes, that their speculative reasonings, in matters of legislation, ought not to be confounded with the actual state of the laws. And he adds, that Stobæus (*Serm.* 73) has preserved a passage from Musonius, in which that philosopher expressly states, that the ancient lawgivers inflicted punishments on females who caused themselves to abort.

It seems indeed difficult to believe, that the practice in question should have been allowed to prevail without being denounced as criminal by the lawgivers of Greece and Rome; but it is not so clear that there was any law which punished it with death. Those readers who have any curiosity to enter more deeply into the inquiry, will be enabled to do so by consulting the various authorities to which M. Clavier and M. Boissonade have appealed, in support of their respective views of the question. The notorious frequency of the practice forms an odious feature in the manners of ancient times. Seneca makes it a ground of distinction for Helvia, that she had never, like others of her countrywomen, destroyed the child in her womb, in order to preserve her shape.

By the law of England till lately, the only party held to be guilty of murder in forcing abortion was the woman, when she was proved to have taken means to destroy a child *quick* in the womb, and actually to have thereby destroyed it. But in 1803, an act was passed, inflicting the punishment of death upon *all* concerned in *administering* any noxious substance with the *intent* to procure the miscarriage of any woman *quick* with child. The procuring or attempting it before the child had quickened, was punishable only with imprisonment or transportation. This law was evidently grounded upon a false hypothesis, that the fœtus is not quick or alive till its motion in the womb becomes perceptible to the mother; and, what is of more importance, it made no provision against the attempt to procure abortion by *manual* application. The reader will find a curious illustration of this defect, in a trial which occurred at the assizes held at Bury St Edmunds in 1808. See *Trial of William Pizzy*, &c. Ipswich, 1808. An act however was passed in Will. IV. 7, & Vict. 1. to remove all those anomalies; and pronounces as guilty of felony all who shall procure the miscarriage of a female by administering to her medicaments or poisons, or by any manual operation, in any period of her pregnancy.

The case of John Fenton, tried at Perth in 1763, was the first instance of a criminal prosecution for this offence in Scotland; and here the public prosecutor restricted the libel to an arbitrary punishment. Our writers indeed agree, that, by the law of Scotland, the forcing of abortion was not homicide, whether the child be quick or not, except where the mother is killed in the process.

*Abortive Vellum*, is made of the skin of an abortive or immature calf.

ABOUKIR, a small town of Egypt, with a castle and a little island adjoining, with which it is connected by a chain of rocks. It stands at the eastern extremity of the long neck of land between the sea and the lakes Mareotis and Maadie, upon which Alexandria, about twelve miles to the westward, is also situated. Eastward lies the spacious bay of Aboukir, reaching to the mouth of the Nile. This vicinity was the scene of some of the greatest events which distinguished the late war between Britain and France. In the bay of Aboukir, Nelson found the French fleet which had conveyed Buonaparte to Egypt, and on the 1st of August 1798, gained that signal victory usually called the "Battle of the Nile," in which the whole of the enemy's fleet, with the exception of two vessels, were destroyed or captured. It was at Aboukir also that Sir Ralph Abercromby, in 1801, effected his landing, and having driven the enemy up the sand hills, took possession of the place. In other respects Aboukir is not of much importance. Lat. 31. 20. N. Long. 30. 5. E. It is said to be the ancient *Canopus*.

ABOULFEDA, or ABULFEDA, the most celebrated of the Arabian writers on history and geography. Among his contemporaries he was also distinguished both as a ruler and a warrior. His descent was in a direct line from Ayoub, father to Saladin, and from whom the house of that conqueror received the appellation of Ayoubites. Omar, the grandson of Ayoub, was one of Saladin's most distinguished generals, and enjoyed the privilege, which he transmitted to his posterity, of being placed always on the right of the army. In reward of his services, he was created Prince of Hamah, the ancient Apamea, which, with some territories adjoining, became hereditary in his family. They were transmitted, in the course of succession, to Mahommed Mahmoud, and to Mahommed, the uncle of Aboulfeda. Although none of these princes equalled the military glory of Omar, they were yet distinguished both in arms and letters. Continually engaged in military expeditions, their court was at the same time open to learned men. It is mentioned, among the proofs of their zeal for science, that Mahmoud caused to be constructed at Hamah, a gilded sphere of great magnitude, on which all the stars then known were represented.

Aboulfeda was son to Ali, the brother of Mahommed. He was born at Damascus in the year 672 of the Hegira, (1273 A. D.) His early years were spent in the study of the Koran and of the sciences. By the age of twelve, however, he was summoned to the field, and was present at the attack of Marcab, a castle belonging to the knights of St John. Syria was then shaken by continual war, and thus scarcely a year elapsed, in which the young prince was not called out upon some military expedition. He successively assisted at the sieges of Tripoli, Acre, and Roum. In 1298, Prince Mahmoud, his cousin, who held the sovereignty, died, and left Aboulfeda his heir. The succession, however, being violently disputed by his two brothers, the court, in consequence of their dissensions, took occasion to supersede all the three; and the Ayoubites lost the principality which they had enjoyed for more than a century. Aboulfeda, however, by his valour and other eminent qualities, soon recommended himself to the favour of the Sultan Melik-el-Nassir. He was present, and took an active part in the victory gained at Alkoroum in 1302, and in the still more signal one near Damascus in 1303, by which Syria was for the time delivered from the incursions of the Tartars. But peace was soon followed by internal dissensions. The throne of Egypt was disputed with Melik-el-Nassir by Bibars, who at first succeeded in obtaining possession of it. His rival, however, being supported by the great men of Syria, among whom Aboulfeda took a conspicuous part, finally triumphed. Aboulfeda, who had always stood well with Melik-el-Nassir, rose then into peculiar favour. The sultan took the first opportunity of establishing him in his patrimonial dignity of Prince of Hamah. Honours continued to shower upon him; he was invested with the distinctive marks of sovereignty, which consisted in the power of coining money, and in having prayers said in his name. The epithet *Melik Mowayyad*, victorious Prince, was conferred upon him; and it is stated by an Arabian author, that the sultan, in writing, addressed him by the appellation of brother.

The rest of Aboulfeda's life was spent in splendour and tranquillity, devoted to the government of his territory, and to the pursuits of science. Besides cultivating, he patronised literature; and his court became the rendezvous of all the learned men of the East. He conversed with them familiarly, bestowed upon them honours and pensions, and being himself superior to all in learning, felt no jealousy of their acquirements. During the same period he composed the works which have transmitted his name to posterity. In this enviable manner he spent the period of twenty years, when an illness, of which the particulars are not related, carried him off on the 26th October 1331. He was succeeded by his son Melik-el-Afdhal, of whom little is recorded, and who was the last Prince of Hamah.

The two works by which Aboulfeda is known in Europe, are his *Geography* and his *History*. The former ranks at least equal to any composed upon that subject by the Arabian writers. It partakes indeed of their general defects; for, although he seems to have paid more attention to the latitudes and longitudes than the rest of his countrymen, yet the imperfect application of astronomy, and the obscurity of his notation, have much diminished the value of this part of his labours. It is chiefly in the historical and descriptive parts that he can now be regarded as an authority. Here, too, his knowledge, as he himself candidly confesses, is chiefly confined to the circle of Moslem dominion; but within those limits, the information conveyed by him is undoubtedly valuable.

His *History* possesses still higher claims to distinction. His method, as was usual with his countrymen, is entirely that of annals, and is in many parts too much abridged; but the work contains much valuable information with regard to the Saracen, and even to the Greek empire. It is divided into five parts, beginning at the creation of the world, and ending with the year 1328.

There are copies of his *Geography* in manuscript in the national library of France, in that of the university of Leyden, and in the Bodleian. It has hitherto been published only in fragments, of which the following are the principal. *Chorasmia et Mawaralnahra* a Joan. Gravio, Londini; reprinted along with *Arabia*, in Hudson's *Geographi Græci Minores*, Oxford, 1698–1712.—*Tabula Syri*, Arab. et Lat. by Koehler and Reiske, 4to. Leipsic, 1766.—*Descriptio Ægypti*, Arab. et Lat. Michaelis, Gotting. 8vo, 1776.—*Africa Arab. cum notis J. G. Eichhorn*, Gotting. 1791.—*Arabia cum commentario*, Chr. Rommel, Gotting. 4to. 1801. Complete editions were undertaken by Bishop Hyde, by D'Arvieux in conjunction with Thevenot, and by Gagnier, the translator of the life of Mahomet: but different circumstances prevented their execution.

The *History* of Aboulfeda is also found in manuscript in the French, Bodleian, and Escurial libraries. A great part of the copy preserved in the first is believed to be autograph. This work has been published only in fragments. *Life of Mahomet*, Arab. et Lat. Gagnier, fol. Oxoniæ, 1723. *Annales Moslemici*, Lat. Reiske, Lipsiæ, 1754.—*Annales Moslemici*, sumptibus P. F. Suhmii, 5 tom. 4to. Hafniæ, 1789–94. Sulim was historiographer and chamberlain to the King of Denmark. The edition is excellent, and enriched with notes by Reiske.

See *Notice Historique sur Abulfeda et ses Ouvrages*, par Am. Jourdain. Malte-Brun. *Annales des Voyages*, tom. xviii. (H.M.)

ABOUTIGE, a town of Upper Egypt, in Africa, near the Nile, where they made the best opium in all the Levant. It was formerly a large, but now is a mean place. N. Lat. 26. 50.

ABRABANEL, Abarbanel, or Avravanel, Isaac, a celebrated rabbi, claiming descent from King David, was born at Lisbon, A.D. 1437. He became counsellor to Alphonso V., king of Portugal, and afterwards to Ferdinand the Catholic; but in 1492 was obliged to leave Spain with the other Jews. In short, after residing at Naples, Corfu, and several other cities, he died at Venice in 1508, aged 71. Abrabanel passed for one of the most learned of the rabbis; and the Jews gave him the names of the Sage, the Prince, and the Great Politician. We have a commentary of his on all the Old Testament, which is pretty scarce: he there principally adheres to the literal sense; and his style is clear, but a little diffuse. His other works are, A Treatise on the Creation of the world; in which he refutes Aristotle, who imagined that the world was eternal: A Treatise on the Explication of the Prophecies relating to the Messiah, against the Christians: A book concerning Articles of Faith; and some others less sought after. Though Abrabanel discovers his implacable aversion to Christianity in all his writings, yet he treated Christians with politeness and urbanity in the common affairs of life.

ABRACADABRA, a magical word, recommended by Serenus Samonicus as an antidote against agues and several other diseases. It was to be written upon a piece of paper as many times as the word contains letters, omitting the last letter of the former every time, as in the margin,[1] and repeated in the same order; and then suspended about the neck by a linen thread. *Abracadabra* was the name of a god worshipped by the Syrians, the wearing of whose name was a sort of invocation of his aid.

[1]
abracadabra
abracadabr
abracadab
abracada
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a

ABRADATAS, a King of Susa, whose wife, Panthea, was taken captive on the conquest of the Assyrian camp by Cyrus. In consequence of the honourable treatment which she received, Abradatas joined Cyrus with all his forces, but soon after perished in battle; and Panthea, inconsolable for her loss, put an end to her life. Xen. *Cyropæd.*; Lucian, *Imag.*

ABRAHAM, the founder of the Hebrew nation. Up to Gen. xvii. 4, 5, he is uniformly called Abram (אברם *father of elevation*, or *high father*; Sept. Ἄβραμ), and this was his original name; but the extended form, which it always afterwards bears, was given to it to make it significant of the promise of a numerous posterity which was at the same time made to him.

Abraham was descended through Heber, in the ninth generation, from Shem the son of Noah. His father was Terah, who had two other sons, Nahor and Haran. Haran died prematurely "before his father," leaving a son Lot, and two daughters, Milcah and Iscah. Lot attached himself to his uncle Abraham; and Milcah became the wife of her uncle Nahor.

Abraham was born A.M. 2008, B.C. 1996 (Hales, A.M. 3258, B.C. 2153), in "Ur of the Chaldees." The concise history in Genesis states nothing concerning the portion of his life prior to the age of 60. He took to wife Sarai, who was his sister by the father's side (Gen. xx. 12), though some suppose that Iscah and Sarai were the same person.



Although Abraham is, by way of eminence, named first, it appears probable that he was the youngest of Terah's sons, and born by a second wife, when his father was 130 years old. Terah was seventy years old when the eldest son was born (Gen. xi. 32; xii. 4; xx. 12: comp. Hales ii. 107). It is shown by Hales (ii. 107), that Abraham was 60 years old when the family quitted their native city of Ur, and went and abode in Charran. The reason for this movement does not appear in the Old Testament; but the real cause transpires in Acts. vii. 2–4: "The God of glory appeared to our father Abraham while he was (at Ur of the Chaldees) in Mesopotamia, *before he dwelt in Charran*, and said unto him, Depart from *thy land*, and from thy kindred, and come hither to *a land* (γῆν) which *I will* shew thee. Then departing from the land of the Chaldees, he dwelt in Charran." This *first* call is not recorded, but only implied in Gen. xii.: and it is distinguished by several pointed circumstances from the *second*, which alone is there mentioned. Accordingly Abraham departed, and his family, including his aged father, removed with him. They proceeded not at once to the land of Canaan, which indeed had not been yet indicated to Abraham. At that convenient station he tarried fifteen years, until Terah died, at the age of 205. Abraham, now 75 years old, received a second and more pointed call to pursue his destination: "Depart from thy land, and from thy kindred, and *from thy father's house, unto the land* which I will shew thee" (Gen. xii. 1). The difference of the two calls is obvious: in the former the *land* is indefinite, being designed only for a temporary residence; in the latter it is definite, intimating a permanent abode. He went forth "not knowing whither he went" (Heb. xi. 8), but trusting implicitly in the Divine guidance, taking with him his nephew Lot, whom, having no children of his own, he appears to have regarded as his heir.

On arriving in the land of Canaan, the rich pastures tempted Abraham to form his first encampment in the vale of Moreh, which lies between the mountains of Ebal and Gerizim. Here the strong faith which had brought him thus far from his home was rewarded by the grand promise:—"I will make of thee a great nation, and I will bless thee and make thy name great, and thou shalt be a blessing; and I will bless them that bless thee, and curse them that curse thee: and in thee shall all the families of the earth be blessed' (Gen. xii. 2, 3). He soon after removed to the district between Bethel and Ai, where he also built an altar to that "Jehovah" whom the world was then hastening to forget. His farther removals tended southward, until at length a famine in Palestine compelled him to withdraw into Egypt, where corn abounded. Here, apprehending that the beauty of his wife Sarai might bring him into danger with the Egyptians, he concealed the fact that she was his wife, and gave out that she was his sister; whereupon she was carried to the king's harem. A grievous disease inflicted on Pharaoh and his household relieved Sarai from her danger, by revealing to the king that she was a married woman; on which he sent for Abraham, and, after rebuking him for his conduct, restored his wife to him, and recommended him to withdraw from the country. He accordingly returned to the land of Canaan, much richer than when he left it "in cattle, in silver, and in gold" (Gen. xii. 8; xiii. 2). Not long after, he removed to the pleasant valley of Mamre, in the neighbourhood of Hebron (then called Arba), and pitched his tent under a terebinth tree (Gen. xiii).

It appears that fourteen years before this time the south and east of Palestine had been invaded by a king called Chedorlaomer, from beyond the Euphrates, who brought several of the small disunited states of those quarters under tribute. Among them were the five cities of the Plain of Sodom, to which Lot had withdrawn. This burden was borne impatiently by these states, and they at length withheld their tribute. This brought upon them a ravaging visitation from Chedorlaomer and four other (perhaps tributary) kings, who scoured the whole country east of the Jordan, and ended by defeating the kings of the plain, plundering their towns, and carrying the people away as slaves. Lot was among the sufferers. When this came to the ears of Abraham, he immediately armed such of his slaves as were fit for war, in number 318, and being joined by the friendly Amoritish chiefs, Aner, Eschol, and Mamre, pursued the retiring invaders. They were overtaken near the springs of the Jordan; and their camp being attacked on opposite sides by night, they were thrown into disorder, and fled. Abraham and his men pursued them as far as the neigbourhood of Damascus, and then returned with all the men and goods which had been taken away.

After ten years' residence in Canaan (B.C. 1913), Sarai, being then 75 years old, persuaded Abraham to take her handmaid Hagar, an Egyptian, as a secondary or concubine wife. The son who was born to Abraham by Hagar, received the name of Ishmael, and was brought up as the heir of his father and of the promises (Gen. xvi.). Thirteen years after, when Abraham was 99 years old, he was favoured with still more explicit declarations of the Divine purposes, and his name was now changed from *Abram* to *Abraham.* The Lord then solemnly renewed the covenant to be a God to him and to the race that should spring from him; and in token of that covenant directed that he and his should receive in their flesh the sign of circumcision. It was then first announced, in distinct terms, that the heir of the special promises was not yet born, and that Sarai, then 90 years old, should twelve months thence be his mother. Then also her name was changed from Sarai to Sarah (*the princess*); and to commemorate the joy with which the patriarch received such strange tidings, it was directed that the name of Isaac (*he laughed*) should be given to the future child. After the destruction of Sodom, Abraham removed into the territories of Abimelech, king of Gerar, where he allowed himself to stoop to the same foolish prevarication in denying his wife, which, twenty-three years before, had occasioned him so much trouble in Egypt, and with a similar result.

The same year Sarah gave birth to the long-promised son, and according to previous direction, the name of Isaac was given to him. This greatly altered the position of Ishmael, who with Hagar his mother, was sent to a distance from his paternal home.

When Isaac was about twenty years old (B.C. 1872) it pleased God to subject the faith of Abraham to a severe trial. He was commanded to go into the mountainous country of Moriah (probably where the temple afterward stood), and there offer up in sacrifice the son of his affection, and the heir of so many hopes and promises. But Abraham's faith shrunk not, assured that what God had promised he would certainly perform, and that he was able to restore Isaac to him "even from the dead" (Heb. xi. 17–19). When Abraham's hand was uplifted to slay his son, the angel of Jehovah interposed at the critical moment and arrested the fatal stroke.

Twelve years after (B.C. 1860) Sarah died at the age of 127 years, being then at or near Hebron; and Abraham purchased for a family sepulchre the cave of Machpelah, with the field in which it stood and the trees that grew thereon. This was the only possession he ever had in the Land of Promise (Gen. xxiii). Some time after Abraham took a wife named Keturah, by whom he had several children. These, together with Ishmael, seem to have been portioned off by their father in his lifetime, and sent into the east and south-east, that there might be no danger of their interference with Isaac, the divinely appointed heir. There was time for this: for Abraham lived to the age of 175 years, 100 of which he had spent in the land of Canaan. He died in B.C. 1822 (Hales 1978), and was buried in the family sepulchre which he had purchased of the Hittites (Gen. xxv. 1–10).



ABRAHAM, *Ben Chaila*, a Spanish rabbi, in the 13th century, who professed astrology, and assumed the character of a prophet. He pretended to predict the coming of the Messiah, which was to happen in the year 1358; but fortunately he died in 1303, fifty-five years before the time when the prediction was to be fulfilled. He wrote a book, *De Nativitatibus*, which was printed at Rome in 1545.

ABRAHAM, *Usque*, a Portuguese Jew, who, in conjunction with Tobias Athias, translated the Hebrew Bible into Spanish. It was printed at Ferrara in 1553, and reprinted in Holland in 1630. This Bible, especially the first edition, which is most valuable, is marked with stars at certain words, which are designed to shew that these words are difficult to be understood in the Hebrew, and that they may be used in a different sense.

ABRAHAM, or ABRAM, *Nicholas*, a learned Jesuit, born in the diocese of Toul, in Lorrain, in 1589. He obtained the rank of divinity professor in the university of Pont-a-Mouson, which he enjoyed 17 years, and died September 7, 1655. He wrote Notes on Virgil and on Nonnius; A Commentary on some of Cicero's Orations, in two vols. folio; an excellent collection of theological pieces in folio, entitled *Pharus Veteris Testamenti;* and a Hebrew Grammar in verse.

ABRAHAMITES, an order of monks exterminated for idolatry by Theophilus in the ninth century. Also the name of another sect of heretics who had adopted the errors of Paulus.

ABRALHOS, a cluster of islets and sand-banks on the coast of Brazil, between 17 and 18 degrees S. Lat. The islets are low, covered with grass and a little scattered brushwood. They consist of gneiss and sandstone in horizontal strata, and their highest point rises about 100 feet above the level of the sea.

ABRANTES, a town of Portugal, province of Estremadura, on the Tagus, near its junction with the Zezare, which is navigable for barges. Lat. 39. 26. N. Long. 8. 15. W. Situation delightful, on the upper part of a sloping hill, with a country below it covered with olive trees, and interspersed with vineyards. Junot, one of Napoleon's marshals, was created duke of Abrantes. It has an hospital and poor-house. Pop. 4500.

ABRASAX, or ABRAXAS, the supreme god of the Basilidian heretics. It is a mystical or cabalistic word, composed of the Greek letters, α, β, ρ, α, ξ, α, ς, which, together, according to the Grecian mode of numeration, make up the number 365. For Basilides taught, that there were 365 heavens between the earth and the empyrean; each of which heavens had its angel or intelligence, which created it; each of which angels likewise was created by the angel next above it; thus ascending by a scale to the Supreme Being, or first Creator. The Basilidians used the word *Abraxas* by way of charm or amulet.

ABRASION is sometimes used among medical writers for the effect of sharp corrosive medicines or humours in wearing away the natural mucus which covers the membranes, and particularly those of the stomach and intestines. The word is composed of the Latin *ab* and *rado, to shave* or *scrape off.*

*ABRASION* is also used to denote the wear and tear of Coins. The deficiency in the weight of the old worn coins, on their being called in to be recoined, falls upon the public. Mr M'Culloch reckons, that if the currency of the United Kingdom consisted wholly of gold, it would amount to at least sixty millions of sovereigns, and that the loss sustained by abrasion, including what results from shipwreck, fire, and other accidents, would amount to a hundredth part of the sum in circulation, or £600,000 annually.—*M'Culloch's Treatises and Essays on Economical Policy*, p. 33.

ABRAUM, a name that has been given by some writers to a species of red clay, used in England by the cabinet-makers, &c., to give a red colour to new mahogany wood. We have it from the Isle of Wight; but it is also found in Germany and Italy.

ABRAVANNUS, in *Ancient Geography*, the name of a promontory and river of Galloway in Scotland, so called from the Celtic term *Aber*, signifying either the mouth of a river or the confluence of two streams, and *Avon*, a river.

ABRAXAS, an antique stone with the word *abraxas* engraven on it. They are of various sizes, and most of them as old as the third century. They are frequent in the cabinets of the curious; and a collection of them, as complete as possible, has been desired by several. There is a fine one in the abbey of St Genevieve, which has occasioned much speculation. Most of them seem to have come from Egypt; whence they are of some use for explaining the antiquities of that country. Sometimes they have no other inscription besides the word: but others have the names of saints, angels, or Jehovah himself annexed; though most usually the name of the Basilidian god. Sometimes there is a representation of Isis sitting on a lotus, or Apis surrounded with stars; sometimes monstrous compositions of animals, obscene images, Phalli and Ithyphalli. The engraving is rarely good, but the word on the reverse is sometimes said to be in a more modern style than the other. The characters are usually Greek, Hebrew, Coptic, or Hetrurian, and sometimes of a mongrel kind, invented, as it would seem, to render their meaning the more inscrutable. It is disputed whether the Veronica of Montreuil, or the granite obelisk mentioned by Gori, be *Abraxases*.

ABRAZITE, a crystallized mineral, a silicate of lime and alumina, called also Gismondine, and Zeagonite.

ABRESCH, Frederic Louis, a celebrated critic born at Hamburg in 1699. His scholia on Greek authors are greatly esteemed. He died in 1782.

ABRIDGMENT, in *Literature*, is the reduction of a book into a smaller compass; the book so reduced is sometimes called also an epitome, or compendium. To condense a work, without detriment to the symmetry and connection of the whole, demands the exercise of both judgment and skill, and not unfrequently of taste; to the absence of which requisites must be imputed the frequent imperfection of this class of works. The advantage of epitomes or abridgments, when ably executed, can scarcely be too highly estimated, for, by the enormous increase of literature, they are yearly growing more important, and will eventually become a matter of necessity. "The universal progress of science during the last two centuries," says Robertson, "the art of printing, and other obvious causes, have filled Europe with such a multiplicity of histories, and with such vast collections of historical materials, that the term of human life is too short for the study or even the perusal of them."—*Charles V.; preface to edit.* 1796. The Reviews and periodicals of the day may be said in a manner to have commenced the great era of abridgment; but whether this system may not tend to superficialness, remains to be seen.

The art of abridgment, though practised before, first came into general use among the Romans about the fifth century; and posterity owes a debt of gratitude to those authors who thus preserved, among less important materials, many valuable fragments of antiquity which otherwise had been lost. Among these abridgments and collections may be noticed the histories of *Lucius A. Florus*, and of *C. Vell. Paterculus*; the *Epitome de Cæsaribus of S. Aur. Victor*; the *Breviarium* of *S. Ruf. Festus*; that of *Eutropius*; and the *Chronicon of Mag. Aur. Cassiodorus*. As examples of excellence in the art of abridgment, may be cited—*Mezeray's Abrégé Chronologique de l'Histoire de France, by the author; Henault's Nouvel Abrégé Chronologique de l'Histoire de la France; Nouvel Abrégé Chronologique de l'Histoire d'Allemagne, by Pfeffel; Hazlitt's Abridgment of Tucker's Light of Nature*; and the *Epitome Historiarum of Tursellinus.*



ABROGATION, the act of abolishing a law, by authority of the maker; in which sense the word is synonymous with abolition, repealing, and revocation.

ABROTONUM, in *Ancient Geography*, a town and harbour on the Mediterranean, one of the three cities that formed Tripolis; called also *Sabrata* and *Neapolis*.

ABRUD-BANYA, a town of Austria, province of Transylvania, and circle of Unter-Weissenburg. It is situate on the river Ampoy, has one Reformed and one Greek church, is the seat of a board of mining, and in its vicinity mines of gold and of silver are wrought. Lat. 46. 14. 9. N. Long. 23. 49. 3. E. Population 4100.

ABRUS, in *Botany*, a genus of diadelphia.

ABRUZZO, one of the four provinces into which the continental part of the kingdom of Naples, or of the two Sicilies, was formerly divided, but now the name given to three out of the 15 provinces of the later division of that country. It is the most northern part of the kingdom of Naples, being bounded on the north and west by the States of the Church, east by the Adriatic, and south by the provinces of Terra di Lavoro, Molise, and Capitanata. It has an area of somewhat more than 5000 square miles, extending from Lat. 41. 40. to 42. 55. N.; and though presenting to the Adriatic a coast of about 80 miles in length, yet it has not a single good port.

This territory is mostly rugged, mountainous, and covered with extensive forests, but contains also many fertile and well-watered valleys. The Apennines traverse its whole extent, running generally from N.W. to S.E., and here they attain their greatest elevation. Near Aquila is Monte Corno, the loftiest peak of that chain, called *Il gran Sasso d'Italia*, or the great rock of Italy, which rises to the height of 9521 feet. Monte Majella and Monte Velino attain the height of 8500 and 8397 feet respectively. From the main range of the Apennines numerous smaller branches run off towards the west. The country is watered by numerous rivers and streams, most of which fall into the Adriatic. They are often suddenly swollen by the rains, especially in the spring, and thus cause considerable damage to the lands through which they pass. The principal rivers are the Tronto, Trentino, Pescara, and the Sangro. A little to the south of the village of Albi in Abruzzo Ulteriore Seconda is lake Celano, the Lacus Fucinus of the Romans; see Fucinus Lacus. The climate differs considerably with the elevation of the soil, but generally speaking, it is temperate and healthy; on the mountains it is cold and bracing, and in the valleys comparatively hot.

Agriculture is but little attended to or understood, although in many of the lower parts of the country the land is of considerable fertility. The art of irrigation is not understood, nor the embankment of the rivers practised, so that the best of the land is frequently rendered useless. Its principal productions are corn, hemp, flax, almonds, olives, figs, grapes, and chestnuts. In the neighbourhood of Aquila, saffron is extensively cultivated, although not to such an extent now as formerly. The rearing and tending of sheep is the principal occupation of the inhabitants of the highlands. The wool, which is of a superior quality, is an important article of commerce, and the skins are sent in large quantities to

Abruzzo Citeriore. the Levant. On the approach of winter, the shepherds with their flocks and families migrate to the more temperate territories on the south. Bears, wolves, and wild boars inhabit the mountain fastnesses; and in the extensive oak forests numerous herds of swine are fed, the hams of which are in high repute. The manufactures are very inconsiderable, being chiefly woollen, linen, and silk stuffs, and earthen and wood wares.

"Abruzzo," says Sir R. C. Hoare, "has been represented as a country uncivilised with regard to society, infested by robbers, inaccessible from mountains, and fitter for the residence of wild beasts than of rational beings. But I must here repeat with gratitude, that in these romantic unfrequented tracts, we met with that genuine and cordial hospitality which is too seldom to be found in more favoured and more populous countries." The inhabitants are a stout, well-built, brave, and industrious race. Many of them emigrate annually to the States of the Church to work during the harvest, and return home in winter with their wages. Their houses are generally miserable dirty huts; their food principally maize, and their beverage bad wine. Abruzzo is of great importance to the kingdom of Naples, as being its chief defence on the north. It has only three roads through which a hostile army could pass, only one of these being practicable for artillery; and they all afford such facilities for defence, that a passage could only be effected at a great loss, in the face of even a small body of defenders. The three provinces into which it is now divided are Abruzzo Ulteriore Prima, Abruzzo Ulteriore Seconda, and Abruzzo Citeriore, being so named from their position relative to Naples.

Abruzzo Ulteriore I., is the most northern of the three provinces, and has an area of 1239 square miles, with a population in 1845 of 216,486. The western part of the province is very mountainous; the highest crest of the Apennines divides it from Abruzzo Ulteriore Seconda, and extends towards the sea. The district on the sea-coast is flat, but everywhere else hilly. The valleys between the hills possess a rich soil, well watered by rivulets and brooks in the winter and spring, but which are generally dried up in the summer months. These streams either run into the Pescara, which bounds the province towards Abruzzo Citeriore, or into the Tronto, which is the boundary on the Papal frontier. The province is divided into two districts, Teramo and Civita di Penne. The city of Teramo is the capital of the province.

Abruzzo Ulteriore II., is an inland district, bounded on the north and west by the Papal States, on the north-east by Abruzzo Ulteriore I., on the south-east by Abruzzo Citeriore, and on the south by the province Terra di Lavoro. The whole province is nearly covered with mountains of various heights, one of which is the *Gran Sasso d'Italia*. There are no plains; but among these mountains some beautiful and fruitful valleys have been formed by the various streams that run through them. None of the rivers are navigable, but all of them have abundance of water, except in the hottest of the summer months. It has an area of 2523 square miles, and in 1845 contained 307,708 inhabitants. Its chief town is Aquila.

Abruzzo Citeriore is bounded on the north-west by Abruzzo Ulteriore I., on the north-east by the Adriatic Sea, on the south-west by the province Molise, and on the west by that of Abruzzo Ulteriore Seconda. This province is less hilly than the other two Abruzzi, but the Apennines are extended through the south-west part. They, however, gradually decline in height, and extend themselves in wide plains of sand and pebbles. The rivers all run to the Adriatic, and are very deficient in water during the summer months. Agriculture is in a very backward state, and the soil is rather ungrateful when labour is bestowed upon it; but the inhabitants prefer the chase and the fishery. It contains 1245 square miles, with a population of 301,746 in 1845. Its chief town is Civita di Chieti.

Absalom. ABSALOM, the third son of David, and his only son by Maachah, daughter of Talmai, king of Geshur (2 Sam. iii. 3). He was deemed the handsomest man in the kingdom; and was particularly noted for the profusion of his beautiful hair. David's other child by Maachah was a daughter named Tamar, who was also very beautiful. She became the object of lustful regard to her half-brother Amnon, David's eldest son; and was violated by him. In all cases where polygamy is allowed, we find that the honour of a sister is in the guardianship of her full brother, more even than in that of her father, whose interest in her is considered less peculiar and intimate. It was not until two years had passed, and when this wound seemed to have been healed, that Absalom found opportunity for the bloody revenge he had meditated. He then held a great sheep-shearing feast at Baal-hazor near Ephraim, to which he invited all the king's sons; and, when they were warm with wine, Amnon was set upon and slain by the servants of Absalom, according to the previous directions of their master. Absalom, after this bloody deed, hastened to Geshur, and remained there three years with his grandfather, king Talmai; at the end of which time, through the contrivance of Joab, he was permitted to return; but David, still mindful of his duties as a king and father, controlled the impulse of his feelings, and declined to admit him to his presence. After two years, however, Absalom, impatient of his disgrace, found means to compel the attention of Joab to his case; and through his means a complete reconciliation was effected, and the father once more indulged himself with the presence of his son. (2 Sam. xiii. xiv.)

Absalom was the third son of David, Amnon and Chileab being his elder brothers. But he alone was of royal descent by the side of his mother; and royal or noble descent by the mother is even now (as we see by the recent instance of Abbas Meerza in Persia) of itself a sufficient ground of preference over an elder brother whose maternal descent is less distinguished. This circumstance may suggest that he early entertained a design upon the succession to the throne, and that the removal of Amnon was quite as much an act of policy as of revenge. His position must have been greatly strengthened when, on his return from exile, he found himself the eldest surviving son, and according to the ordinary laws of primogeniture, the heir apparent of the crown; and there is every reason to think that David, if left to himself, would have been glad to have seen the rule of succession take its *ordinary* course in favour of his best loved son. But then, under the peculiar theocratical institutions of the Hebrews, the Divine king reserved and exercised a power of dispensation, over which the human king, or viceroy, had no control. The house of David was established as a reigning dynasty; and although the law of primogeniture was allowed eventually to take in general its due course, the Divine king reserved the power of appointing any member of that house whom he might prefer. David had known many years before that his dynasty was to be established in a son not yet born (2 Sam. vii. 12); and when Solomon was born, he could not be ignorant, even if not specially instructed, that *he* was the destined heir. This fact must have been known to many others as the child grew up, and probably the mass of the nation was cognizant of it. In this we find a clear motive for the rebellion of Absalom—to secure the throne which he deemed to be his right by the laws of primogeniture, during the lifetime of his father; lest delay, while awaiting the natural term of his days, should so strengthen the cause of Solomon with his years, as to place his succession beyond all contest.

Four years after his return from Geshur, he repaired to Hebron and there proclaimed himself king. The great body of the people declared for him; and so strong ran the tide of opinion in his favour, that David found it expedient to quit Jerusalem and retire to Mahanaim, beyond the Jordan.

When Absalom heard of this, he proceeded to Jerusalem and took possession of the throne without opposition. The king soon raised a large force, which he properly organised and separated into three divisions, commanded severally by Joab, Abishai, and Ittai of Gath. A battle took place in the borders of the forest of Ephraim; and the tactics of Joab, in drawing the enemy into the wood, and there hemming them in, so that they were destroyed with ease, eventually decided the action against Absalom. Twenty thousand of his troops were slain, and the rest fled to their homes. Absalom himself fled on a swift mule; but as he went, the boughs of a terebinth tree caught the long hair in which he gloried, and he was left suspended there. The charge which David had given to the troops to respect the life of Absalom prevented any one from slaying him: but when Joab heard of it, he hastened to the spot, and pierced him with three darts. His body was then taken down and cast into a pit in the forest, and a heap of stones was raised upon it.

Absalom's Tomb, a remarkable monument in the valley of Jehoshaphat, near Jerusalem, and close by the lower bridge over the Kedron. The identity of this monument with that mentioned in 2 Sam. xviii. 18, insisted on by some, is disproved by the character of the architectural ornaments; and neither this nor the adjoining monument called that of Zecharias, have any connection with the era of the persons whose names they bear.

Absalom, archbishop of Lund in Denmark, an eminent statesman and warrior, a patron of learning, and the counsellor and friend of Waldemar, his sovereign. By the vigour of his administration, and his successes in the field, he gave a lustre to the Danish name, and he is said to have been the founder of the city of Copenhagen. He was born A.D. 1128, and died in 1191.

ABSCESS, in *Surgery;* from *abscedo*, to separate; a cavity containing *pus*, or a collection of puriform matter in a part: so called, because the parts which were joined are now separated; one part recedes from another, to make way for the collected matter.

ABSCISSE, in *Conics*, a part of the diameter or transverse axis of a conic section, intercepted between the vertex or some other fixed point and a semiordinate. See Conic Sections.

ABSCONSA, a dark lantern used by the monks at the ceremony of burying their dead.

ABSENTEE is a term applicable to those landlords who reside in another country than that from which they draw their rents. The discussions which have taken place on this subject have generally had a reference to Ireland.

Mr M'Culloch maintains that, in so far as the question of expenditure is concerned, absenteeism is not injurious to a country. On the contrary, that it is in the majority of cases advantageous, as its tendency is to turn industry into those channels into which it is most for the public advantage that it should be turned, and eventually to increase the national capital. He allows that a resident landed proprietor has the means of doing a vast deal of good, by setting an example of good order, virtue, and piety, and protecting his tenants and dependents. But, in the case of Ireland, the superiority of resident over absentee landlords must be tried, not by what they ought to have been, but by their actual conduct. And he maintains that nine-tenths of the proprietors of Ireland being the lineal descendants of those who purchased or received grants of the property confiscated during the 17th century, and being almost all Englishmen and Protestants, —intruders on their soil, and enemies of their religion,—the residence of such landlords was more likely to produce discord than good-will. And by a comparison of the actual condition of the baronies where absenteeism prevailed, he has brought forward evidence to shew that the estates are better managed, and the inhabitants have been more contented and tranquil in these, than in the districts most thickly occupied by resident landlords.



The opposite side of this question has been ably argued by writers in the Quarterly Review. *M'Culloch's Treatises and Essays on Economical Policy; Quarterly Review*, vol. xxxiii., p. 455.

ABSINTHIATED, any thing tinged or impregnated with absinthium or wormwood. Bartholin mentions a woman whose milk was become absinthiated, and rendered as bitter as gall, by the too liberal use of wormwood.

*Vinum absinthites*, or *poculum absinthiatum*, "wormwood wine," is much spoken of among the ancients as a wholesome drink, and even an antidote against drunkenness. Its medical virtues depend on its aromatic and bitter qualities. Infused in wine or spirits, it may prove beneficial in cases of indigestion or debility of the stomach.

ABSOLUTE (*ab*, and *solvo*, I loose), in a general sense, something that stands free or independent.

Absolute is more particularly understood of a being or thing which does not proceed from any cause, or does not subsist by virtue of any other being, considered as its cause; in which sense God alone is *absolute*. *Absolute*, in this sense, is synonymous with *independent*, and stands opposed to *dependent.*

Absolute also denotes a thing that is free from conditions or limitations; in which sense the word is synonymous with *unconditional.* We say, an *absolute* decree, *absolute* promise, *absolute* obedience.

*Absolute Government*, that in which the prince is left solely to his own will, being not limited to the observance of any laws except those of his own discretion.

*Absolute Equations*, in *Astronomy*, is the aggregate of the optic and eccentric equations. The apparent inequality of a planet's motion, arising from its not being equally distant from the earth at all times, is called its optic equation, and would subsist even if the planet's real motion were uniform. The eccentric inequality is caused by the planet's motion being uniform. To illustrate which, conceive the sun to move, or to appear to move, in the circumference of a circle, in whose centre the earth is placed. It is manifest, that if the sun moves uniformly in this circle, it must appear to move uniformly to a spectator on the earth; and in this case there will be no optic nor eccentric equation: but suppose the earth to be placed out of the centre of the circle, and then, though the sun's motion should be really uniform, it would not appear to be so, when seen from the earth; and in this case there would be an optic equation, without an eccentric one. Imagine further, the sun's orbit to be not circular but elliptic, and the earth in its focus; it will be as evident that the sun cannot appear to have a uniform motion in such eclipse: so that his motion will then be subject to two equations, the optic and the eccentric.

*Absolute Number*, in *Algebra*, is any pure number standing in any equation without the conjunction of literal characters; as $2x + 36 = 48$; where 36 and 48 are absolute numbers, but 2 is not, as being joined with the letter $x$.

ABSOLUTION, in *Civil Law*, is a sentence whereby the party accused is declared innocent of the crime laid to his charge.

Absolution, in the *Canon Law*, is a juridical act, whereby the priest declares the sins of such as are penitent remitted. —The Romanists hold absolution a part of the sacrament of penance; the council of Trent, sess. xiv. cap. iii., and that of Florence, in the decree *ad Armenos*, declare the form or essence of the sacrament to lie in the words of *absolution*, "I absolve thee of thy sins." The *formula* of absolution, in the Roman church, is absolute; in the Greek church, it is deprecatory; and in the churches of the Reformed, declarative.

ABSOLUTION is chiefly used among Protestants for a sentence by which a person who stands excommunicated is released or freed from that punishment.

ABSORBENT, in general, any thing possessing the faculty of *absorbing*, or swallowing up another.

*ABSORBENT Medicines*, testaceous powders, or substances into which calcareous earth enters, as chalk, crabs eyes, &c., which are taken inwardly, for drying up or absorbing any acid or redundant humours in the stomach or intestines. They are likewise applied externally to ulcers or sores with the same intention.

*ABSORBENTS*, or *ABSORBING Vessels*, in *Anatomy*, a name given promiscuously to the lacteal vessels, lymphatics, and inhalant arteries; a minute kind of vessels found in animal bodies, which imbibe fluids that come in contact with them. On account of their minuteness and transparency, they escape observation in ordinary dissection. They have, however, been detected in every tribe of animals, and, in the animals which have been examined, in every part of the body.

ABSORPTION, in the animal economy, is the function of the absorbent vessels, or that power by which they take up and propel substances. This power has been ascribed to the operation of different causes, according to the theories which physiologists have proposed. Some attribute it to capillary attraction, others to the pressure of the atmosphere, and others to an ambiguous or unknown cause, which they denominate *suction;* for this last is nothing else than the elastic power of one part of the air restoring the equilibrium, which has been destroyed by the removal or rarefaction of another part. See PHYSIOLOGY.

*ABSORPTIONS of the Earth*, a term used by Kircher and others for the sinking in of large tracts of land by means of subterranean commotions, and many other accidents.

Pliny tells us, that in his time the mountain Cybotus, with the town of Curites, which stood on its side, were wholly absorbed into the earth, so that not the least trace of either remained; and he records the like fate of the city of Tantalis in Magnesia, and after it of the mountain Sipylus, both thus absorbed by a violent opening of the earth. Galanis and Gamales, towns once famous in Phœnicia, are recorded to have met the same fate; and the vast promontory called *Phegium*, in Ethiopia, after a violent earthquake in the night-time, was not to be seen in the morning, the whole having disappeared, and the earth closed over it. These and many other histories, attested by the authors of greatest credit among the ancients, abundantly prove the fact in the earlier ages. (KIRCHER'S *Mund. Subter.*, p. 77.)

Picus, a lofty mountain in one of the Molucca isles, which was seen at a great distance, and served as a landmark to sailors, was entirely destroyed by an earthquake; and its place is now occupied by a lake, the shores of which correspond exactly to the base of the mountain. In 1556, a similar accident happened in China. A whole province of the mountainous part of the country, with all the inhabitants, sunk in a moment, and was totally swallowed up: the space which was formerly land was also covered with an extensive lake of water. And, during the earthquakes which prevailed in the kingdom of Chili, in the year 1646, several whole mountains of the Andes sunk and disappeared. In Java the volcano of Papandayang disappeared during an eruption in 1772.

ABSORUS, APSORUS, ABSYRTIS, ABSYRTIDES, (Strabo, Mela, Ptolemy), islands in the Adriatic, in the gulf of Carnero; said to be so called from Absyrtus, Medea's brother, there slain. They are now called *Cherso* and *Osero*.

ABSTEMII, in *Church History*, a name given to such persons as could not partake of the cup of the eucharist on account of their natural aversion to wine. Calvinists allow these to communicate in the species of bread only, touching the cup with their lip; which, on the other hand, is by the Lutherans deemed a profanation.



ABSTENTION, in *Law*, is the act of preventing an heir from taking possession.

ABSTERGENT MEDICINES, those employed for resolving obstructions, concretions, &c., such as soap, &c.

ABSTINENCE, in a general sense, the act or habit of refraining from something to which there is a strong propensity. Among the Jews, various kinds of abstinence were ordained by their law. The Pythagoreans, when initiated, were enjoined to abstain from animal food, except the remains of sacrifices; and to drink nothing but water, unless in the evening, when they were permitted to take a small portion of wine. Among the primitive Christians, some denied themselves the use of such meats as were prohibited by that law, others regarded this abstinence with contempt; of which St Paul gives his opinion, Rom. xiv. 1–3. The council of Jerusalem, which was held by the apostles, enjoined the Christian converts to abstain from meats strangled, from blood, from fornication, and from idolatry. Abstinence, as prescribed by the gospel, is intended to mortify and restrain the passions, to humble our vicious natures, and by that means raise our minds to a due sense of devotion. But there is another sort of abstinence, which may be called *ritual*, and consists in abstaining from particular meats at certain times and seasons. It was the spiritual monarchy of the western world which first introduced this ritual abstinence, the rules of which were called *rogations;* but grossly abused from the true nature and design of fasting. In England, abstinence from flesh has been enjoined by statute since the Reformation, particularly on Fridays and Saturdays, on vigils, and on all commonly called *fish days*. The like injunctions were renewed under Queen Elizabeth; but at the same time it was declared that this was done, not out of motives of religion, as if there were any difference in meats, but in favour of the consumption of fish, and to multiply the number of fishermen and mariners, as well as to spare the stock of sheep. The great fast, says St Augustin, is to abstain from sin.

ABSTINENCE is more particularly used for a spare diet or a slender parsimonious use of food. Physicians relate wonders of the effects of abstinence in the cure of many disorders, and protracting the term of life. The noble Venetian Cornaro, after all imaginable means had proved vain, so that his life was despaired of at 40, recovered, and lived to near 100, by the mere effect of abstinence; as he himself gives the account. It is indeed surprising to what a great age the primitive Christians of the East, who retired from the persecutions into the deserts of Arabia and Egypt, lived, healthful and cheerful, on a very little food. Cassian assures us, that the common rate for 24 hours was 12 ounces of bread, and pure water: with such frugal fare St Anthony lived 105 years; James the Hermit, 104; Arsenius, tutor of the Emperor Arcadius, 120; St Epiphanius, 115; Simeon the Stylite, 112; and Romauld, 120. Indeed, we can match these instances of longevity at home. Buchanan informs us, that one Laurence arrived at the great age of 140 by force of temperance and labour; and Spotswood mentions one Kentigern, afterwards called St Mongah or Mungo, who lived to 185 by the same means. Abstinence, however, is to be recommended only as it means a proper regimen; for in general it must have bad consequences when observed without a due regard to constitution, age, strength, &c. According to Dr Cheyne, most of the chronical diseases, the infirmities of old age, and the short lives of Englishmen, are owing to repletion, and may be either cured, prevented, or remedied by abstinence; but then the kinds of abstinence which ought to be observed, either in sickness or health, are to be deduced from the laws of diet and regimen.

Among the inferior animals, we see extraordinary instances of long abstinence. The serpent kind, in particular, bear abstinence to a wonderful degree. We have seen rattle-snakes which had lived many months without any food, yet still retained their vigour and fierceness. Dr Shaw speaks of a couple of cerastes (a sort of Egyptian serpents), which had been kept five years in a bottle close corked, without any sort of food, unless a small quantity of sand in which they coiled themselves up in the bottom of the vessel may be reckoned as such; yet when he saw them, they had newly cast their skins, and were as brisk and lively as if just taken. But it is natural for divers species to pass four, five, or six months every year, without either eating or drinking. Accordingly, the tortoise, bear, dormouse, serpent, &c. are observed regularly to retire, at those seasons, to their respective cells, and hide themselves, some in the caverns of rocks or ruins; others dig holes under ground; some get into woods, and lay themselves up in the clefts of trees; others bury themselves under water, &c. And these animals are found as fat and fleshy, after some months' abstinence, as before.—Sir G. Ent[1] weighed his tortoise several years successively, at its going to earth in October, and coming out again in March; and found, that of four pounds four ounces, it only used to lose about one ounce.

*Phil. Trans.* No. 134.

We have alleged instances of men passing several months as strictly abstinent as other creatures. In particular, the records of the Tower mention a Scotsman imprisoned for felony, and strictly watched in that fortress for six weeks, during which time he did not take the least sustenance; and on this account he obtained his pardon. Numberless instances of extraordinary abstinence, particularly from morbid causes, are to be found in the different periodical Memoirs, Transactions, Ephemerides, &c., as *Birch's History of the Royal Society*, in the writings of Planque, of Hooglied and Haller; but the investigations of this latter author led to the conclusion, that the extreme cases of persons sustaining inanition for months, or even years, are more than apocryphal, the consequences of very inaccurate observation in the investigators, or of deception in the pretended sufferers; yet Haller gives instances of persons affected by peculiar cerebral diseases, or in extremely low states of the system, surviving inanition until the 8th, 9th, 13th, and even the 21st day. The recent cases of *John Brown*, an Ayrshire miner, who lived 23 days buried in a coal-mine, without swallowing anything but small quantities of a chalybeate water sucked through a straw, is a well-authenticated instance of how little will sustain life, especially in a contaminated atmosphere, which, by diminishing nervous excitability, would mitigate the cravings of hunger. The *fasting woman of Rosshire*, described by *Pennant*, is not one of absolute want of food, but one in which we see how small a quantity of nutriment will sustain life for years in a person suffering under a cerebral affection. *Anne Moore, the fasting woman of Tutbury*, was an impostor detected at length by *Dr Alexander Henderson*. How far nutrition is aided by absorption by the lungs and the skin, is not ascertained; and it is not improbable that each process may contribute to prolong life in real cases of starvation.

ABSTINENTS, or Abstinentes, a set of heretics that appeared in France and Spain about the end of the third century. They are supposed to have borrowed part of their opinions from the Gnostics and Manicheans, because they opposed marriage, condemned the use of flesh meat, and placed the Holy Ghost in the class of created beings. We have, however, no certain accounts of their peculiar tenets.

ABSTRACT (*abs*, and *traho*, I draw), in a general sense, any thing separated from something else.



Abstract *Ideas*, in *Metaphysics*. See Abstraction.

Abstract *Mathematics*, otherwise called *Pure Mathematics*, is that which treats of magnitude or quantity, absolutely and generally considered, without restriction to any species of particular magnitude; such are Arithmetic and Geometry. In this sense, abstract mathematics is opposed to mixed mathematics; wherein simple and abstract properties, and the relations of quantities primitively considered in pure mathematics, are applied to sensible objects, and by that means become intermixed with physical considerations: such are Hydrostatics, Optics, Navigation, &c.

Abstract *Numbers*, are assemblages of units, considered in themselves, without denoting any particular and determinate things. Thus, six is an abstract number when not applied to any thing; but if we say 6 feet, 6 becomes a concrete number.

Abstract *Terms*, words that are used to express abstract ideas. Thus *beauty, ugliness, whiteness, roundness, life, death*, are abstract terms.

Abstract, in *Literature*, a compendious view of any large work; shorter and more superficial than an abridgment.

ABSTRACTION, in *Metaphysics*, is a term used to denote the mind's power of considering certain qualities or attributes of an object apart from the rest; or the power which the understanding has of separating the combinations which are presented to it.

Abstraction is chiefly employed in these three ways. First, When the mind considers any one part of a thing, in some respect distinct from the whole; as a man's arm, without the consideration of the rest of the body. Secondly, When we consider the *mode* of any substance, omitting the substance itself; or when we separately consider several modes which subsist together in one subject. This abstraction the geometricians make use of when they consider the length of a body separately, which they call *a line*, omitting the consideration of its breadth and thickness. Thirdly, It is by abstraction that the mind forms general ideas. Thus, when we would understand a thinking being in general, we gather from our self-consciousness what it is to think; and omitting those things which have a particular relation to our own minds, or to the human mind, we conceive a thinking being in general.

Ideas formed in this manner, which are what we properly call *abstract ideas*, become general representatives of all objects of the same kind. Thus the idea of colour that we receive from chalk, snow, milk, &c. is a representative of all of that kind; and has a name given it, *whiteness*, which signifies the same quality wherever found or imagined. See the article Metaphysics.

ABSURDUM, *reductio ad absurdum*, is a mode of demonstration employed by mathematicians when they prove the truth of a proposition by demonstrating that the contrary is impossible, or leads to an absurdity. It is in this manner that Euclid demonstrates the fourth proposition of the first book of the Elements, by showing that the contrary involves a manifest absurdity, viz. *That two straight lines can inclose a space.*

ABSYRTUS, in heathen mythology, the son of Æetes and Idyia, and brother of Medea. When the latter fled with Jason, she carried Absyrtus with her; but being closely pursued by her father she slew him, and scattered his limbs in the way, that he might be diverted from the pursuit in gathering the mangled remains of his child.

ABTHANES, in *History*, a title of honour used by the ancient inhabitants of Scotland, who called their nobles *thanes*, which in the old Saxon signifies *king's ministers;* and of these the higher rank were styled *abthanes*, and those of the lower *underthanes*.

ABU-ARISCH, a narrow strip of land in the S.W. of Arabia, lying on the borders of the Red Sea, between Lat. 15. 50. and 17. 40. N. and Long. 41. 30. and 43. E. It is a very dry and barren country, and only preserved from utter sterility by periodical inundations of rain from the neighbouring mountains. Its principal traffic is in coffee and senna leaves, and its breed of asses is highly esteemed.

ABU-ARISCH, the capital of the territory of the same name, is situated about 24 miles from the Red Sea, in Lat. 16. 40. N. and Long. 42. 20. E. The town is supposed to have been once much nearer the sea, both from the appearance of the surrounding country, and from the fact that the land here is rapidly gaining upon the sea. In its neighbourhood are several rock-salt mines. Population about 5000.

ABUBEKER, or ABU-BEKR, the first caliph, the immediate successor of Mahomet, and one of his first converts. His original name was Abdulcaaba, signifying *servant of the caaba* or *temple*, which, after his conversion to Mahometanism, was changed to Abdallah, *servant of God;* and on the marriage of the prophet with his daughter Ayesha, he received the appellation of Abu-Bekr, *Father of the virgin.* Illustrious by his family, and possessed of immense wealth, his influence and example were powerful means of propagating the faith he had adopted, and in gaining converts to the new religion. Abubeker was a sound believer; and although he lived in the greatest familiarity with Mahomet, he had always the highest veneration for his character. He vouched for the truth of his revelations after his nightly visits to heaven, and thus obtained the appellation of the *faithful.* He was employed in every mission of trust or importance, was the constant friend of the prophet, and when he was forced to fly from Mecca, was his only companion. But notwithstanding his blind devotion to Mahometanism, his moderation and prudence were conspicuous in checking the fanatical zeal of the disciples of the new religion on the death of Mahomet. This event threatened destruction to the doctrines of Islamism. Its followers could not doubt that it had taken place, and they were afraid to believe it. In this uncertainty and fluctuation of belief, Omar drew his sword, and threatened to cut in pieces all who dared to assert that the prophet was dead. Abubeker, with more coolness and wisdom, addressed the people, *Is it,* says he, *Mahomet whom you adore, or the God whom he has revealed to you? Know that this God is alone immortal, and that all those whom he has created are subject to death.* Appeased and reconciled by this speech, they elected him successor to Mahomet, and he assumed the modest title of caliph, which has continued with all his successors. Ali, the son-in-law of the prophet, regarding the elevation of Abubeker as a violation of his legal rights to the succession, refused at first to recognise the appointment, till he was forced by threats into compliance and submission. His partisans, however, still considered him as the legitimate successor, and their opinion has prevailed among many Mussulmans, who believe that the sovereign authority, both spiritual and temporal, remains with his descendants.

Abubeker first collected and digested the revelations of Mahomet, which had hitherto been preserved in detached fragments, or in the memories of the believers; and to this the Arabians gave the appellation *Almoshaf,* or the Book. He died in the 13th year of the Hegira, respected as a prudent and equitable ruler.

ABUKESO, in commerce, the same with ASLAN.

ABULAHOR, a market town of Greece, on the Aspropotamus, in the province of Acarnania. It exports silk, oil, and fruits.

ABUL CASSIM, the pretended author of a Spanish chronicle of the Conquest of Spain by the Arabs, long supposed to be a translation from the Arabic, and used as such by Mariana and others in writing their histories, but now proved to be spurious.



ABULFARAGIUS, GREGORY, son of Aaron, a physician, born in 1226, in the city of Malatia, near the source of the Euphrates in Armenia. He at first followed the profession of his father, and practised with great success; but he acquired a higher reputation by the study of the Greek, Syriac, and Arabic languages, as well as by his knowledge of philosophy and divinity. He wrote a history in Arabic, which does great honour to his memory. It is divided into dynasties, and consists of ten parts, forming an epitome of universal history from the creation of the world to his own time. The parts of it relating to the Saracens, Tartar Moguls, and the conquests of Jenghis Khan, are esteemed the most valuable. He was bishop of Guba and then of Aleppo. About 1266, being elected primate of the Jacobites in the East, he held that dignity till his death in 1286. His contemporaries speak of him in a strain of most extravagant panegyric. He is styled the *king of the learned, the pattern of his times, the phœnix of the age, and the crown of the virtuous.* Dr Pococke published his history with a Latin translation in 1663, in two vols. 4to.

ABUL FARAJ ALI, a celebrated Arabian poet, born A.D. 897. Of his numerous works, the only one published in Europe is the *Kiteb Agnani*, a collection of ancient poems. *Leipsic*, 2 vols. 4to, 1789.

ABULFAZL, who is called by Sir William Jones, "a learned and elegant," and by others, "the most elegant" writer that the East has produced, was vizier and historiographer to the great Mogul, Akbar. We have not been able to discover the year of his birth, but his death took place in 1602, when he was assassinated on his return from a mission to the Deccan. According to some writers, this foul act was perpetrated at the instigation of the heir apparent to the throne, who had become jealous of the minister's influence with the emperor. Akbar greatly lamented the loss of a man who was not only an able minister of state, but of such talents as a writer, as to make it a common saying in the East, "that the neighbouring monarchs stood more in awe of his pen than of the sword of his master." He wrote, by the emperor's command, a history of his reign, which came down to the forty-seventh year, in which he was assassinated. In connection with this, he also compiled a volume, intended to exhibit a geographical and statistical view of the empire, and of the revenue, household, and expenses of the sovereign. It likewise embraces an account of the religion of the Hindoos, of their sacred books, and their several sects in religion and philosophy. This work, which is fraught with much curious and valuable information, is known under the name of the *Ayeen Akbery.* It has been translated into English with great accuracy by Mr Francis Gladwin. The translation was undertaken and published at Calcutta, under the intelligent patronage of Mr Hastings. "Such a work," he said, in a minute of council, "could not but prove peculiarly useful; as it comprehends the original constitution of the Mogul Empire, described under the immediate inspection of its founder, and will serve to assist the judgment of the Court of Directors on many points of importance to the first interests of the company."—The Calcutta edition, published in 1783–6, in three volumes quarto, is a splendid book, and the most valuable in every respect, as the London reprints are by no means accurate.

ABULGAZI, BAYADUR, (1605–1663,) a khan of the Tartars, who wrote an esteemed history of Tartary, which has been translated into Russian, German, and French.

ABU MANSUR, a celebrated Arabian astronomer of the 9th and 10th centuries, who did much service to science by his observations. He wrote the lives of the Arabian poets; but this work has not appeared in Europe.

ABUNA, the title given to the archbishop or metropolitan of Abyssinia.

ABUNDANT NUMBER, in *Arithmetic*, is a number, the sum of whose aliquot parts is greater than the number itself. Thus, the aliquot parts of 12 being 1, 2, 3, 4, and 6, they make, when added together, 16. An abundant number is opposed to a *deficient* number, or that which is greater than all its aliquot parts taken together; as 14, whose aliquot parts are 1, 2, and 7, which make no more than 10; and to a *perfect* number, or one to which its aliquot parts are equal, as 6, whose aliquot parts are 1, 2, and 3.

ABUNDANTIA, a heathen divinity, a personification of plenty, represented in ancient monuments under the figure of a woman with a pleasing aspect, crowned with garlands of flowers, pouring all sorts of fruit out of a horn which she holds in her right hand, and scattering grain with her left, taken promiscuously from a sheaf of corn. On a medal of Trajan she is represented with two cornucopiæ.

ABURY. See AVIBURY.

ABUS, in *Ancient Geography*, a river of Britain, now the Humber.

ABUSAID, EBN ALJAPTU, sultan of the Moguls, succeeded his father anno 717 of the Hegira. He was the last monarch of the race of Jenghis Khan, who held the undivided empire of the Moguls; for after his death, which happened the same year that Tamerlane was born, it became a scene of blood and desolation, and was broken into separate sovereignties.

ABUSUMBOL, or EBSAMBOUL, or IPSAMBOUL, anciently *Aboccis*, or *Abuncis*, a town on the Nile, in Nubia, to the south of the island of Kogos, in Lat. 22. 20. 11. N. and Long. 31. 40. 57. E. About twenty feet above the river is a temple hewn out of the perpendicular face of the rock. At the entrance are several colossal figures of young persons, in bas-relief, the space between them being filled with hieroglyphics indicating a very high antiquity. A description of this famous temple is given in the article NUBIA.

ABU-TEMAN, an Arabian poet, of whom, though but little can be said, it would be improper to omit all notice, seeing he was held to be the prince of Arabian poets, during the best periods of Arabian literature. He was born about the year 787; and, happily for him, under sovereigns whose love and patronage of literature made poetical eminence an unfailing road to wealth and honour. Part of his early life was passed in Egypt, in the servile capacity of administering drink to those who frequented a mosque. It is also said, that he was for some time employed in the trade of a weaver at Damascus. But his talents for poetry soon lifted him from this humble sphere, and removed him to Bagdad, where the caliphs loaded him with presents, and treated him with the greatest respect. If we are to believe the Arabian historians, a single poem sometimes procured for him many thousand pieces of gold. So highly was he esteemed by his countrymen, that it was said "no one could ever die whose name had been praised in the verses of Abu-Teman!" His own life was very short, for he died in his fortieth year; "the ardour of his mind," says one of his contemporaries, "having wasted his body, as the blade of an Indian scimitar destroys its scabbard." Besides being a great original poet, he was the compiler of three collections of select pieces of the poetry of the East; the most esteemed of which collections is that called the *Hamasa*. Sir William Jones speaks of it as a very valuable compilation. Many of the elegant specimens of Arabian poetry contained in Professor Carlyle's well-known work, were translated from pieces contained in this miscellany. A large portion of it, with a Latin version, was annexed by Schultens to his edition of Erpenius's *Arabic Grammar*, published at Leyden in 1748; and there are also many extracts from it in the collection entitled *Anthologia Arabica*, published at Jena in 1774.



ABYDOS, in *Ancient Geography*, a city of Mysia, in Asia Minor, situated on the Hellespont, which is here scarcely a mile broad. It probably was originally a Thracian town, but was afterwards colonised by Milesians. Nearly opposite, on the European side of the Hellespont, stood Sestos; and it was here that Xerxes crossed the strait on his celebrated bridge of boats when he invaded Greece. Abydos was celebrated for the vigorous resistance it made when besieged by Philip of Macedon; and is famed in story for the loves of Hero and Leander. The old castle of the Dardanelles, built by the Turks, lies a little southward of Sestos and Abydos.

ABYDOS, in *Ancient Geography*, an inland town of Egypt, between Ptolemais and Diospolis Parva, famous for the palace of Memnon and the temple of Osiris. In the latter was discovered by Mr Bankes in 1818, the tablet containing a double series of twenty-six shields of the predecessors of Rameses the Great, which is now deposited in the British Museum.

ABYLA (Ptolemy, Mela), one of Hercules's pillars, on the African side, called by the Spaniards *Sierra de las Monas*, opposite to Calpe in Spain, the other pillar; supposed to have been formerly joined, but separated by Hercules, and thus to have given entrance to the sea now called the *Mediterranean;* the limits of the labours of Hercules. (Pliny.)

ABYSS (Ἄβυσσος). The Greek word means literally '*without bottom*,' but actually, *deep, profound*. It is used in the Septuagint for the Hebrew term תהום, which we find applied either to the ocean or to the under world. In the New Testament it is used as a noun to describe Hades, or the place of the dead generally, but more especially that part of Hades in which the souls of the wicked were supposed to be confined.

Most of these uses of the word are explained by reference to some of the cosmological notions which the Hebrews entertained in common with other Eastern nations. It was believed that the abyss, or sea of fathomless waters, encompassed the whole earth. The earth floated on the abyss, of which it covered only a small part. According to the same notion, the earth was founded upon the waters, or, at least, had its foundations in the abyss beneath. Under these waters, and at the bottom of the abyss, the wicked were represented as groaning, and undergoing the punishment of their sins.

The notion of such an abyss was by no means confined to the East. It was equally entertained by the Celtic Druids, who held that *Annwn* (the deep, the low port), the abyss from which the earth arose, was the abode of the evil principle (Gwarthawn), and the place of departed spirits, comprehending both the Elysium and the Tartarus of antiquity. With them also wandering spirits were called *Plant annwn*, "the children of the deep," (Davis's *Celtic Researches*, p. 175; *Myth. and Rites of the B. Druids*, p. 49).

ABYSS is also used in *Heraldry* to denote the centre of an escutcheon. In which sense a thing is said to be borne in abyss, *en abysme*, when placed in the middle of the shield, clear from any other bearing: He bears azure, a fleur-de-lis, in abyss.

# ABYSSINIA.

Abyssinia.

ABYSSINIA is an extensive country on the eastern coast of Africa, lying between 8° and 16° N. Lat. and 34° and 43° E. Long., bounded on the north-west by Nubia, on the north-east by the Red Sea, on the south by the country of the Gallas, and on the west by countries almost unknown, in the interior of Africa. Its extent is estimated at about 245,000 geographical square miles, and its population at from four to five millions.

Abyssinia is pre-eminently an alpine country. It rises from the low arid district on the borders of the Red Sea, in lofty ranges of mountains, with extensive and elevated table-lands, intersected by numerous valleys. Its mountains assume wild and fantastic forms, with sides frequently abrupt and precipitous, and are only accessible by very difficult passes. The summits of the more lofty are frequently, if not always, covered with snow, a statement not admitted by Bruce, but asserted by both Pearce and Salt, the former of whom was overtaken by a snow-storm on the Samen Mountains in the middle of October; the latter saw snow there from a distance on the 8th of May; and the more recent traveller, Dr Rüppell, found newly-fallen snow on the same mountains in the month of July. The Samen range of mountains are the highest in Abyssinia, and together with the Lamalmon and Lasta mountains, form a long but not continuous chain running north-east and south-west. Several of these mountains, as the Amba-Hai and the Beyeda, are upwards of 12,000 feet high, while the Abba Yaret and the Buahat rise to a height of almost 15,000 feet. Lying between the Samen mountains and the Red Sea, and almost parallel to the coast, is the Taranta range, which attains a height of upwards of 7000 feet. The table-lands or plateaux have been classed by that celebrated geographer Ritter, into three distinct groups or terraces, rising one above another from the borders of the Red Sea. The first of these is the plain of Baharnegash, lying to the west of the Taranta mountains, and extending to the river Mareb. On a higher elevation, lying between the rivers Mareb and Tacazze, is the Tigré plateau. The third or Amhara plateau is separated from the preceding by the Samen mountains, and has a mean elevation of 8000 feet. From this the country descends to unknown regions on the west.

Of the rivers of Abyssinia the most important are the Abai, called also the Bahr-el-Azrek, or Blue River, and the Tacazze. The former, which is the eastern branch of the Nile, and was considered by Bruce to be the main stream of that river, rises from two mountains near Geesh, in Lat. 10. 59. 25. N., 36. 55. 30. E. Long., at an elevation of about 10,000 feet above the level of the sea. It flows first north to the lake of Dembea, through which it has a perceptible current; it then takes a long semicircular sweep round the province of Gojam, and afterwards flows northward till about the 15th degree of north latitude, when it unites with the Bahr-el-Abiad, or White River, which is now considered to be the true Nile. The Tacazze or Atbara rises in the mountains of Lasta, and after draining those of Samen and Tigré, at length falls into the Nile in north latitude 17. 40. The Hawash rises in the south of Abyssinia, about latitude 9. 30. N., and longitude 38. E., and flowing in a north-easterly direction towards the Red Sea, is lost in Lake Abbebad, in latitude 11. 30. N., longitude 41. 40. E. The Mareb rises in the mountains of Taranta, and, flowing nearly parallel to the Tacazze, is afterwards lost in the sand; but Bruce says that in the rainy season it reaches that river. Besides these, there are numerous smaller rivers which rise in the mountains and are lost in the sandy plains below, or fall into larger rivers or lakes. The principal lake of Abyssinia is the Dembea or Tzana in the country of Amhara. It is about 60 miles long, and 40 broad, is fed by numerous rivulets, and abounds in small islands. Lake Ashangee is in the country of Tigré, and about 30 miles long by 15 broad. In the south of Abyssinia, near the Bay of Tajura, in the gulf of Bab-el-Mandeb, is the remarkable lake of Assal. This lake, which has only recently become known to travellers, is of an elliptical form, and about seven miles long. It is half filled with water of the deepest cerulean blue, and half with a solid sheet of glittering snow-white salt, and is no less than 570 feet below the level of the neighbouring gulf.

Abyssinia, from its more or less elevated situation, presents almost every variety of climate, from the burning heat of a tropical sun on the coast, to severe cold on the summits of its snow-crowned mountains. On the table-lands one breathes a pure mountain air, while in the valleys the heat is almost suffocating.

Few countries are more richly endowed by nature than Abyssinia. Its fertility is so great as in some places to produce three crops annually: vegetation gradually increases as it rises from the sandy coast. On the table-lands are found extensive pastures, and cedar forests crown the tops of many of its mountains. Among its fruit trees are numbered the date, orange, lemon, pomegranate, and banana. Coffee grows wild on the western mountains, and on its western declivities the cotton plant is found in great abundance. On the table-lands are extensive maize fields, and there, as well as in other parts of the country, the sugar-cane and vine are cultivated. On the higher grounds, wheat and barley are raised in large quantities, and the low grounds are chiefly covered with *teff*, *Poa abyssinica*, with grains not larger than the head of a pin, of which is made the bread in general use throughout the country. The low grounds produce also a kind of corn called *tokussa*, a species of Eleusine, of which a black bread is made, which constitutes the food of the lowest classes. Durra, or *Holcus Sorghum*, in Abyssinian, *Maschella*, is common. In some provinces *Schami*, Zea Mais, has been introduced; and the natives cultivate other esculent vegetables as *Schimbera*, Circe arietinum; *Misani*, lentils; *Atar*, vetches; *Bagela*, lupines; *Nuck*, oriental sesame; *Telwa*, a species of lintseed; *Schankurte*, a small onion; *Gamal*, a species of cabbage. Myrrh, senna, and various kinds of costly medicinal plants, are very plentiful.

Most of the domestic animals of Europe are found here. The horses are strong and active, and the oxen very numerous—a remarkable species of which, the Galla ox, has horns sometimes four feet long. Goats and sheep are very plentiful, but the latter are small, and have black wool. Of the animals of prey, the most numerous is the striped hyæna, which is very fierce and untameable, and, protected by superstition, roams unchecked in immense numbers over the country, entering the towns and even the houses of the inhabitants. The elephant and rhinoceros are numerous in the low grounds. The Abyssinian rhinoceros has two horns; its skin, which has no folds, is used for shields; as well as for lining drinking-vessels, being regarded as an antidote to poison. Crocodiles and hippopotami are plentiful in the rivers; lions, panthers, and the common and black varieties of leopards, are seen occasionally, and buffaloes frequently. Besides these, there are found several species of monkeys; the common, the caracal, and the booted lynx; the wild cat, a small species of wolf, the Barbary jackal, common fox, fenneck, zibet, weasel, rat, mouse, marmot, Barbary and palm squirrel, jerboa, hare, Syrian hyrax, wild boar, cameleopard, zebra, quagga, camel, and antelopes of the species *oryx*, *oreas*, *bubalis*, *euchore*, *grimmia*, and *dorcas*. The number of birds in this country is immense. Great numbers of eagles, vultures, hawks, and other birds of prey are met with; and partridges, snipes, pigeons, and swallows, are very plentiful. Among the birds of Abyssinia are the *barbatus* and *percnopterus* species of vulture, the occipital eagle, several species of falcons, the *poliocephalus*, *cubla*, and *ferrugineus* species of shrikes, *Psittacus Taranta*, or *Taranta parrakeet*, *Coracias Bengalensis*, or Bengal roller, *Bucco Saltii* or Salt's bucco, *Oriolus monachus*, *Cuculus Senegalensis*, *Picus Abyssinicus*, *Alcedo Abyssinica* or *chelicuti*, *Merops erythropterus*, and *forficatus* or *furcatus*, *Certhia Tacazze*, *Tanagra erythrorhynca*, *Sylvia pammelania*, *Colius striatus*, and *Senegalensis*, *Loxia leucotis*, *Emberiza capensis*, *Fringilla Senegalensis* and *Bengalensis*, *Muscicapa paradisea* and *mutata*, *Alauda desertorum*, *Struthio camelus* or ostrich, *Cursorius Europœus*, *Columba Guinea*, or Guinea pigeon, *Columba Abyssinica*, *Numida mitrata*, *Tringa Senegalensis*, and *Abyssinica*, *Ardea Pondiceriana*, or rather *Erodia Amphilensis*, and the *Phœnicurus musicus*, *capensis*, and the *nitens* species of the Turdus. Serpents of different species are not uncommon, among which of the venomous sort are *Naja Haje*, *Vipera Arcelaus*, *V. Echis*, and probably *V. Cerastes*. Among its insects the most numerous and useful is the bee; for honey everywhere constitutes an important part of the food of the inhabitants, and several of the provinces pay a large proportion of their tribute in this article. Of an opposite class is the locust, the ravages of which here, as in the other parts of Northern Africa, are terrible.

Abyssinia, according to MM. Galinier and Ferret, ought to be ranked among the most complex and remarkable countries in a geological point of view. The formations range from the first to the last degree of the geological scale. They found the primary and transition formations in the country of the Chohos in Tigré; secondary formations at the extremity of Tigré; tertiary and modern formations on the shores of the Red Sea, &c.; besides a great variety of sedimentary rocks, rocks of plutonic and volcanic origin; and besides those commonly named metamorphic rocks, a number of extinct volcanoes, hot springs, repositories of sulphur, rock salt, combustible substances, malachite, and native copper, lead, iron, &c.

Of the mineral wealth of Abyssinia little is known. Granite, slate, and gneiss, form a great part of its mountains; antimony and iron ore, with small quantities of gold and silver, are mentioned among its productions. South-east of Tigré, and about 50 miles from Amphila bay, is an extensive plain of salt, which to the depth of two feet is perfectly pure, and so hard as to require to be cut with a hatchet; at a greater depth it is much coarser and softer, till purified and hardened by exposure to the air. The savage tribes in the vicinity, ever on the watch for plunder, render the digging and carrying off the salt very dangerous to those engaged in these operations, who are therefore obliged to associate in numerous and well-armed bands. This salt is used by the Abyssinians, not only to season and preserve food, but also as a medium of exchange, increasing in value the farther it is carried into the country.

The ancients included Abyssinia under the general name of Ethiopia, and the people under that of Ethiopians, from a word in the Greek language signifying of a dark colour; and the Abyssinians of the present day call themselves Itiopians, and their country Itiopia. Abyssinia, or more correctly Habessina, is a corruption of Habesch, a name given to the country by the Arabs, and signifying a mixed people.

The ancient history of Abyssinia is very imperfectly known. The story of the Abyssinians, that their country is the Sheba mentioned in Scripture whose queen visited Solomon, is unworthy of credit; equally so is the assertion that Solomon had a son by that queen, named Menilebek, from whom sprang the Abyssinian kings. The kingdom of the Auxumitæ flourished in Abyssinia, in the first or second century of our era. Its chief town was Auxume, whose site is now occupied by the modern Axum in Tigré, where many vestiges of its greatness are to be found. It appears that at this time the arts of the Greeks and Egyptians had penetrated into the country; and we find the Greek language used in their monumental inscriptions, as in the famous monument at Axum, executed before the introduction of Christianity, in which the king calls himself "son of the invincible Mars." In the year 522, the Abyssinians, under the command of their king Elesbaan, the most powerful, and the only conquering prince that occupied the throne, attacked and destroyed the kingdom of the Homerites, on the opposite coast of the Red Sea. Elesbaan afterwards resigned the government, and ended his life in a monastery. About 60 years later, the Abyssinians were expelled from Arabia, and from this time till about the year 960 we have very little information respecting them that can be depended on. About the latter period, Queen Judith, a Jewish princess, of more than manly courage and ruthless ambition, conceived the bloody design of murdering all the members of the royal family, and establishing herself in their stead. During the execution of the project the infant king was carried off by some faithful adherents, and conveyed to Shoa, where his authority was acknowledged; while Judith reigned for 40 years over the rest of the kingdom, and transmitted the crown to her posterity. In 1268, however, the kingdom was restored to the royal house, in the person of Icon Amlac. On the accession of this prince the royal residence was removed from Axum to Shoa, and the Amharic became the language of the court. About the close of the 15th century, the Portuguese missions into Abyssinia commenced, and were continued from time to time, till Mendez, by his arrogance and cruelty, brought about their expulsion. This Portuguese Jesuit had so ingratiated himself with the Emperor Lusneius, as to be intrusted with the management of the religious affairs of the country. The emperor himself swore obedience to the Roman Pontiff, and commanded his people to embrace the Roman Catholic religion. But the people had not suffered papal tyranny sufficiently long to submit tamely to the inquisitorial punishments that Mendez administered to the recusants. Civil commotions and insurrections were the consequence, till at length, in 1631, the emperor freed the people from the tyranny of Mendez, by granting them liberty to exercise the religion they preferred; and Basilides, who succeeded his father in 1632, drove Mendez and the whole Jesuitical persecutors out of the country. Abyssinia then became the seat of anarchy and confusion, occasioned by the encroachments of the Gallas from without, and the contests between the governors of the different provinces in the interior. Might everywhere triumphed over right; cities and villages were burned down, and the inhabitants driven out and sold for slaves. In these circumstances, the king, who lived in Gondar, with only a small retinue of servants, received but little respect or obedience from the governors of the different provinces, each of whom was anxious to obtain that title for himself, and was only prevented by the jealousy of the others. The result of these contests has been that Abyssinia, as a kingdom, has ceased to exist. It is now divided into numerous independent kingdoms or provinces, governed either by Galla princes, or by the successors of former governors, who had raised themselves to independence. These petty kings are constantly at war with each other, and the most deadly animosities exist between them.



The most important of the kingdoms of Abyssinia are those of Tigré, Amhara, Gondar, Shoa, and Angot. Tigré is situate in the north-eastern part of Abyssinia, separated from Amhara by the river Tacazze, and comprehends the provinces of, 1. Tigré proper, with Adowa the chief town, and Axum the ancient capital of Abyssinia; 2. Agame; 3. Enderta; 4. the Lasta country, consisting of rude and almost inaccessible mountains; 5. Lamen; 6. Baharnegash; 7. Woijerat; 8. Wofila; besides these are the districts of Tembea, Shirè, Waldubha, &c.

Amhara consists of the large province of Amhara, lying along the Dembea lake, and several of the neighbouring districts; and is governed by a Galla prince.

Gondar is in the possession of a Mahommedan Galla prince and contains, 1. The province of Dembea, named after the lake in its vicinity, with the city of Gondar, which was formerly the chief town of Abyssinia. 2. The province of Bejemder. 3. The province of Maidsha, besides the districts of Godsham, Damot, &c.

Shoa is situate in the south of Abyssinia, and at present seems to be the most powerful and flourishing kingdom in that country. It is inhabited chiefly by Gallas, and is governed by a Galla prince, who resides at Ankobar; the population is estimated at one and a-half million. Angot also in the south of Abyssinia, is inhabited by Gallas and governed by a Galla prince. Its capital is Agof.

The aborigines, who are the most numerous people of Abyssinia, belong to the Caucasian race, and are of a dark olive colour, approaching to black, and generally handsome, with long hair and lively eyes. They are divided into tribes, as the Tigreans, Amharans, Agows, &c. Other races have, at various times, established themselves in the country. A Jewish race inhabit the district of Lamen, and are known by the name of Talashas. They affirm that their forefathers came into the country as early as the days of Rehoboam; but it seems more probable that they had come about the time of the destruction of Jerusalem. From the tenth century they enjoyed their own constitutional rights, and were subject to their own kings, who, they pretend, were descended from king David, until the year 1800, when the royal race became extinct, and since then they have been subject to Tigrè. The Gallas are a wild and savage race from the south, who have overrun the greater part of Abyssinia, so that at present there are few chiefs who have not an intermixture of Galla blood. They are mostly idolaters, but many have

Abyssinia. adopted the Mahommedan faith, and not a few the Christianity of the Abyssinians. Their young men are denied certain privileges, and are despised by their seniors, and even by the women, till they have given proof of their manhood by killing an enemy.

The principal languages of Abyssinia belong to the Ethiopic class, and are divided into several branches. The Geez, which is the language of Tigré, and of which the modern Tigré is a dialect, is that of the religion and literature of the country; and while Tigré was dominant, it was that of the court. From its affinity to the Arabic, it may reasonably be supposed to have been introduced by conquerors or settlers from the opposite shores of the Red Sea. The Amharic, which is the language of the present dominant race, is that used by the court and merchants, and that which travellers who penetrate beyond Tigré, generally have occasion to use. Though this language has many words in common with the Geez, yet whether it be a dialect of that or an ancient African language, is a question which has not been settled. The Agow in its various dialects is the language of the people generally; in some provinces it is used almost exclusively, and in others where it has been superseded by the language of the dominant race, it still exists among the lowest classes. The Gallas have introduced their own language into various parts of the country; but in many cases they have adopted the language of the people whose place they have usurped.

The religion of the Abyssinians is a very degraded form of Christianity. It was introduced as early as the beginning of the fourth century by Frumentius, who was consecrated first Bishop of Abyssinia by St Athanasius of Alexandria. Since that time, it has been so corrupted by errors of various kinds, as to have now become little more than a dead formality mixed up with superstition and Judaism. Their children are circumcised, and the Mosaic commandments with respect to food and purification are observed. Fasts and feast-days are very frequent; baptism and the Lord's Supper are dispensed after the manner of the Greek church. Their worship consists merely in reading passages of Scripture, and dispensing the Lord's Supper without any preaching or singing. Of the more ignorant of the clergy, the greater part are married; and even among the monks, marriage is not rare, though contrary to the rules of their order; and indeed, some of them even live in polygamy, which among the Abyssinians is not uncommon. Their primate or chief bishop, whom they call *Abuna* (*i.e.* our father) is nominated by the Patriarch of Cairo, whom they acknowledge as their spiritual father. The ecclesiastical body is very numerous, consisting of priests of various kinds, with monks and nuns, and is looked upon with great awe and reverence. They have innumerable saints, but above all is the Virgin, whom they consider as queen of heaven and earth, and the great intercessor for the sins of mankind. Their churches are rude edifices, chiefly of a circular form, with thatched roofs, and surrounded by pillars of cedar. Like the Greek church, they have no images of any kind in their places of worship, but paintings are very common; and on entering, every one must leave his shoes at the door. Legends of saints, and works of religious controversy, form almost their entire literature.

The Abyssinians are very rude and barbarous. Engaged as they are in continual wars, and accustomed to bloodshed, human life is not respected among them. Murders and executions are frequent, and at Gondar Bruce seldom went out without seeing dead bodies in the streets, left to be devoured by the dogs and hyænas. When one commits murder, he must make satisfaction to the relatives of the deceased, who may either put him to death or accept of a ransom. When the murdered person has no relatives, the priests take upon themselves the office of avengers. Raw flesh is with them a favourite article of food. At their *brinds*, or raw flesh feasts, the cattle are brought to the door and slaughtered; and the flesh, while yet warm and quivering, is brought in to the guests, and devoured by them with great gusto. Marriage is a very slight connection, dissolvable at any time by either party. The engagement is concluded between the lover and the bride's parents, her consent not being considered at all necessary to the agreement. The lover then carries off the bride on his shoulders, and the ceremony concludes with a brind feast. Their principal liquor is mead; but the common drink of the lower classes is *bouza*, a species of sour beer, made from the fermentation of their bread, principally of that left at their feasts. Their dress consists of a large folding mantle and close drawers; their houses are very rude, of a conical form, and covered with thatch.

The inhabitants of Abyssinia are chiefly engaged in agricultural and pastoral pursuits. Their industrial productions are insignificant, consisting chiefly in preparations of leather, parchment, cotton cloths, and tapestry fabricated from wool and goats' hair, and in manufactures of iron and brass.

Abyssinia is equally unimportant in a commercial point of view. It only possesses a single harbour; and there is no road or navigable river to facilitate intercourse with the interior of the country. In addition to these obstacles, merchants, when travelling, are exposed to the attacks of wild marauding hordes, and subjected to high taxes and duties, which annually amount to a considerable sum. Massuah, its principal, or rather only seaport town, is the chief place for foreign traffic. Caravans bring here the merchandise of this and some of the western countries, and carry away European and Indian goods. Its principal imports are lead, tin, copper, silk, gunpowder, glass, Indian goods, Persian carpets, French cloths, coloured skins from Egypt; the exports are ivory, gold, slaves, cattle, cotton cloth, mules, honey.

The steam navigation of the Red Sea has given an increased degree of importance to Abyssinia in the eyes of several of the European powers. The British, since they got possession of Aden, have been very anxious to establish commercial intercourse with this country; while the French have been no less desirous to attain the same object. The latter have despatched several embassies for the purpose of ascertaining the mercantile capabilities of the country, and have also, in order to effect a union between that country and the See of Rome, established a Catholic mission at Adowa. The English, in the beginning of 1841, sent a political mission to Shoa, with the view to a commercial union with that kingdom. Major Harris, who commanded the expedition, afterwards published an account of his travels there, in three volumes. In 1829, the Church Missionary Society sent Messrs Gobat and Kugler as missionaries to Abyssinia. Mr Kugler died shortly after his arrival, but his place was supplied by Isenberg, who was followed by Messrs Blumhardt and Krapf. Mr Gobat returned to Europe in 1833, and next year published a journal of his residence in Abyssinia. On account of the opposition of the native priests, the missionaries were, in 1838, compelled to leave the country; and after several fruitless attempts to re-establish themselves, the mission was abandoned in 1843. Dr Edward Rüppell, a German naturalist, arrived at Massuah in 1831, and remained in the country nearly two years. His researches have thrown much light on the nature and productions of the country. He brought to Europe a large collection of animals, including many new species, which he deposited in the museum of his native city, Frankfort on the Maine; and in 1838 he published an account of his travels, in two volumes, entitled, *Reise in Abyssinien*. But of all the travellers to this country, perhaps none have done more to extend our knowledge of it than Dr Beke. He reached several places which had never before been visited by Europeans, collected vocabularies of no fewer than thirteen of its languages and dialects, and is the first traveller who has described the sources of Abai since the days of Bruce, whose statements he confirms. He arrived at Tajura in November 1840, and travelling through Shoa, Gojam, Lasta, and Tigré, arrived at Massuah in May 1843. From time to time he communicated an account of his travels to the Royal Geographical Society, which is published in their journal.

ABYSSINIAN, in *Ecclesiastical History*, is the name of a sect in the Christian church, established in the empire of Abyssinia. The Abyssinians are a branch of the Copts or Jacobites, with whom they agree in admitting but one nature in Jesus Christ, and rejecting the council of Chalcedon: whence they are called *Eutychians* or *Monophysites*, and stand opposite to the Melchites. They are only distinguished from the Copts, and other sects of Jacobites, by some peculiar national usages. The Abyssinian sect or church is governed by a bishop or metropolitan styled *Abuna*, sent them by the Coptic patriarch of Alexandria residing at Cairo, who is the only person that ordains priests. The next dignity is that of Komos, or Hegumenos, who is a kind of archpresbyter. They have canons also, and monks: the former of whom marry; the latter, at their admission, vow celibacy, but with a reservation: these, it is said, make a promise aloud, before their superior, to keep chastity; but add in a low voice, *as you keep it*. The emperor has a kind of supremacy in ecclesiastical matters. He alone takes cognizance of all ecclesiastical causes, except some smaller ones reserved to the judges, and confer all benefices, except that of Abuna. See Abyssinia.

ACA, Ace, or Acon, in *Ancient Geography*, a town of Phœnicia, on the Mediterranean; afterwards called *Ptolemais;* now *Acre.*

ACACIA, Egyptian Thorn, or Binding Bean-tree, in *Botany*, a species of mimosa, according to Linnæus, though other botanists make it a distinct genus. Several species of acacia produce *gum arabic*, especially *A. Ehrenbergii*, *A. tortilis*, *A. arabica*, *A. vera*, *A. Seyal*, *A. Verek*. An inferior sort is produced by *A. Adansonii*, *A. albida*, and *A. Karro*. These are natives of Egypt, Arabia, or Africa. The inspissated gum of the bark of *A. catechu* forms the astringent substance name catechu; which, however, is also produced in India from several other trees. The bark of several species of acacia produce a *tannin;* of which a large quantity is now imported from Van Diemen's Land, for the purposes of the tanner, and is chiefly the produce of *A. decurrens* and *A. mollissima.*

*A. julibrissin*, a native of Persia, has, on account of its elegant foliage and flowers, been long acclimated in England; *A. sophora* is a fragrant species, that has more lately been introduced, and is nearly acclimated in the south of our island. It flowers early in spring, and bears many clusters of rich yellow flowers.

The flowers of a species of the acacia are used by the Chinese in making that yellow which we see bears washing in their silks and stuffs, and appears with so much elegance in their painting on paper. The method is this: They gather the flowers before they are fully open; these they put in a clean earthen vessel over a gentle heat, and stir them continually about as they do the tea-leaves, till they become dryish and of a yellow colour; then to half a pound of flowers they add three spoonfuls of fair water, and after that a little more, till there is just enough to hold the flowers incorporated together; they boil this for some time, and the juice of the flowers mixing with the water, it becomes thick and yellow; they then take it from the fire, and strain it through a piece of coarse silk. To the liquor they add half an ounce of common alum, and an ounce of calcined oyster-shells reduced to a fine powder. All is then well mixed together; and this is the fine lasting yellow they have so long used.

The dyers of large pieces use the flowers and seeds of the acacia for dyeing three different sorts of yellow. They roast the flowers, as before observed; and then mix the seeds with them, which must be gathered for this purpose when fully ripe; by different admixtures of these they give the different shades of colour, only for the deepest of all they add a small quantity of Brazil wood.



Mr Geoffroy attributes the origin of bezoar to the seeds of this plant; which being browsed by certain animals, and vellicating the stomach by their great sourness and astringency, cause a condensation of the juices, till at length they become coated over with a stony matter which we call Bezoar.

Acacia, in the *Materia Medica*, the inspissated juice of the unripe fruit of the *Mimosa Nilotica.*

The juice is brought to us from Egypt, in roundish masses wrapt up in thin bladders. It is outwardly of a deep brown colour, inclining to black; inwardly of a reddish or yellowish brown; of a firm consistence, but not very dry. It soon softens in the mouth, and discovers a rough, not disagreeable taste, which is followed by a sweetish relish. This inspissated juice entirely dissolves in watery liquors, but is scarce sensibly acted on by rectified spirit.

This acacia is a mild astringent medicine. The Egyptians give it in spitting of blood, in the quantity of a drachm, dissolved in any convenient liquor; and repeat this dose occasionally: they likewise employ it in collyria for strengthening the eyes, and in gargarisms for quinsy. Among us, it is little otherwise used than as an ingredient in mithridate and theriaca, and is rarely met with in the shops. What is usually sold for the Egyptian acacia, is the inspissated juice of unripe sloes; this is harder, heavier, of a darker colour, and somewhat sharper taste, than the true sort. See the next article.

*German Acacia*, the juice of unripe sloes inspissated nearly to dryness over a gentle fire, care being taken to prevent its burning. It is moderately astringent, similar to the Egyptian acacia, for which it has been commonly substituted in the shops. It is given in fluxes, and other disorders where styptic medicines are indicated, from a scruple to a drachm.

Acacia, among *Antiquaries*, something resembling a roll or bag, seen on models, as in the hands of several consuls and emperors. Some take it to represent a handkerchief rolled up, wherewith they made signals at the games; others, a roll of petitions or memorials; and some a purple bag full of earth, to remind them of their mortality.

ACACIANS, in *Ecclesiastical History*, the name of several sects of heretics; some of which maintained, that the Son was only a similar, not the same, substance with the Father; and others, that he was not only a distinct but a dissimilar substance. Two of these sects had their denominations from Acacius, bishop of Cæsarea, who lived in the fourth century, and changed his opinions so as, at different times, to be head of both. Another was named from Acacius, patriarch of Constantinople, who lived in the close of the fifth century.

ACACIUS, surnamed Luscus, because he was blind of one eye, was bishop of Cæsarea in Palestine, and succeeded the famous Eusebius: he had a great share in the banishment of Pope Liberius, and bringing Felix to the see of Rome. He gave name to a sect, and died about the year 365. He wrote the life of Eusebius, which is lost, and several other works.

Acacius, *Saint*, bishop of Amida in Mesopotamia, in 420, was distinguished by his piety and charity. He sold the plate belonging to his church, to redeem seven thousand Persian slaves who were perishing with hunger. He gave each of them some money and sent them home. Veranius, their king, was so affected with this noble instance of benevolence, that he desired to see the bishop; and this interview procured a peace between that prince and Theodosius I.

There have been several other eminent persons of the same name; particularly, a martyr under the Emperor Decius;

a patriarch of Antioch, who succeeded Basil in 458, and died in 459; a bishop of Melitene in the fifth century; a famous rhetorician in the reign of the Emperor Julian; and a patriarch of Constantinople in the fifth century, who was ambitious to draw the whole power and authority of Rome by degrees to Constantinople, for which he was excommunicated by Pope Felix II. He in his turn passed sentence of excommunication against the pope. Still, however, he held his patriarchate till his death in 488.

ACAD, ACCAD, or ACHAD, one of the five cities in "the land of Shinar," or Babylonia, said (Gen. x. 10) to have been built by Nimrod. Their situation has been much disputed. Without giving the details of the question, it is sufficient to say that Colonel Taylor, the British resident at Baghdad, who has given much attention to the subject, has, with great probability, identified the ancient Achad (or *Achar*, as it is given in some Hebrew MSS.), with the remarkable pile of ancient buildings called *Akker-koof*, in Sittacene, and which the Turks know as *Akker-i-Nimrood* and *Akker-i-Babil.* Akker-koof is about nine miles west of the Tigris, at the spot where that river makes its nearest approach to the Euphrates. The heap of ruins to which the name of Nimrod's Hill—*Tel-i-Nimrood*, is more especially appropriated, consists of a mound surmounted by a mass of brick-work, which looks like either a tower or an irregular pyramid, according to the point from which it is viewed. It is about 400 feet in circumference at the bottom, and rises to the height of 125 feet above the sloping elevation on which it stands. The mound, which seems to form the foundation of the pile, is a mass of rubbish accumulated by the decay of the superstructure. In the ruin itself, the layers of sun-dried bricks, of which it is composed, can be traced very distinctly. They are cemented together by lime or bitumen, and are divided into courses varying from 12 to 20 feet in height, and are separated by layers of reeds, as is usual in the more ancient remains of this primitive region. The use of this remarkable monument has been a subject of doubt and conjecture. The embankments of canals and reservoirs, and the remnants of brick-work and pottery occupying the place all around, evince that the Tel stood in an important city; and, as its construction announces it to be a Babylonian relic, the greater probability is that it was one of those pyramidal structures erected upon high places, which were consecrated to the heavenly bodies, and served at once as the temples and the observatories of those remote times.

ACADEMICS, or ACADEMISTS, a denomination given to the cultivators of a species of philosophy originally derived from Socrates, and afterwards illustrated and enforced by Plato, who taught in a grove near Athens, consecrated to the memory of Academus, an Athenian hero; from which circumstance this philosophy received the name of *Academical.* Before the days of Plato, philosophy had in a great measure fallen into contempt. The contradictory systems and hypotheses which had successively been advanced were become so numerous, that, from a view of this inconstancy and uncertainty of human opinions, many were led to conclude, that truth lay beyond the reach of our comprehension. Absolute and universal scepticism was the natural consequence of this conclusion. In order to remedy this abuse of philosophy and of the human faculties, Plato laid hold of the principles of the academical philosophy; and, in his Phædo, reasons in the following manner: "If we are unable to discover truth," says he, "it must be owing to two circumstances: either there is no truth in the nature of things; or the mind, from a defect in its powers, is not able to apprehend it. Upon the latter supposition, all the uncertainty and fluctuation in the opinions and judgments of mankind admit of an easy solution: Let us therefore be modest, and ascribe our errors to the real weakness of our own minds, and not to the nature of things themselves. Truth is often difficult of access: in order to come at it, we must proceed with caution and diffidence, carefully examining every step; and, after all our labour, we will frequently find our greatest efforts disappointed, and be obliged to confess our ignorance and weakness."

Labour and caution in the researches, in opposition to rash and hasty decisions, were the distinguishing characteristics of the disciples of the ancient academy. A philosopher possessed of these principles will be slow in his progress, but will seldom fall into errors, or have occasion to alter his opinion after it is once formed. In his essay on the academical or sceptical philosophy, Mr Hume has confounded two very opposite species of philosophy. After the days of Plato, the principles of the first academy were grossly corrupted by Arcesilaus, Carneades, &c. This might lead Mr Hume into the notion, that the *academical* and *sceptical* philosophy were synonymous terms. But no principles can be of a more opposite nature than those which were inculcated by the old academy of Socrates and Plato, and the sceptical notions which were propagated by Arcesilaus, Carneades, and the other disciples of the new academical school.

ACADEMUS, an Athenian hero. See ACADEMY.

# ACADEMY.

ACADEMY, ακαδημια, ακαδημεια, or εκαδημεια, (the first two forms being probably derived from ακος, *medela* and δημος, *populus*, and the last from ἑκας, *procul* or *seorsim*, and δημος, *populus*,) a garden, villa, or grove, situate in the Ceramicus, one of the suburbs of Athens, about six stadia, or nearly a Roman mile to the north-west of the city. The common tradition is, that it took its name from one *Academus* or *Ecademus*, the original owner, who was contemporary with Theseus, and made it a kind of gymnasium; and that after his death it retained his name, and was consecrated to his memory. When Castor and Pollux came to Athens to reclaim by force of arms the person of their sister Helena, who, according to the legend, had been carried off by Theseus, and concealed in some obscure retreat by the ravisher, the Athenians declared that they knew not where the lady was to be found; but as this answer was not deemed satisfactory by the warlike brothers, *Academus*, cognisant with the secret, and anxious to avert a contest about so frivolous a subject of dispute, apprised them that she was concealed in the town of Aphidna; which was immediately attacked, taken by assault, and razed to the ground. Grateful for this traditionary service, the Lacedemonians, who worshipped the Dioscuri (Castor and Pollux), spared the house and gardens known by the name of the *Academy*, when they ravaged the suburbs of Athens; and, in consideration of the disclosure just mentioned, they honoured the memory of the original owner, from whom the place took its name.[1] Such is the legend which the Greek writers have transmitted to us. With regard to the spot itself, which afterwards became so famous, in connection with the name of Plato and his philosophical disciples, it appears to have remained almost in a state of nature, covered with stagnant water, and exceedingly insalubrious, until the time of Cimon, when it was drained, planted with alleys of trees, and embellished with groves and with fountains: after which it became the promenade of the most distinguished Athenians, and particularly of the Platonic philosophers, thence called the *Academics;* just as the *Lyceum*, another gymnasium, situated to the south-east of Athens, became the promenade of the Aristotelian sect of philosophers, called also Peripatetics (*α περιπατεω, obambulo*), from the locomotive fashion in which they communicated or discoursed concerning their peculiar doctrines. The Academy formed part of the Ceramicus (a word derived from κεραμος, signifying *potter's earth* or *earthen vase*, from its being filled with cinerary urns), and was therefore devoted to purposes of sepulture; it being then the practice to inter in a public garden or grove, as in a sort of elysian field, those who had signalized themselves by rendering important services to their country. Cicero, desirous to revive or preserve the name of the Academy, bestowed it on his villa or country-seat near Puzzuoli, where he loved to converse with his friends on philosophical subjects, and where, also, he composed his *Academical Questions*, his treatise on the *Nature of the Gods*, and his celebrated work on the *Commonwealth*, a considerable portion of which was, several years ago, recovered from rescribed or palimpsest manuscripts, by Signor Angelo Maio, librarian of the Vatican.

Academy, in its generalized acceptation, is employed to signify a society of learned men, established for the improvement of science, literature, or the arts. This term, as we have seen, is one of very high antiquity. It was amidst the umbrageous recesses of the gardens of Academus, so favourable to philosophical meditation, that the divine Plato, surnamed the swan of the Academy, established his school, collected his disciples, and taught his sublime morality; wherefore the sect of this illustrious philosopher was called the Academic, and the philosophers who adopted his doctrines Academics. For a long period, accordingly, this title marked out the disciples of Plato alone; but it came afterwards to be applied to all those who belonged to the different learned or literary societies instituted, under the name of Academies, in imitation of the school of Athens, and in order to extend the boundaries of human knowledge. Of these institutions several were established in Athens itself, but none ever equalled the renown of that founded by Plato; and, in point of fact, they were merely schools where Arcesilaus, Carneades, Philo, Antiochus, and other philosophers of less note, explained the different systems with which each in his turn sought to supersede those of his predecessors, but which have since fallen into the most profound neglect and oblivion.



Ptolemy Soter, having by his victories secured undisturbed possession of the throne of Egypt, and wishing to unite to the title of conqueror the more glorious appellation of patron of learning, founded, under the name of Musæon, the celebrated Academy of Alexandria, and provided it with a collection of books, which formed the nucleus of the Alexandrian library. Here he assembled the most distinguished philosophers and scholars of his time, charging them with the investigation of philosophical truth and the improvement of art; and it was to the care and researches of these eminent men and their successors that the famous library, commenced by Ptolemy, and afterwards so barbarously given up to the flames by the Caliph Omar, was enlarged and improved, until it became the pride of Egypt and the glory of the world. This academy, distinguished alike for its useful labours and its improvements in science, has served as a model to modern academies, both as regards the principles on which it was founded, and the object and end of its institution. It admitted into the number of its associates the poets and philosophers of all countries: persons came from every part of the earth to seek instruction, or to deposit new information in its bosom: and all parties were enriched by the continual interchange of ideas and discoveries. For a long period it was the great centre of knowledge. All the literary treasures, scattered throughout the different countries which the tide of barbarism had overflowed, were there collected together: towards the period when Greece began to decline, the spirit and the genius which once presided in her schools of philosophy were in some degree revived in that of Alexandria; and it shone forth like a resplendent beacon-light in the midst of the surrounding darkness, shooting forth rays which have traversed the long course of ages, and guided the academies of modern times in their researches and investigations.

Rome had no academies. In the eyes of the conquerors and masters of the world, the sciences appeared only a secondary object, and of comparatively little importance This Virgil has admitted in his Æneid, where he says, that in art and in science the Romans must yield the palm to other nations, and content themselves with the glory of conquest, and a knowledge of the means by which it might be secured and maintained.[2] The Latin poets and writers, indeed, were formed by the study of Greek models. But no national establishment fostered their genius and favoured their progress, either under the republic, which despised letters, or under the imperial tyrants, who dreaded them. Augustus himself only patronised and rewarded the poets who flattered him; while Mæcenas, in surrounding himself with assemblages of celebrated writers, thought less of extending the boundaries of learning, than of tasting the pleasures of learned society, and wearing off the fatigues of business amidst the sweets of an inter-

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[1] From certain expressions of Eupolis, and this among others, εν ευσκιοις δρυμοισιν Ακαδημου θεου, "in the umbrageous groves of the god Academus," it would appear that this person was accounted not merely a hero, but a sort of divinity. Hence the Academy was consecrated to Bacchus Academus, or to the beneficent sun of the ascending signs; as the Lyceum with its *temenos* or *lucus* was dedicated to Apollo Lycæus (so called from λυκος, a wolf), or to the destroying sun of the descending signs of the zodiac: and hence also these schools were the astronomical symbols or representatives of the celestial houses of the two solstices; the Academy, of the higher, and the Lyceum, of the lower solstice.

[2] Excudent alii spirantia mollius æra,
Credo equidem; vivos ducent de marmore voltus;
Orabunt caussas melius, cœlique meatus
Describent radio, et surgentia sidera dicent:
Tu regere imperio populos, Romane, memento;
Hæ tibi erunt artes; pacisque imponere morem,
Parcere subjectis, et debellare superbos.
*Æneid.* lib. vi. l. 848.

Academy. course entirely Epicurean, or of enjoyments such as literature alone can afford to men of refined and cultivated minds.

When the darkness which had settled down upon Europe after the fall of the Western Empire began at length to disperse, and when a faint glimmering of light, symptomatic of slowly approaching day, began to flicker and tremble on the dusky brow of the long night of ignorance and barbarism, a passion for instruction became in some measure the mode, and gave birth simultaneously to a multitude of learned associations; and these proceeded at once to the study and improvement of the sciences and arts, long neglected, and almost lost in those very countries where they had formerly been cultivated with the greatest success. The Gauls, however, although partially civilized by the Romans and by Julian the philosopher (vulgarly called the Apostate), had relapsed, under the indolent and imbecile monarchs of the first race, into the most profound ignorance; while the monks, who passed for learned men when they could read, were from policy opposed to the instruction of the people. The spirit of monopoly and exclusion was then, as afterwards, a prominent characteristic of the ecclesiastical system; and the danger of educating the people was as vehemently exaggerated as by certain alarmists of our own day. "The clergy," said Charlemagne, "wish to monopolize all learning, and to continue the sole expounders of the sciences and the laws." Nevertheless this prince, who would have done honour to an age far less barbarous, attempted to resuscitate letters, with which he had some acquaintance; and with this view he, encouraged by the celebrated Alcuin, founded in his palace an academy for promoting the study of grammar, orthography, rhetoric, poetry, history, and the mathematics. This academy was composed of the principal wits of the court, Charlemagne himself being a member. In their academical conferences, every member was to give an account of the ancient authors which he had read; and in order to efface all distinctions of rank among the academicians, he required each of them to choose a name purely literary (as, for example, that of some ancient author or celebrated person of antiquity), which should in no degree serve to recall the birth, station, or dignity of the person assuming it. Accordingly, Egilbert, a young lord, and one of the grandees about the court, modestly took the name of Homer; the archbishop of Mayence called himself Damœtas; Alcuin became Flaccus Albinus; Eginhard, Calliopus; Adelard, abbot of Corbie, Augustin; Theodulph, Pindar; and Charlemagne himself, somewhat forgetful of his own rule, David.[1] Fantastical as all this may appear to us, it was nevertheless productive of good. The nobles, who had been accustomed to value themselves solely on their birth and ancestry, began to acquire a relish for more substantial distinctions, and to feel the force of Charlemagne's remark, that the state was likely to be better served by men who had improved their minds and cultivated their talents, than by those who had no other recommendation than overweening pride and a long pedigree. Hence the academy of Charlemagne soon obtained great celebrity; and although few monuments of its labours remain, yet it unquestionably gave an impulse to learning, diffused a taste for knowledge, and probably laid the first foundations of the French language, which was then a rude idiom, composed of a barbarous mixture of the language of the Goths, of Latin, and of the dialect of Celtic spoken by the ancient Gauls. This idiom the academy subjected to principles, forming it into a regular language, which afterwards became the provençal, or language of romance: and when it had thus, as it were, been licked into shape, Charlemagne proposed to have the hymns, the prayers, and the laws translated into it, for the benefit of the people; a proposal which reflects the greatest honour on his memory. But the clergy resolutely set their faces against an innovation which would have deprived them of part of their influence as the sole expounders both of the civil and the divine laws, and thus in a great measure frustrated the principal object which Charlemagne had in view in founding his academy. Still its labours, though in some respects neutralized by the personal interest of the monks, were not altogether useless, but, on the contrary, were instrumental in diffusing the first gleams of light throughout France, and in preparing it to emerge from a state of barbarism. Academy.

In the following century, Alfred, a man worthy of being classed with the first French legislator, founded an *academy* at Oxford, which formed the basis of the University afterwards established there; but this being a school for instruction rather than an institution for exciting emulation among the instructed, it does not, for that reason, fall within the scope of the present article. About the same period the Moors of Spain, celebrated for their gallantry, their chivalrous manners, and their taste for poetry, music, and letters, had also their academies at Granada and Cordoba; but of the precise nature and object of these institutions little or nothing is known. In the year 1325, the *Academy of the Floral Games* was established at Toulouse. This academy is still in existence, and is of course the most ancient establishment of the kind in Europe. The members assumed the somewhat fantastical name of *Maintainers of the Gay Science;* and the prizes which it awarded, consisting of flowers of gold and silver, excited a strong spirit of emulation among the Troubadours of Languedoc and Provence. This society, to which Clemens Isaurus bequeathed the whole of his property, still enjoys a considerable reputation; and many of the young poets of France, who aspire to be one day crowned with the genuine laurels of Parnassus, repair to it, at the commencement of their career, to dispute for the *violet*, the *marigold*, the *amaranth*, and the *eglantine.*

A whole host of academies sprung up in different countries immediately after the revival of letters in the fifteenth century; but it was in Italy that they were most numerous, every city in fact having its own; and they were frequently distinguished by appellations remarkable either for their oddity or extravagance. Thus, Rome had its *Lincei;* Naples, its *Ardenti;* Parma, its *Insensati;* and Genoa, its *Addormentati;*—names which some modern academicians might adopt without the slightest impropriety. Many flourishing academies existed in France

[1] Some modern writers have supposed that this assumption of ancient or classical names originated in an ardent admiration of antiquity, blended with the genius of an age essentially pedantic; and thus they have endeavoured to account for Alcuin taking the surname of Horace as a prænomen, and calling himself Flaccus Albinus. But from what is stated in the text, this appears to be a mistake. With regard to the circumstance of Charlemagne taking the name of David, which, as a royal one, appears to have been a contravention of his own rule, it is evident that his choice was determined by his passion for the composition of canticles or psalms, in which he believed himself to be eminently skilful, and also by his decided preference of sacred to profane literature. The emperor, in fact, had great pretensions as a theologian; and on one occasion, when reproaching Reibode, archbishop of Treves, with his admiration of Virgil's poetry, he remarked of himself, that he would much rather possess the spirit of the four evangelists than that of the twelve books of the Æneid.

before the Revolution, most of them having been established and endowed by the munificence of Louis XIV. In Britain we have but few, and those of the greatest note fall to be classed under a different appellation, namely, Society.

In giving an account of the principal academies, which is all that this article professes to do, we shall, for the sake of clearness, arrange them under different heads, according to the subjects for the cultivation and improvement of which they were instituted. And we shall commence with

I. *Medical Academies.* Of this description are, the Academy of the *Naturæ Curiosi* of Germany; that founded at Palermo in 1645; that established at Venice in 1701, which used to meet weekly in a hall near the grand hospital; and an institution which took its rise at Geneva in 1715. The Royal Colleges of Physicians at London and Edinburgh have also been ranked by some in the number of academies, but, in our opinion, erroneously; for they are rather of the nature of corporations, organized with a view to guard the privileges and promote the interests of a particular profession, than academies instituted for facilitating the advancement of medical science. This is the exclusive object of the Royal Medical Society, and other institutions of the same sort; which, however, fall to be treated of under a different head, viz. that of Society.

The Academy of *Naturæ Curiosi*, called also the *Leopoldine Academy*, was founded in 1662, by J. L. Bauschius, a physician, who, imitating the example of the English, published a general invitation to medical men to communicate all extraordinary cases that occurred in the course of their practice: and, the scheme meeting with success, the institution was regularly organized, and Bauschius elected president. The works of the *Naturæ Curiosi* were at first published separately; but this being attended with considerable inconvenience, a new arrangement was formed, in 1770, for publishing a volume of observations annually. From some cause, however, the first volume did not make its appearance until 1784, when it came forth under the title of *Ephemerides;* and the work was afterwards continued, at irregular intervals, and with some variations in the title. In 1687, the Emperor Leopold took the society under his protection, and granted its members several privileges, the most remarkable of which was, that its presidents should be entitled to enjoy the style and rank of counts palatine of the holy Roman empire; and hence the title of *Leopoldine* which it in consequence assumed. But though it thus acquired a name, it had no local habitation or fixed place of meeting, and no regular assemblies; instead of which there was a kind of bureau or office, first established at Breslau, and afterwards removed to Nuremberg, where letters, observations, and communications from correspondents, were received, and persons properly qualified admitted as members. By its constitution, the Leopoldine Academy consists of a president, two adjuncts or secretaries, and colleagues or members, without any limitation as to numbers. At their admission, the last come under a twofold obligation; first, to choose some subject for discussion out of the animal, vegetable, or mineral kingdom, provided it has not been previously treated of by any colleague of the academy; and, secondly, to apply themselves to furnish materials for the annual *Ephemerides.* Each member also bears about with him the symbol of the academy, consisting of a gold ring, whereon is represented a book open, with an eye on one side, and on the other the academical motto of *Nunquam otiosus.*

II. *Chirurgical Academies.* An association of this sort was, not many years ago, instituted, by public authority, at Paris; the members of which were not only to publish their own observations and improvements, and those of their correspondents, but also to give an account of the various publications on surgery, and to compose a complete history of the art from the works of all the authors, ancient and modern, who have treated of it. Besides, a question in surgery was to be annually proposed, as the subject of a prize essay, and a gold medal of the value of 200 livres given to the successful competitor.



The *Academy of Surgery* at Vienna was instituted by the present emperor, under the direction of the celebrated Brambella. In it there were at first only two professors; and to their charge the instruction of a hundred and thirty young men was committed, thirty of whom had formerly been surgeons in the army. But latterly the number both of teachers and pupils was considerably increased. Gabrielli was appointed to teach pathology and practice; Boecking, anatomy, physiology, and physics; Streit, medical and pharmaceutical surgery; Hunczowsky, surgical operations, midwifery, and the chirurgia forensis; and Plenk, chemistry and botany. To these was also added Beindel, as prosector and extraordinary professor of surgery and anatomy. Besides this, the emperor provided a large and splendid edifice in Vienna, which affords accommodation both for the teachers, the students, pregnant women, patients for clinical lectures, and servants. For the use of this academy the emperor also purchased a medical library, which is open every day; a complete set of chirurgical instruments; an apparatus for experiments in natural philosophy; a collection of natural history; a number of anatomical and pathological preparations; a collection of preparations in wax, brought from Florence; and a variety of other useful articles. Adjoining to the building, also, there is a good botanical garden. With a view to encourage emulation among the students of this institution, three prize medals, each of the value of 40 florins, are annually bestowed on those who return the best answers to questions proposed the year before. These prizes, however, are not entirely founded by the emperor, but are in part owing to the liberality of Brendellius, formerly protochirurgus at Vienna.

III. *Ecclesiastical Academies.* Under this head may be mentioned the academy at Bologna in Italy, instituted in 1687, for the purpose of investigating the doctrine, discipline, and history, of each age of the church.

IV. *Cosmographical Academies;* as that at Venice, called the *Argonauts.* This was instituted at the solicitation of F. Coronelli, for the improvement of geographical knowledge. Its design was to publish exact maps, particular as well as general, both of the celestial and terrestrial sphere, together with geographical, historical, and astronomical descriptions. Each member, in order to defray the expense of such a publication, was to subscribe a proportional sum, for which he was to receive one or more copies of each piece published. To this end three societies were established; one under F. Moro, provincial of the Minorites in Hungary; another under the Abbot Laurence au Ruy Payenne au Marais; and the third under F. Baldigiani, Jesuit, professor of mathematics in the Roman College. The device of this academy is the terraqueous globe, with the motto *Plus ultra;* and at its expense all the globes, maps, and geographical writings of F. Coronelli have been published.

In the year 1799, a *Geographical Academy* was established at Lisbon, principally for the purpose of elucidating the geography of Portugal. By the labours of the members of this academy, an accurate map of the country, which was much wanted, has been completed.

V. *Academies of Science.* These comprehend such

Academy. as have been erected for improving natural and mathematical knowledge, and are otherwise called *Philosophical* and *Physical Academies.*

The first of these was instituted at Naples, about the year 1560, in the house of Baptista Porta. It was called the Academy *Secretorum Naturæ;* and was succeeded by the Academy of *Lincei,* founded at Rome by Prince Frederic Cesi, towards the end of the same century. This academy was afterwards rendered famous in consequence of the discoveries made by some of its members, among whom, the first place is due to the celebrated Galileo, one of the most illustrious names of which the history of science can boast. Several other academies, instituted about this time, also contributed to the advancement of the sciences; but none of them was in any respect comparable to that of the *Lincei.*

Some years after the death of Torricelli, the *Accademia del Cimento* made its appearance, under the protection of Prince Leopold, afterwards Cardinal de' Medici. Redi was one of its chief members. In so far as regards the studies pursued by the other academicians, a very correct idea of them may be formed from the curious experiments published in 1667, by their secretary Count Laurence Magulotti, under the title of *Saggi di Naturali Esperienze;* a copy of which was presented to the Royal Society, translated into English by Mr Waller, and published at London in 4to.

The *Accademia degl'Inquieti,* afterwards incorporated into that of *Della Tracia,* in the same city, followed the example of that of Del Cimento. Some excellent discourses on physical and mathematical subjects, by Geminiano Montenari, one of the chief members, were published in 1667, under the title of *Pensieri Fisico-Matematici.*

The *Academy of Rossano,* in the kingdom of Naples, was originally an academy of belles lettres, founded in 1540, and transformed into an academy of sciences in 1695, at the solicitation of the learned abbot Don Giacinto Gimma; who being made president, under the title of Promoter General of the institution, gave it a new set of regulations. He divided the academicians into the following classes: grammarians, rhetoricians, poets, historians, philosophers, physicians, mathematicians, lawyers, and divines; with a class apart for cardinals and persons of quality. To be admitted a member, it was requisite to have taken a degree in one or other of the faculties. The members were not allowed to take the title of *Academicians* in the title-pages of their works, without a written permission from their president, which was not granted till their works had been examined by the censors of the academy; and this permission was the greatest honour the academy could confer, as they thereby adopted the works thus examined, and became answerable for them against all criticisms that might be made upon them. To this law the president or promoter himself was subject; and no academician was allowed to publish anything against the writings of another without leave obtained from the society.

But Italy boasts of a number of scientific academies besides those above mentioned. The Royal Neapolitan Academy was established in 1779; and the published memoirs contain some valuable researches on mathematical subjects. The Royal Academy of Turin was established by the late king when duke of Savoy. Its memoirs were originally published in Latin, under the title of *Miscellanea Philosophica Mathematica Societatis Privatæ Taurinensis;* and the first volume appeared in 1759. Among the original members of this institution the most celebrated was Lagrange, who burst on the scientific world quite unexpectedly, by the novelty and depth of his papers in the first volume of the transactions. An Academy of Sciences, Belles Lettres, and Arts, was established at Padua by the senate, near the close of the eighteenth century. It is composed of twenty-four pensionaries, twelve free associates, twenty-four pupils, twelve associates belonging to the *ci-devant* Venetian States, and twenty-four foreigners, besides honorary members. It has published several volumes of memoirs in the Italian language. The Academy of Sciences and Belles Lettres of Genoa was established in 1783. It consists of thirty-two members; but their labours have been chiefly directed to poetry, nor are we aware that they have published any memoirs. The Academy of Milan was preceded, and perhaps introduced, by a literary assembly, consisting of ten persons, who published a sheet weekly, containing short remarks on subjects of science, belles lettres, and criticism. This society terminated in 1767. But soon afterwards another was established, the transactions of which, published under the title of *Scelta d'Opuscoli Scientifici,* contain several very interesting papers. The Academy of Sciences at Siena, instituted in 1691, published the first volume of its transactions in 1761, and has since continued them, at long intervals, under the title of *Atti dell'Accademia di Siena.* Between the years 1770 and 1780, M. Lorgna established at Verona an academy of sciences of a novel description. The object of it was to form an association among the principal scientific men in all parts of Italy, for the purpose of publishing their memoirs. The first volume appeared in the year 1782, under the title of *Memorie di Matematica e Fisica della Societa Italiana.* The most celebrated names that appear in this volume are those of Boscovich, the two Fontanas, and Spallanzani. There are also scientific academies at Mantua, Pisa, Pavia, and Modena; but several of these do not publish their transactions.

Towards the beginning of the seventeenth century, F. Mersenne is said to have given the first idea of a philosophical academy in France, by the conferences of naturalists and mathematicians occasionally held at his lodgings. At these Gassendi, Descartes, Hobbes, Roberval, Pascal, Blondel, and other celebrated persons, assisted. F. Mersenne proposed to each certain problems to be examined, or certain experiments to be made, and acted, to use a Gallic idiom, as the centre of re-union. By and by these private assemblies were succeeded by more public ones, formed by M. Montmort, and by Thevenot the celebrated traveller. Nor was this spirit confined to France. Animated by the example which had been set in that country, several Englishmen of learning and distinction instituted a kind of philosophical academy at Oxford towards the close of Cromwell's government; and this, after the Restoration, was erected into a Royal Society. And the English example, in its turn, re-acted upon France; for, in 1666, Louis XIV., assisted by the counsels of Colbert, founded at Paris

The *Royal Academy of Sciences.* Being desirous of establishing the sciences, arts, and literature upon a solid foundation, Louis, immediately after the peace of the Pyrenees, directed M. Colbert to form a society of men of known abilities and experience in the different branches of knowledge, who should meet together under the king's protection, in order to communicate freely their respective discoveries; and with the view of carrying his design the more effectually into execution, he appropriated a sufficient revenue, not only to defray the charge of experiments, but likewise to afford moderate salaries to the members. The commands of the Grand Monarque were executed with equal zeal and ability by his minister. For having conferred with those who were at that time most celebrated for their learning, M. Colbert resolved to form a society of such persons as were conversant in natural philosophy and mathematics; to join to them persons skilled in history and other branches of erudition; and, lastly, to draw together those who were engaged in the cultivation of what was then called the belles lettres, as well as of grammar, eloquence, and poetry. The geometricians and natural philosophers were ordered to meet on Tuesdays and Saturdays, in a great hall of the king's library, where the books of mathematics and natural philosophy were contained; the learned in history to assemble, on Mondays and Thursdays, in the hall where the books of history were arranged; and the class of belles lettres to meet on Wednesdays and Fridays; while all the different classes were directed to assemble together upon the first Thursday of every month, and by their respective secretaries to make a report of the proceedings of the previous month. In a short time, however, the classes of history and belles lettres were united to the *French Academy*, which was originally instituted for the improvement of the French language; in consequence of which the Royal Academy contained only two classes, viz. that of natural philosophy and that of mathematics.

In the year 1696, the king, by an ordonnance dated the 26th of January, gave this academy a new form, and put it upon a footing still more respectable. By this decree it was provided, that henceforth it should consist of four descriptions of members, viz. honorary, pensionary, associates, and élèves; which last were a kind of pupils or scholars, one of whom was attached to each of the pensionaries. The first class was to contain ten persons, and each of the rest twenty. The honorary academicians were to be all inhabitants of France, the pensionaries were all to reside in Paris, and the élèves were also to live in the capital; but eight of the associates might be chosen from among foreigners. The officers were, a president, named by the king out of the class of honorary academicians, and a secretary and treasurer, who held their offices for life. Of the pensionaries, three were to be geometricians, three astronomers, three mechanicians, three anatomists, three botanists, and the remaining two perpetual secretary and treasurer. Of the twelve associates, two were to apply themselves to geometry, two to botany, and two to chemistry; while the élèves were to devote themselves to the particular branches of science cultivated by the pensionaries to whom they were respectively attached, and not to speak except when called to do so by the president. Clerical persons, whether regular or otherwise, were declared inadmissible, except into the class of honorary academicians; nor could any one be admitted an associate or pensionary unless known by some considerable printed work, some machine, or other discovery. The assemblies were held on Wednesdays and Saturdays, except when either chanced to be a holyday; in which case the meeting was held on the day immediately preceding. To encourage members to pursue their inquiries and researches, the king engaged to pay not only the ordinary pensions, but even to confer extraordinary gratifications according to the degree of merit displayed in their respective performances; and, furthermore, his Majesty became bound, as we have already stated, to defray the whole expense of experiments and other investigations which it might be judged necessary from time to time to institute. Hence, if any member gave in a bill of charges for experiments he had made, or desired the printing of any book, and tendered an account of the disbursements required to effect that object, the money was immediately paid by the king, upon the president's allowing and signing the bill. In like manner, if an anatomist required, we shall say, live tortoises in order to make experiments on the action and functions of the heart, he had only to signify his intention through the president, and as many as he pleased were brought him at the king's charge. The motto of the academy was *Invenit et perfecit.*

In the year 1716, the Duke of Orleans, then regent, made an alteration in the constitution of this body, augmenting the number of honorary members and of associates eligible from among foreigners, admitting regular clergy among such associates, and suppressing the class of élèves, the existence of which had been attended with some inconveniences, particularly that of producing too great an inequality among the academicians, and of giving rise to misunderstandings and animosities among the members. At the same time he created two other classes; the one consisting of twelve adjuncts, who, like the associates, were allowed a deliberative voice in matters relative to science; and the other of six free associates, who were not attached to any particular science, nor obliged to pursue any particular work.

From the period of its re-establishment in 1699, this academy was very exact in publishing annually a volume containing either the works of its own members, or such memoirs as had been composed and read to the academy during that year. To each volume was prefixed a history of the academy, or an extract of the memoirs and of the *res gestæ* of the different sittings; and appended to the history were éloges pronounced on such academicians as had died in the course of the year. M. Rouille de Meslay, counsellor to the parliament of Paris, founded two prizes, one of 2500 and the other of 2000 livres; the former for the best work, essay, or treatise, on physical astronomy, and the latter for any treatise or improvement relating to navigation and commerce. But notwithstanding all the advantages which the members of this academy enjoyed, and the great facilities afforded them for the prosecution of their researches, the institution latterly degenerated; in consequence, doubtless, of the perpetual interference of the court in behalf of its favourites, or to effect the exclusion of men of unquestionable merit who had incurred its displeasure. The effect of all this was, that persons of inferior acquirements were frequently admitted, while those of the most distinguished talents and reputation were excluded; and hence it gradually sunk in public estimation, until admission not only ceased to be an honour, but even became a subject of contempt and derision. Hence the well-known lines—

Ci gît Pirot, qui ne fut rien,
Pas même Académicien.

The Revolution swept away the academy amidst the wrecks of the monarchy. It was suppressed by the Convention in the year 1793; and being new-modelled and re-organized upon a better and more efficient plan, it received the name of Institute, an appellation which it still bears, notwithstanding the great political changes which have since taken place. See INSTITUTE.

The French had also considerable academies in most of their great cities. Montpellier, for example, had a royal academy of sciences on nearly the same footing as that at Paris, of which, indeed, it was in some measure the counterpart; Toulouse also had an academy under the denomination of Lanternists; and there were analogous institutions at Nismes, Arles, Lyons, Dijon, Bordeaux, and other places. Of these several, we believe, are still in existence, if not in activity.

The *Royal Academy of Sciences at Berlin* was founded in 1700, by Frederic II. king of Prussia, on the model of the Royal Society of England; excepting that, besides natural knowledge, it likewise comprehended the belles lettres. In 1710, it was ordained that the president should be one of the counsellors of state, and nominated by the king. The members were divided into four classes: the first for prosecuting physics, medicine, and chemistry; the second for mathematics, astronomy, and mechanics; the third for the German language and the history of the country; and the fourth for oriental learning, particularly in so far as it concerns the propagation of the gospel among heathen nations. Each class was empowered to elect a director for itself, who should hold his post for life. The members of any of the classes were entitled to free admission into the assemblies of the other classes.

The great promoter of this institution was the celebrated Leibnitz, equally distinguished as a jurist, philologist, linguist, antiquary, mathematician, and philosopher, and who accordingly was chosen the first director. The first volume of their transactions was published in 1710, under the title of *Miscellanea Berolinensia;* and although the institution received but few marks of the royal favour for some time, they continued to publish new volumes in 1723, 1727, 1734, and 1740. But Frederic III., the late king of Prussia, at length imparted new vigour to this academy, by inviting to Berlin such foreigners as were most distinguished for their merit and literature, at the same time that he encouraged his own subjects to prosecute the study and cultivation of the sciences; and thinking that the academy, over which some minister or opulent nobleman had till that time presided, would derive advantage from having a man of letters at its head, he conferred that honour on M. Maupertuis. At the same time he gave a new set of regulations to the academy, and took upon himself the title of its protector.

The effect of these changes, however, it is not necessary to enlarge upon, as innovations still more recent have been introduced, with a view to direct the attention of the members to researches of real utility, to improve the arts, to stimulate national industry, and to purify the different systems of moral and literary education. To attain these ends a directory was chosen, consisting of a president and the four directors of the classes, and two men of business, not members of the academy, though at the same time persons of acknowledged learning; and to the body thus constituted was intrusted the management of the funds, and the conduct of the economical affairs of the institution. The power of choosing members was granted to the academy; but the king reserved to himself the privilege of confirming or annulling their choice, as he might think fit. The public library at Berlin, and the collection of natural curiosities, were united to the academy, and intrusted to its superintendence.

The academicians hold two public assemblies annually; at the latter of which is given, as a prize, a gold medal of fifty ducats value. The subject prescribed for this prize is successively taken from natural philosophy, mathematics, metaphysics, and general erudition.

The *Imperial Academy of Sciences at St Petersburg* was projected by the Czar Peter the Great. That despotic reformer, having in the course of his travels observed the advantage of public societies for the encouragement and promotion of literature, formed the design of founding an academy of sciences at St Petersburg. By the advice of Wolf and Leibnitz, whom he consulted on this occasion, the society was accordingly regulated, and several learned foreigners were invited to become members. Peter himself drew the plan, and signed it on the 10th of February 1724; but he was prevented, by the suddenness of his death, from carrying it into execution. His decease, however, did not prevent its completion; for on the 21st of December 1725, Catharine I. established it according to Peter's plan, and on the 27th of the same month the society assembled for the first time. On the 1st of August 1726, Catharine honoured the meeting with her presence, when Professor Bulfinger, a German naturalist of great eminence, pronounced an oration upon the advances made in the theory of magnetic variations, and also on the progress of research in so far as regarded the discovery of the longitude. A short time afterwards the empress settled a fund of L.4982 *per annum* for the support of the academy; and fifteen members, all eminent for their learning and talents, were admitted and pensioned, under the title of Professors in the various branches of science and literature. The most distinguished of these professors were Nicholas and Daniel Bernoulli, the two De Lisles, Bulfinger, and Wolf.

During the short reign of Peter II. the salaries of the members were discontinued, and the academy utterly neglected by the court; but it was again patronised by the Empress Anne, who even added a seminary for the education of youth, under the superintendence of the professors. Both institutions flourished for some time under the direction of Baron Korf; but upon his death, towards the latter end of Anne's reign, an ignorant person being appointed president, many of the most able members quitted Russia. At the accession of Elizabeth, however, new life and vigour were infused into the academy. The original plan was enlarged and improved; some of the most learned foreigners were again drawn to Petersburg; and, what was considered as a good omen for the literature of Russia, two natives, Lomonosof and Rumovsky, men of genius and abilities, who had prosecuted their studies in foreign universities, were enrolled among its members. Lastly, the annual income was increased to L.10,659, and sundry other advantages were conferred upon the institution.

The late Empress Catharine II., with her usual zeal for promoting the diffusion of knowledge, took this useful society under her immediate protection. She altered the court of directors greatly to the advantage of the whole body, corrected many of its abuses, and infused a new vigour and spirit into their researches. By her Majesty's particular recommendation the most ingenious professors visited the various provinces of her vast dominions; and as the funds of the academy were not sufficient to defray the whole expense of these expeditions, the empress supplied the deficiency by a grant of L.2000, which was renewed as occasion required.

The purpose and object of these travels will appear from the instructions given by the academy to the several persons who engaged in them. They were ordered to institute inquiries respecting the different sorts of earths and waters; the best methods of cultivating barren and desert spots; the local disorders incident to men and animals, together with the most efficacious means of relieving them; the breeding of cattle, particularly of sheep; the rearing of bees and silk-worms; the different places and objects for fishing and hunting; minerals of all kinds; the arts and trades; and the formation of a *Flora Russica*, or collection of indigenous plants. They were particularly instructed to rectify the longitude and latitude of the principal towns; to make astronomical, geographical, and meteorological observations; to trace the courses of the rivers; to construct the most exact charts; and to be very distinct and accurate in remarking and describing the manners and customs of the different races of people, their dresses, languages, antiquities, traditions, history, religion; in a word, to gain every information which might tend to illustrate the real state of the whole Russian empire. More ample instructions cannot well be conceived; and they appear to have been very zealously and faithfully executed. The consequence has been, that perhaps no country can boast, within the space of so few years, such a number of excellent publications on its internal state, its natural productions, its topography, geography, and history, and on the manners, customs, and languages of the different tribes who inhabit it, as have issued from the press of this academy.

The first transactions of this society were published in 1728, and entitled *Commentarii Academiæ Scientiarum Imperialis Petropolitanæ ad annum* 1726, with a dedication to Peter II. The publication was continued under this form until the year 1747, when the transactions were called *Novi Commentarii Academiæ*, &c.; and in 1777, the academy again changed the title into *Acta Academiæ Scientiarum Imperialis Petropolitanæ*, and likewise made some alteration in the arrangement and plan of the work. The papers, which had been hitherto published in the Latin language only, are now written indifferently either in that language or in French; and a preface is added, entitled *Partie Historique*, which contains an account of its proceedings, meetings, the admission of new members, and other remarkable occurrences. Of the *Commentaries*, fourteen volumes were published: the first of the *New Commentaries* made its appearance in 1750, and the twentieth in 1776. Under the new title of *Acta Academiæ*, a number of volumes have been given to the public; and two are printed every year. These transactions abound with ingenious and elaborate disquisitions upon various parts of science and natural history; and it may not be an exaggeration to assert, that no society in Europe has more distinguished itself for the excellence of its publications, particularly in the more abstruse parts of the pure and mixed mathematics.

The academy is still composed, as at first, of fifteen professors, besides the president and director. Each of these professors has a house and an annual stipend from L.200 to L.600. Besides the professors, there are four adjuncts, with pensions, who are present at the sittings of the society, and succeed to the first vacancies. The direction of the academy is generally intrusted to a person of distinction.

The buildings and apparatus of this academy are extraordinary. There is a fine library, consisting of 36,000 curious books and manuscripts; together with an extensive museum, in which the various branches of natural history, &c. are distributed in different apartments. The latter is extremely rich in native productions, having been considerably augmented by the collections made by Pallas, Gmelin, Guldenstaedt, and other professors, during their expeditions through the various parts of the Russian empire. The stuffed animals and birds occupy one apartment. The chamber of rarities, the cabinet of coins, &c. contain innumerable articles of the highest curiosity and value. The motto of the society is exceedingly modest: it consists of only one word, *Paulatim*.

The *Academy of Sciences at Bologna*, called the *Institute of Bologna*, was founded by Count Marsigli in 1712, for the cultivation of physics, mathematics, medicine, chemistry, and natural history. Its history is written by M. de Limiers, from memoirs furnished by the founder himself.

The *Academy of Sciences at Stockholm*, or the *Royal Swedish Academy*, owes its institution to six persons of distinguished learning, amongst whom was the celebrated Linnæus. They originally met on the 2d of June 1739, when they formed a private society, in which some dissertations were read; and in the latter end of the same year their first publication made its appearance. As the meetings continued and the members increased, the society attracted the notice of the king; and, accordingly,  on the 31st of March 1741, it was incorporated under the name of the Royal Swedish Academy. Not receiving any pension from the crown, it is merely under the protection of the king, being directed, like our Royal Society, by its own members. It has now, however, a large fund, which has chiefly arisen from legacies and other donations; but a professor of experimental philosophy, and two secretaries, are still the only persons who receive any salaries. Each of the members resident at Stockholm becomes president by rotation, and continues in office during three months. There are two kinds of members, native and foreign; the election of the former description takes place in April, that of the latter in July; and no money is paid at the time of admission. The dissertations read at each meeting are collected and published four times in the year: they are written in the Swedish language, and printed in octavo; and the annual publications make a volume. The first forty volumes, which were completed in 1779, are called the *Old Transactions;* for in the following year the title was changed into that of *New Transactions.* The king is often present at the ordinary meetings, and regularly attends the annual assembly in April for the election of members. Any person who sends a treatise which is thought worthy of being printed, receives the Transactions for that quarter *gratis;* together with a silver medal, which is not esteemed for its value, being worth only three shillings, but for its rarity and the honour conveyed by it. All the papers relating to agriculture are published separately under the title of *Œconomica Acta.* Annual premiums, in money and gold medals, principally for the encouragement of agriculture and inland trade, are also distributed by the academy. The fund for these prizes is supplied by private donations.

The *Royal Academy of Sciences at Copenhagen* owes its institution to the zeal of six individuals, whom Christian VI., in 1742, ordered to arrange his cabinet of medals. These persons were, John Gram, Joachim Frederic Ramus, Christian Louis Scheid, Mark Woldickey, Eric Pontopidan, and Bernard Moelman, who, occasionally meeting for this purpose, extended their designs; associated with them others who were eminent in several branches of science; and forming a kind of literary society, employed themselves in searching into, and explaining the history and antiquities of their country. The Count of Holstein, the first president, warmly patronised this society, and recommended it so strongly to Christian VI. that, in 1743, his Danish majesty took it under his protection, called it the Royal Academy of Sciences, endowed it with a fund, and ordered the members to join to their former pursuits, natural history, physics, and mathematics. In consequence of the royal favour, the members engaged with fresh zeal in their pursuits; and the academy has published fifteen volumes in the Danish language, some of which have been translated into Latin.

The *American Academy of Sciences* was established in 1780, by the council and house of representatives in the province of Massachusetts Bay, for promoting a knowledge of the antiquities of America, and of the natural history of the country; for determining the uses to which its various natural productions might be applied; for encouraging medicinal discoveries, mathematical disquisitions, philosophical inquiries and experiments, astronomical, meteorological, and geographical observations, and improvements in agriculture, manufactures, and commerce; and, in short, for cultivating every art and science which may tend to advance the interest and increase the happiness of the people. The members of this academy can never exceed 200, nor fall below forty.

The *Royal Irish Academy* arose out of a society established at Dublin about the year 1782, and consisting of a number of gentlemen, most of whom belonged to the University. They held weekly meetings, and read essays in turn on various subjects. The members of this society afterwards formed a more extensive plan, and, admitting only such names as might add dignity to their new institution, became the founders of the *Royal Irish Academy;* which professed to unite the advancement of science with the history of mankind and polite literature. The first volume of their transactions for 1787 appeared in 1788, and seven volumes were afterwards published. A society was formed in Dublin, similar to the Royal Society in London, as early as the year 1683; but the distracted state of the country proved unpropitious to the cultivation of philosophy and literature.

The *Academy of Sciences at Manheim* was established by Charles Theodore, Elector Palatine, in the year 1755. The plan of this institution was furnished by Schæpflin, according to which it was divided into two classes, the historical and physical. In 1780, a sub-division of the latter took place, into the physical properly so called, and the meteorological. The meteorological observations are published separately, under the title of *Ephemerides Societatis Meteorologicæ Palatinæ.* The historical and physical memoirs are published under the title of *Acta Academiæ Theodoro-Palatinæ.*

The *Electoral Bavarian Academy of Sciences at Munich* was established in 1759, and publishes its memoirs under the title of *Abhandlungen der Baierischen Akademie.* Soon after the Elector of Bavaria was raised to the rank of King, the Bavarian government, by his orders, directed its attention to a new organization of the Academy of Sciences of Munich. The design of the king was, to render its labours more extensive than those of any similar institution in Europe, by giving to it, under the direction of the ministry, the immediate superintendence over all the establishments for public instruction in the kingdom of Bavaria. The Privy-Councillor Jacobi, a man of most excellent character, and of considerable scientific attainments, was appointed president.

The *Electoral Academy at Erfurt* was established by the Elector of Mentz, in the year 1754. It consists of a protector, president, director, assessors, adjuncts, and associates. Its object is to promote the useful sciences. Their memoirs were originally published in the Latin language, but afterwards in German. The Hessian Academy of Sciences at Giessen publish their transactions under the title of *Acta Philosophico-Medica Academiæ Scientiarum Principalis Hessiacæ.* In the Netherlands there are scientific academies at Flushing and Brussels, both of which have published their transactions.

A branch of the royal family of Portugal established at Lisbon, a number of years ago, a Royal Academy of the sciences, agriculture, arts, commerce, and economy in general. It is divided into three classes; natural science, mathematics, and national literature. It is composed of honorary members, as ministers of state and persons of high rank in Lisbon; foreign members, called *socios veteranos;* and acting members. The total number is sixty, of which twenty-four belong to the last class. They enjoy an allowance from government, which has enabled them to establish an observatory, a museum, a library, and a printing office. Their published transactions consist of *Memorias de Litteratura Portugueza,* and *Memorias Economicas,* besides *Scientific Transactions.* They have also published *Collecçao de Livros ineditos de Historia Portugueza.*

VI. Academies or Schools of Arts. Under this we may mention, first of all, the academy at Petersburg, established by the Empress Elizabeth, at the suggestion of Count Shuvalof, and annexed to the Academy of Sciences. The fund for its support was L.4000 *per annum,* and the foundation admitted forty scholars. The late empress formed it into a separate institution, augmented the annual revenue to L.12,000, and increased the number of scholars to three hundred: she also constructed, for the use and accommodation of the members, a large circular building, which fronts the Neva. The scholars are admitted at the age of six, and continue until they have attained that of eighteen. They are clothed, fed, and lodged, at the expense of the crown; and are all instructed in reading and writing, arithmetic, the French and German languages, and drawing. At the age of fourteen they are at liberty to choose any of the following arts, divided into four classes, viz. first, painting in all its branches, of history, portraits, battles, and landscapes, architecture, mosaic, enamelling, &c.; secondly, engraving on copperplates, seal-cutting, &c.; thirdly, carving on wood, ivory, and amber; fourthly, watch making, turning, instrument making, casting statues in bronze and other metals, imitating gems and medals in paste and other compositions, gilding, and varnishing. Prizes are annually distributed to those who excel in any particular art; and from those who have obtained four prizes, twelve are selected, who are sent abroad at the charge of the crown. A certain sum is paid to defray their travelling expenses; and when they are settled in any town, they receive an annual salary of L.60, which is continued during four years. There is a small assortment of paintings for the use of the scholars; and those who have made great progress are permitted to copy the pictures in the imperial collection. For the purpose of design, there are models in plaster, all done at Rome, of the best antique statues in Italy, and of the same size with the originals, which the artists of the academy were employed to cast in bronze.

The *Royal Academy of Arts in London* was instituted for the encouragement of designing, painting, sculpture, &c. &c. in the year 1768. This academy is under the immediate patronage of the king, and under the direction of forty artists of the first rank in their several professions. It furnishes, in winter, living models of different characters to draw after; and in summer, models of the same kind to paint after. Nine of the ablest academicians are annually elected out of the forty, whose business it is to attend by rotation, to set the figures, to examine the performance of the students, and to give them necessary instructions. There are likewise professors of painting, architecture, anatomy, and perspective, who annually read public lectures on the subjects of their several departments; besides a president, a council, and other officers. The admission to this academy is free to all students properly qualified to reap advantage from the studies cultivated in it; and there is an annual exhibition of paintings, sculptures, and designs, open to all artists of distinguished merit.

The *Academy of Painting and Sculpture at Paris.* This took its rise from the disputes that happened between the master painters and sculptors in the French capital; in consequence of which, MM. le Brun, Sarrazin, Corneille, and others of the king's painters, formed a design of instituting a particular academy; and having presented a petition to the king, obtained an arrêt dated January 20. 1648. In the beginning of 1655, they obtained from Cardinal Mazarin, a brevet, and letters patent, which were registered in parliament; in gratitude for which favour, they chose the cardinal their protector, and made the chancellor their vice-protector. In 1663, they obtained, through M. Colbert, a pension of 4000 livres. The academy consisted of a protector, a vice-protector, a director, a chancellor, four rectors, adjuncts to the rectors, a treasurer, four professors (one of whom was professor of anatomy, and another of geometry), several adjuncts and counsellors, an historiographer, a secretary, and two ushers.

Every day for two hours in the afternoon, the Academy of Painting held a public assembly, to which the painters resorted either to design or to paint, while the sculptors modelled after the naked figure. There were twelve professors, each of whom kept the school for a month; and there was an equal number of adjuncts to supply their places in case of need. The professor upon duty placed the naked figure as he thought proper, and set it in two different attitudes every week. This was what they called *setting the model.* In one week of the month he set two models together, which was called *setting the group.* The paintings and models made after this model, were called *academics*, or *academical figures.* They had likewise a woman who stood as a model in the public school. Three prizes for design were distributed among the élèves or disciples every quarter; and four others, two for painting, and two for sculpture, every year.

There was also an Academy of Painting, Sculpture, &c. at Rome, established by Louis XIV., wherein those who had gained the annual prize at Paris were entitled to be three years entertained at the king's expense, for their further improvement.

In 1778, an Academy of Painting and Sculpture was established at Turin. Their meetings were held in the palace of the king, who distributed prizes among the most successful members. In Milan, an Academy of Architecture was established so early as the year 1380, by Galeas Visconti. About the middle of the last century, an Academy of the Arts was established there, after the example of those at Paris and Rome. The pupils were furnished with originals and models, and prizes were distributed annually. The prize for painting was a gold medal, and no prize was bestowed till all the competing pieces had been subjected to the examination and criticism of competent judges. Before the effects of the French revolution reached Italy, this was one of the best establishments of the kind in that kingdom. In the hall of the academy were some admirable pieces of Correggio, as well as several ancient paintings and statues of great merit; particularly a small bust of Vitellius, and a statue of Agrippina, of most exquisite beauty, though it wants the head and arms. The Academy of the Arts, which had been long established at Florence, but which had fallen into decay, was restored by the late Grand Duke. In it there are halls for naked and plaster figures, for the use of the sculptor and the painter. The hall for plaster figures had models of all the finest statues in Italy, arranged in two lines; but the treasures of this, as well as all the other institutions for the fine arts, were greatly diminished by the rapacity of the French. In the saloon of the Academy of the Arts at Modena, there are many casts of antique statues; but since it was plundered by the French it has dwindled into a petty school for drawings from living models: it contains the skull of Correggio. There is also an Academy of the Fine Arts in Mantua, and another at Venice.

In Madrid, an Academy for Painting, Sculpture, and Architecture, was founded by Philip V. The minister for foreign affairs is president. Prizes are distributed every three years. In Cadiz, a few students are supplied by government with the means of drawing and modelling from figures; and such as are not able to purchase the requisite instruments are provided with them.



An Academy of the Fine Arts was founded at Stockholm in the year 1733 by Count Tessin. In its hall are the ancient figures of plaster presented by Louis XIV. to Charles XI. The works of the students are publicly exhibited, and prizes are distributed annually. Such of them as display distinguished talents obtain pensions from government, to enable them to reside in Italy for some years, for the purposes of investigation and improvement. In this academy there are nine professors, and generally about four hundred students. In the year 1705, an Academy of Painting, Sculpture, and Architecture was established at Vienna, with the view of encouraging and promoting the fine arts.

The *Royal Academy of Music* is a name given in France to the grand opera, which is considered as in some sort a combination of all the liberal arts; painting, music, and the dance forming the principal part of that enchanting spectacle. The opera is of Venetian origin; and the Abbé Perrin, who officiated as master of the ceremonies to Gaston, Duke of Orleans, was the first who introduced it at Paris. He obtained letters patent from the king, dated the 28th June 1669, conferring upon him the privilege of establishing *Operatic Academies in Music and in French Verse* throughout the kingdom. Latterly, the theatre where operas are represented has been denominated the *Théâtre des Arts;* a name which has probably been suggested by the following verses of Voltaire, which convey a just definition of this delightful entertainment:—

> Il faut se rendre à ce palais magique,
> Où les beaux vers, la danse, la musique,
> L'art de tromper les yeux par les couleurs,
> L'art plus heureux de séduire les cœurs,
> De cent plaisirs font un plaisir unique.

The *Academy of Ancient Music* was established in London in 1710, by several persons of distinction, and other amateurs, in conjunction with the most eminent masters of the time, in the view of promoting the study and practice of vocal and instrumental harmony. This institution, which had the advantage of a library, consisting of the most celebrated compositions, both foreign and domestic, in manuscript and in print, and which was aided by the performances of the gentlemen of the chapel royal, and the choir of St Paul's, with the boys belonging to each, continued to flourish for many years. In 1731, a charge of plagiarism brought against Bononcini, a member of the academy, for claiming a madrigal of Lotti of Venice as his own, threatened the existence of the institution. Dr Greene, who had introduced the madrigal into the academy, took part with Bononcini, and withdrew from the society, taking with him the boys of St Paul's. In 1734, Mr Gates, another member of the society, and master of the children of the royal chapel, also retired in disgust; so that the institution was thus deprived of the assistance which the boys afforded it in singing the soprano parts. From this time the academy became a seminary for the instruction of youth in the principles of music and the laws of harmony. Dr Pepusch, who was one of its founders, was active in accomplishing this measure; and by the expedients of educating boys for their purpose, and admitting auditor members, the subsistence of the academy was continued. The *Royal Academy of Music* was formed by the principal nobility and gentry of the kingdom, for the performance of operas, composed by Mr Handel, and conducted by him at the theatre in the Haymarket. The subscription amounted to L.50,000, and the king, besides subscribing L.1000, allowed the society to assume the title of *Royal Academy.* It consisted of a governor, deputy-governor, and twenty directors. A contest between Handel and Senesino, one of the performers, in which the directors took the part of the latter, occasioned the dissolution of the academy, after it had subsisted with reputation for more than nine years.

The *Academy of Architecture* was founded, under Louis XIV., by his celebrated minister Colbert in 1671, and was composed of the most distinguished architects of the time. It was provided, however, that the professor of architecture, and the secretary to the academy, should always be chosen from those architects intrusted with the superintendence of royal edifices; and the title of academician was conferred by brevet. The Academy of Architecture held its sittings every Monday at the Louvre, where it occupied the apartment called the *Queen's Saloon;* but at the commencement of the Revolution it was remodelled, like the Academy of Sciences, and transformed into a school for the cultivation and improvement of the fine arts. This school was divided into two sections, the first of which was devoted to painting and sculpture, and the second to architecture; and these two sections received, by a royal ordonnance of the 11th August 1819, the title of *Royal Academy of the Fine Arts.* The instruction in architecture at this institution consists of lessons given in special courses of lectures by four different professors; first, on the theory of the art; secondly, on its history; thirdly, on the mathematical principles of construction; and, fourthly, on perspective; which last branch is common to both sections. By the munificence of the government, this institution is amply provided with means for supporting the pupils admitted within its walls, as also for affording them every facility in the prosecution of their studies; and with the view of exciting emulation as well as rewarding excellence, a grand prize is annually given.

The *Academy of Dancing* was erected by Louis XIV., and had particular privileges conferred upon it.

VII. *Academies of Law.* Under this head we may mention the famous academy at Berytus, and that of the *Sitientes* at Bologna. We are not aware of any other.

VIII. *Academies of History.* The first of these to which we shall advert, is the *Royal Academy of Portuguese History at Lisbon.* This academy was instituted by King John V. in 1720. It consists of a director, four censors, a secretary, and fifty members, to each of whom is assigned some part of the ecclesiastical or civil history of the nation, which he is required to treat either in Latin or Portuguese. In the church history of each diocese, the prelates, synods, councils, churches, monasteries, academies, persons illustrious for sanctity or learning, and places famous for miracles or relics, must be distinctly related in twelve chapters. The civil history comprises the transactions of the kingdom, from the government of the Romans down to the present time. The members who reside in the country are obliged to make collections and extracts out of all the registers, &c. where they live. Their meetings take place once every fifteen days. A medal was struck by this academy in honour of their prince, on the obverse of which was his effigy, with the inscription *Johannes V. Lusitanorum Rex*, and on the reverse, the same prince represented standing, and raising History, almost prostrate before him, with the legend, *Historia, Resurges.* Underneath are the following words in abbreviature: REGia ACADemia HISToriæ LUSITanæ, INSTITuta VI. Idus Decembris MDCCXX.

An *Academy of History* was some time ago established by some learned men at Tubingen, for publishing the best historical writings, the lives of the chief historians, and compiling new memoirs on any matter of importance connected with either.

About the year 1730, a few individuals in Madrid agreed to assemble at stated periods, for the purpose of preserving and illustrating the historical monuments of Spain. In the year 1738, the rules which they had drawn up were confirmed by a royal cedula of Philip V. This academy consists of twenty-four members. The device is a river at its source; the motto, *In patriam populumque fluit.* It has published editions of Mariana, Sepulveda, Solis, and the ancient Chronicles relative to the affairs of Castile, several of which were never before printed. All the diplomas, charters, &c. belonging to the principal cities in Spain, since the earliest period, are in its possession. It has long been employed in preparing a geographical dictionary of that country.



IX. *Academies of Antiquities;* as that at Cortona in Italy, and that at Upsal in Sweden. The first is designed for the study of Hetrurian antiquities; the other for illustrating the northern languages, and the antiquities of Sweden, in which valuable discoveries have been made by it. The head of the Hetrurian academy is called *Lucomon,* a name by which the ancient governors of the country were distinguished. One of their laws is, to give audience to poets only one day in the year; and another is, to fix their sessions, and impose a tax of a dissertation on each member in his turn.

The *Academy of Medals and Inscriptions at Paris* was set on foot by M. Colbert, under the patronage of Louis XIV. in 1663, for the study and explanation of ancient monuments, and for perpetuating great and memorable events, especially those of the French monarchy, by coins, relievos, inscriptions, &c. The number of members was at first confined to four or five, chosen out of those of the French academy; and they met in the library of M. Colbert, from whom they received his Majesty's orders. Though the days of their meetings were not determined, they generally assembled on Wednesdays, especially in the winter season; but, in 1691, the king having given the inspection of this academy to M. de Pontchartrain, comptroller-general of the finances, he fixed their meetings on Tuesdays and Saturdays. By a new regulation, dated the 16th of July 1701, the academy was composed of ten honorary members; ten associates, each of whom had two declarative voices; ten pensioners; and ten élèves, or pupils. They then met every Tuesday and Wednesday, in one of the halls of the Louvre; and had two public meetings yearly, one the day after Martinmas, and the other the 16th after Easter. The class of élèves was suppressed, and united to the associates. The king nominated their president and vice-president yearly; but their secretary and treasurer were perpetual. The rest were chosen by the members themselves, agreeably to the constitutions on that head given to them. One of the first undertakings of this academy was to compose, by means of medals, a connected history of the principal events of Louis XIV.'s reign. In this design, however, they met with very great difficulties, and consequently it was interrupted for a number of years; but at length it was completed down to the advancement of the Duke of Anjou to the crown of Spain. In this celebrated work, the establishment of the academy itself was not forgotten. The medal on this subject represents Mercury sitting, and writing with an antique stylus on a table of brass; he leans with his left hand upon an urn full of medals, and at his feet are several others placed upon a card. The legend is, *Rerum gestarum fides*, and on the exergue, *Academia Regia Inscriptionum et Numismatum, instituta* MDCLXIII.; signifying, that the Royal Academy of Medals and Inscriptions, founded in 1663, ought to give to future ages a faithful testimony of all great actions. Besides this work, we have several volumes of their memoirs; and their history, written and continued by their secretaries.

Under this class the *Academy of Herculaneum* properly ranks. It was established at Naples about 1755, at which period a museum was formed of the antiquities found at Herculaneum, Pompeii, and other places, by the Marquis Tanucci, who was then minister of state. Its object was to explain the paintings, &c. which were discovered at those places; and for this purpose the members met every fortnight, and at each meeting three paintings were submitted to three academicians, who made their report on them at their next sitting. The first volume of their labours appeared in 1775, and they have been continued under the title of *Antichità di Ercolano.* They contain engravings of the principal paintings, statues, bronzes, marble figures, medals, utensils, &c. with explanations. In the year 1807, an Academy of History and Antiquities, on a new plan, was established at Naples, by Joseph Buonaparte. The number of members was limited to forty; twenty of whom were to be appointed by the king, and these twenty were to present to him, for his choice, three names for each of those wanted to complete the full number. Eight thousand ducats were to be annually allotted for the current expenses, and two thousand for prizes to the authors of four works, which should be deemed by the academy most deserving of such a reward. A grand meeting was to be held every year, when the prizes were to be distributed, and analyses of the works read. The first meeting took place on the 25th of April 1807; but the subsequent changes in the political state of Naples have prevented the full and permanent establishment of this institution. In the same year an academy was established at Florence, for the illustration of Tuscan antiquities, which has published some volumes of memoirs.

In consequence of the attention of several literary men in Paris having been directed to Celtic antiquities, a *Celtic Academy* was established in that city in the year 1807. Its objects were, first, the elucidation of the history, customs, antiquities, manners, and monuments of the Celts, particularly in France; secondly, the etymology of all the European languages, by the aid of the Celto-British, Welsh, and Erse; and, thirdly, researches relating to Druidism. The attention of the members was also particularly called to the history and settlements of the Galatæ in Asia. Lenoir, the keeper of the museum of French monuments, was appointed president. A fasciculus, consisting of 150 or 160 pages, was to be published monthly; and the engravings illustrative of Celtic antiquities were to be under the inspection of Lenoir. The devices are, *Gloriæ Majorum*, and *Sermonem patriam moresque requiret.*

X. Academies of Belles Lettres are those wherein eloquence and poetry are chiefly cultivated. These are very numerous in Italy, and were not uncommon in France.

The *Academy of Umidi at Florence* has contributed greatly to the progress of the sciences by the excellent Italian translations executed by some of its members, of the ancient Greek and Latin historians. But their chief attention was directed to Italian poetry, at the same time that they applied themselves to the polishing of their language, which produced the *Academy della Crusca.*

The *Academy of Humourists, Umoristi*, had its origin at Rome in the marriage of Lorenzo Marcini, a Roman gentleman, at which several persons of rank were guests; for it being carnival time, to give the ladies some diversion, they betook themselves to the reciting of verses, sonnets, speeches, first *extempore*, and afterwards premeditately; which gave them the denomination of *Belli Humori.* After some experience, and coming more and more into the taste of these exercises, they resolved to form an academy of belles lettres, and changed the title of *Belli Humori* for that of *Humoristi;* choosing for their device a cloud, which, after being formed of exhalations from the salt waters of the ocean, returns in a gentle sweet shower; with this motto from Lucretius, *Redit agmine dulci.*



In 1690, the *Academy of Arcadi* was established at Rome, for reviving the study of poetry and of the belles lettres. Besides most of the politer wits of both sexes in Italy, this academy comprehended many princes, cardinals, and other ecclesiastics; and, to avoid disputes about pre-eminence, all appeared masked after the manner of Arcadian shepherds. Within ten years from its first establishment, the number of *Academicians* amounted to six hundred. They held assemblies seven times a year in a meadow or grove, or in the gardens of some nobleman of distinction. Six of these meetings were employed in the recitation of poems and verses of the Arcadi residing at Rome, who read their own compositions; except ladies and cardinals, who were allowed to employ others. The seventh meeting was set apart for the compositions of foreign or absent members. This academy is governed by a custos, who represents the whole society, and is chosen every four years, with a power of electing twelve others yearly for his assistance. Under these are two sub-custodes, one vicar or pro-custos, and four deputies or superintendents, annually chosen. The laws of the society are immutable, and bear a near resemblance to the ancient model. There are five modes of electing members. The first is by *acclamation.* This is used when sovereign princes, cardinals, and ambassadors of kings desire to be admitted; and the votes are then given *viva voce.* The second is called *annumeration.* This was introduced in favour of ladies and academical colonies, where the votes are taken privately. The third, *representation*, was established in favour of colonies and universities, where the young gentry are bred, who have each a privilege of recommending one or two members privately to be balloted for. The fourth, *surrogation*, whereby new members are substituted in the room of those dead or expelled. The last, *destination*, whereby, when there is no vacancy of members, persons of poetical merit have the title of Arcadi conferred upon them till such time as a vacancy shall happen. All the members of this body, at their admission, assume new pastoral names, in imitation of the shepherds of Arcadia. The academy has several colonies of Arcadi in different cities of Italy, who are all regulated after the same manner.

XI. Academies of Languages, called by some, *Grammatical Academies;* as,

The *Academy della Crusca at Florence*, famous for its vocabulary of the Italian tongue, which was formed in 1582, but scarce heard of before the year 1584, when it became noted for a dispute between Tasso and several of its members. Many authors confound this with the Florentine academy. The discourses which Torricelli, the celebrated disciple of Galileo, delivered in the assemblies, concerning levity, the wind, the power of percussion, mathematics, and military architecture, are a proof that these academies applied themselves to things as well as words.

The *Academy of Fructiferi* had its rise in 1617, at an assembly of several princes and nobility of the country, who met with a design to refine and perfect the German tongue. It flourished long under the direction of princes of the empire, who were always chosen presidents. In 1668, the number of members arose to upwards of nine hundred. It was prior in time to the French academy, which only appeared in 1629, and was not established into an academy before the year 1635. Its history is written in the German tongue, by George Neumarck.

The *French Academy* had its rise from a meeting of men of letters in the house of M. Conrart, in 1629. In 1635, it was erected into an academy by Cardinal Richelieu, for refining and ascertaining the French language and style. The number of its members was limited to forty, out of whom a director, chancellor, and secretary were to be chosen; the two former of whom were to hold their posts for two months; the latter was perpetual. The members of this academy enjoyed several privileges and immunities, among which was that of not being obliged to answer before any court but that of the king's household. They met three times a week in the Louvre. At the breaking up of each meeting forty silver medals were distributed among the members, having on one side the king of France's head, and on the reverse, *Protecteur de l'Académie*, with laurel, and this motto, *A l'Immortalité.* By this distribution, the attendance of the academicians was secured; for those who were present received the surplus intended for the absent. To elect or expel a member, the concurrence of at least eighteen was required; nor could any one be chosen unless he petitioned for it; by which expedient the affront or refusals on the part of persons elected was avoided. Religious persons were not admitted; nor could any nobleman or person of distinction be elected on any other footing than as a man of letters. None could be expelled, except for base and dishonest practices; and there were but two instances of such expulsions, the first of M. Grainer for refusing to return a deposit, the other of the Abbé Furetière for plagiarism. The design of this academy was to give not only rules, but examples, of good writing. They began with making speeches on subjects taken at pleasure, about twenty of which were printed. At their first institution they met with great opposition from the parliament; it being two years before the patents granted by the king could be registered. This institution has been severely satirized, and the style of its compositions has been ridiculed as enervating instead of refining the French language. They were also charged with having surfeited the world by flattery, and exhausted all the topics of panegyric in praise of their founder; it being a duty incumbent on every member, at his admission, to make a speech in praise of the king, the cardinal, the chancellor Seguier, and the person in whose room he is elected. The most remarkable work of this academy is a dictionary of the French tongue; which, after fifty years spent in settling the words and phrases to be used in writing, was at last published in 1694.



An academy similar to the above was founded at Petersburg under the auspices of the Princess Dashkof; and the plan having been approved by the crown, a fund was established for its support. It is attached to the Imperial Academy of Sciences at St Petersburg.

The *Royal Spanish Academy at Madrid* held its first meeting in July 1713, in the palace of its founder, the Duke d'Escalona. It consisted at first of eight academicians, including the duke; to which number fourteen others were afterwards added, the founder being chosen president or director. In 1714, the king granted them the royal confirmation and protection. Their device is a crucible in the middle of the fire, with this motto, *Limpia Fixa, y da Esplendor;* "It purifies, fixes, and gives brightness." The number of its members was limited to twenty-four; the Duke d'Escalona was chosen director for life, but his successors were elected yearly, and the secretary for life. Their object, as marked out by the royal declaration, was to cultivate and improve the national language. They were to begin with choosing carefully such words and phrases as have been used by the best Spanish writers; noting the low, barbarous or obsolete ones; and composing a dictionary wherein these might be distinguished from the former.

The *Royal Swedish Academy* was founded in the year 1786, for the purpose of purifying and perfecting the Swedish language. A medal is struck by its direction every year in honour of some illustrious Swede. This academy does not publish its transactions.

XII. Academies of Politics. Of this description was that at Paris, consisting of six persons, who met at the Louvre, in the chamber where the papers relating to foreign affairs were lodged. But this academy proved of little service, as the kings of France were unwilling to trust any but their ministers with the inspection of foreign affairs.

Academy is a term also applied to those royal collegiate seminaries in which young men are educated for the navy and army. In our country there are three seminaries of this description; the Naval Academy at Portsmouth, the Royal Military Academy at Woolwich, and the Royal Military College at Farnham and Sandhurst. Besides these there are the Colleges of Addiscombe and Haileybury for the education of young men destined for the military and civil service of the Honourable East India Company. For an account of each of these, see the respective articles.

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ACADIE, or Acady, in *Geography*, a name formerly given to Nova Scotia, or New Scotland, in America.

ACÆNA, in *Antiquity*, a Grecian measure of length, being a ten feet rod, used in measuring their lands.

ACAMANTIS, the ancient name of the island of Cyprus, taken from one of its promontories situated to the west, and called *Acamas*, from the hero of that name.

ACAMAS, son of Theseus and Phædra, was chosen to accompany Diomedes to Troy, to demand the restoration of Helen. During his residence at the court of Priam he gained the affections of Laodice, the second daughter of the king, by whom he had a son called *Munitus*. He is mentioned by Virgil as one of the heroes who concealed themselves in the wooden horse. He founded a city in Phrygia, called *Acamantium;* and one of the Athenian tribes was called after him, *Acamantis*. Homer mentions two other heroes of this name: one a Thracian prince, who came to succour Priam; another a son of Antenor.

ACANTHA, in *Botany*, the prickle of any plant: in *Zoology*, a term for the spine or prickly fins of fishes.

ACANTHOPTERYGIOUS Fishes, a term for those fishes whose back fins are hard, osseous, and prickly.

ACANTHUS, in *Architecture*, an ornament representing the leaves of the Acanthus, used in the capitals of the Corinthian and Composite orders, but the species of the plant is still doubtful.

ACAPULCO, a town and port in Mexico, on a bay of the Pacific Ocean, about 190 miles S.S.W. of Mexico, in Lat. 16. 50. N. Long. 99. 46. W. The harbour, which is one of the finest in the world, is easy of access, and the anchorage is so secure that heavily-laden ships can anchor close to the rocks which surround it. The town lies N.W. of the harbour, and is defended by the castle of San Diego, which stands on an eminence. During a part of the dry season the air is infected with the putrid effluvia of a morass eastward of the town. This, together with the heat of the climate, which ranges from 86 to 90 degrees Fahr., aggravated by the reflection of the sun's rays from the granite rocks that environ the town, renders it very unhealthy, especially to Europeans, though a passage cut through the rocks on the east side has tended to improve its salubrity. The population amounts to about 4000, mostly people of colour. The exports are chiefly silver, indigo, cochineal, Spanish cloth, and some peltry. Formerly, a galleon sailed annually from this port to Manilla in the Philippine Islands, and another annually returned from thence, laden with the treasures and luxuries of the East. On the arrival of this galleon a great fair was held, to which merchants resorted from all parts of Mexico. The trade between Acapulco and Manilla has been annihilated by the revolution in America; and the town has dwindled into comparative insignificance. Captain Hall found in it only 30 houses, and some reed-huts. In the beginning of December 1852 this town suffered severely from an earthquake.

ACARNANIA, a province of ancient Greece, now called Carnia. It was bounded on the N. by the Ambracian gulf, on the N.E. by Amphilochia, on the W. and S.W. by the Ionian sea, and on the E. by the river Achelous. It was a mountainous country, with numerous lakes and tracts of rich pasture, and its hills are to the present day crowned with thick wood. It was celebrated for its excellent breed of horses. The Acarnanians, according to Mr Grote, though admitted as Greeks to the Pan-Hellenic games, were more akin in character and manners to their barbarian neighbours of Epirus. Up to the time of the Peloponnesian war, they are mentioned only as a race of rude shepherds, divided into numerous petty tribes and engaged in continual strife and rapine. They were, however, favourably distinguished from their Ætolian neighbours by the fidelity and stedfastness of their character. They were good soldiers and excelled as slingers. At the date above mentioned they begin, as the allies of the Athenians, to make a more prominent figure in the history of Greece. The chief town was Stratos, and subsequently Leucas.

ACARON, or Accaron, a town of Palestine, called *Ekron* in Scripture, now Akri.

ACASTUS, son of Pelias, king of Iolcus, was one of the Argonauts, and took part in the hunt of the Calydonian boar. His sisters, at the instigation of Medea, cut their father to pieces and boiled him in a cauldron, expecting to see him restored to them in the bloom of youth. The sorceress having failed in her promise, Acastus drove her and Jason out of Iolcus, buried his father, and instituted games to his memory. Peleus, after having been purified by Acastus from the murder of Eurytion, appeared at these games, where he contended with Atalanta. Astydamia, or Hippolyte, the wife of Acastus, falling in love with this hero, and finding him proof against her solicitations, accused him to her husband of having made an attempt on her virtue. Acastus, unwilling to slay his guest, took his revenge by depriving him of his sword while he slept, after the fatigues of the chase, on Mount Pelion. Peleus on awakening missed his sword, and found himself in imminent danger of destruction by the hands of the Centaurs, but was rescued by the timely intervention of Chiron, who restored to him his sword. Returning, he slew both Acastus and his wife, and took possession of Iolcus. (*Apollod.* i. 9, iii. 13.)

ACATALECTIC, a term in ancient poetry for such verses as have all their feet or syllables, in contradistinction to those that have a syllable too few.

ACCA, Saint, bishop of Hagustaldt, or Hexham, in Northumberland, succeeded Wilfrid in that see in 709. He ornamented his cathedral in a most magnificent manner; and erected a noble library, consisting chiefly of ecclesiastical learning, and a large collection of the lives of the saints. He was an able divine, and famous for his skill in church music. He wrote several books, particularly *Passiones Sanctorum*, and *Pro illustrandis Scripturis, ad Bedam.* He died in 740.



ACCAPITARE, in *Law*, the act of becoming vassal of a lord, or of yielding him homage and obedience. Hence,

ACCAPITUM signifies the money paid by a vassal upon his admission to a feu.

Accapitum, in our *Ancient Law*, was used also to express the relief or fee payable on the entry of an heir to the chief lord.

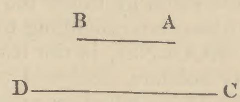
ACCEDAS ad curiam, in *English Law*, a writ used where a man has received, or fears, false judgment in an inferior court. It lies also for justice delayed, and is a species of the writ Recordare.

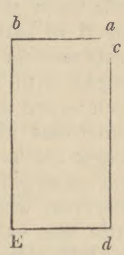
ACCELERATION, in *Natural Philosophy*, denotes generally an increase of motion or velocity, and is chiefly applied to the motion of such bodies as go on, not with a uniform motion, but one which becomes continually quicker and quicker as they advance. A body, for example, rolling down a hill proceeds slowly at first, but gradually increases as it descends, until at last it acquires a velocity and momentum which bears down every thing before it. The same thing takes place when a body is dropped, and allowed to fall freely in the air; although the acceleration is here less observable, on account of the great rapidity of the descent. The earth, in its annual motion round the sun, is subject to a continued acceleration from the apogee to the perigee, while from thence again it suffers a similar retardation. Many other examples occur of such acceleration; but the most interesting is the Acceleration of Falling Bodies. That such an acceleration does take place, is obvious from many circumstances, particularly the increasing momentum which a body acquires in proportion to the height of its descent. But it was only by considering the cause of the descent that the true law of the acceleration was determined. This great discovery we owe to the genius of Galileo. Various theories had been framed by philosophers to account for the accelerated descent of falling bodies, but all of them inconclusive and visionary. Some, for instance, ascribed it to the weight of the pure air above increasing as the body descended. The followers of Gassendi pretended that there are continually issuing out of the earth certain attractive corpuscles directed in an infinite number of rays; these, say they, ascend and then descend in such a manner, that the nearer a body approaches to the earth's centre, the more of these attractive rays press upon it, in consequence of which its motion becomes accelerated. The Cartesians again ascribed the effect to the reiterated impulses of their *materia subtilis* acting continually on falling bodies, and propelling them downwards. It appears now incredible how such dreams could have been gravely proposed by men having the reputation of philosophers. Galileo, however, on considering the subject attentively, and applying the powerful aids of geometry and mathematics, soon discovered that the true cause was simply the continued action of the moving force of gravity. This force, Galileo reasoned, must operate continually on the body, not only at the moment of starting, but also during every moment of its descent. And as the body retains and accumulates all these impressions according to the great and original law of moving bodies, no wonder that its motion should become continually accelerated: for, suppose that gravity were to act only at certain small intervals, each second for instance, and suppose that at first it communicates such a motion to the body as causes it to descend, say ten feet in the first second; the body could not stop here even though gravity were ceasing altogether to act on it: retaining the original impression, it would still go on moving uniformly at the rate of ten feet every second of its descent; but at the end of the first second, gravity

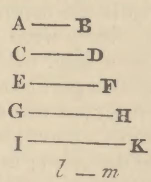
Accelera-tion.

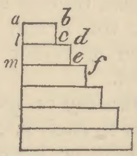
again acts on it and communicates a second impression, by virtue of which it would descend ten feet during the second interval, in addition to the ten feet arising from the original impulse; so that on the whole it descends 20 feet in the second interval. In the same manner, during the third interval it would descend 30 feet, and during the fourth 40, and so on; the space described in each second thus increasing regularly with the increase of the time.

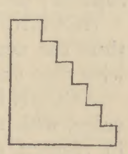
Hence Galileo deduced the fundamental law of acceleration in falling bodies, that the *Velocity*, which in every case is just the space described in each second or other fixed interval, *increases in exact proportion to the whole time of descent;* so that whatever be the velocity at the end of the first second, then at the end of any number of seconds the velocity would just be as many times greater,—a law from which he easily deduced all the others regarding the descent of falling bodies, which are of so much importance in mechanical inquiries. The most remarkable is that which regards the *Space*[1] described, or the total amount of the descent in a given time. This Galileo deduced very elegantly from a simple geometrical consideration. In every case of a body moving uniformly without acceleration, the space described in any given time must be proportional to the time, and must be found by multiplying the time by the velocity: it may be represented, therefore, by a simple diagram. Let A B, for instance, denote by its length the velocity of the body, or the number of feet described by it in a second, and C D the time or number of seconds during which it is in motion; then, if we construct a rectangle $a$ E, of which one of the sides, $a\ b$, is equal to A B, and the other, $c\ d$, equal to C D, this rectangle, that is, the number of square feet in it, will denote the space, that is, the number of lineal feet described during the whole period. Let us now apply this principle to the case of a body moving with an accelerated velocity, and let AB, CD, EF, &c. denote the velocities at the end of certain equal intervals of time, of which let each be denoted by $l\ m$; and suppose also, that during each of these intervals the motion is uniform, and is only accelerated by a sort of start which takes place at the end of each: then, if we construct a rectangle $a\ l\ b$, of which $a\ b$ is equal to A B, the velocity at the end of the first interval, and $a\ l$ equal to $l\ m$ the first interval, this rectangle will denote the space described during that interval. Continue now the line $a\ l$ to $m$, making $l\ m = a\ l = l\ m$, and continue also $l\ c$ to $d$, so that $l\ d$ may be equal to D C, the velocity during the second interval, and complete the rectangle $d\ l\ m\ e$, this will denote the space described in the second interval; and, in the same manner, each of the succeeding rectangles in descending will denote the space described in



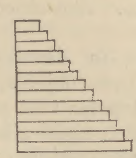



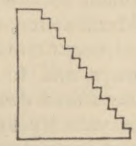



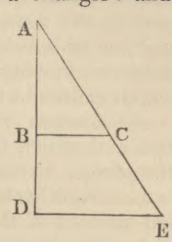



the succeeding interval, so that the total amount of the descent will be denoted by the sum of all the rectangles together, or by the compound figure which they form. But what is the nature of this figure? It is evidently, as appears more clearly by taking out the parallel lines, triangular, only that the longest side presents a serrated outline. What is the cause of this? It is clearly owing to the supposition we have made of the motion continuing uniform during the intervals, and then increasing by starts; instead of growing continually, as it really does. Suppose then that we shorten the intervals one-half, for instance, and double their number, we shall then be much nearer the truth; but the inequalities in the hypothenuse of the triangle are now greatly reduced; and the more we thus diminish the intervals, and increase their number, the more nearly does it approach to a straight line. In the extreme case, therefore, where there are in reality no intervals, but where the velocity goes on continually increasing, neither will there be any inequalities in the outline; the figure will be really a triangle: and while the vertical side A B denotes the time of descent, and the horizontal B C the velocity, the area of the triangle will denote in square measure the space descended in the given time. But the areas of similar triangles are in every case proportional to the squares of their corresponding sides; that is, the area A B C is to A D E as the square of A B or B C is to the square of A D or D E. Hence in general it follows, that the *spaces* described in any given time or times are always *proportional to the squares of these times*, and also to the *squares of the velocities at the end of such times.* Thus, if a body describes 16 feet during the first second of its descent, it will, during the next, descend 4 times as much, or 64; during the third 9 times, or 144 feet; during the fourth 16 times, or 256, and so on.








Such, then, is the great law of acceleration in regard to the spaces described. It is easily deducible also from numerical or algebraical considerations. Let the velocity, for example, at the end of any given time, such as a second, be denoted by 1; then in the second, third, and fourth, it will be 2, 3, 4, &c. But the space described at the end of any time is evidently equal to the time multiplied by the mean velocity; that is, the velocity at the half-interval. During the first second, therefore, the space described will be $\frac{1}{2}$, during the second $\frac{3}{2}$, during the third $\frac{5}{2}$, during the fourth $\frac{7}{2}$, and so on; adding these successively, the whole space from the beginning at the end of each interval will be $\frac{1}{2}$, $\frac{4}{2}$, $\frac{9}{2}$, $\frac{16}{2}$, &c., being each proportional to the square of the time. Algebraically again, if we suppose gravity to act only at the end of successive intervals, and the motion to continue uniform during these, then the spaces described will form an arithmetical progression, such as $a$, $2\ a$, $3\ a$, $4\ a$, $5\ a$, &c. ... $n\ a$, and the whole space will be the sum of this series, or $a + n\ a \times \frac{n}{2} =$

[1] This phrase, we may remark, probably from Galileo's geometrical illustration, has been rather awkwardly introduced in these discussions, and in a way which tends to produce a little obscurity. Space generally includes the idea of extension, in at least two dimensions, both length and breadth; whereas it is here employed to denote merely the lineal extent, the length of the track described by the moving body.

$n^2 + n \times \frac{a}{2}$. Suppose now the intervals diminished in extent and increased in number indefinitely, they will bear no sort of proportion to $n^2$: the second term of the above sum therefore may be neglected, and ultimately the whole space will be proportional to $n^2$, the square of the time. In every view, then, this great law is established; and when we come to try it experimentally, which is done by means of Atwood's machine, it is confirmed by the nicest observation; every falling body describing in the first second $16\frac{1}{12}$ feet, and in every other a space proportional to the time. See *Atwood's* Machine, Dynamics, Mechanics, &c. (J. B.)

Acceleration, in *Astronomy*, is applied in various ways, and to different objects. Thus, the *Acceleration of the Fixed Stars* denotes that apparent increase of motion or velocity by which night after night they arrive sooner and sooner upon the meridian than before. A star which passes the meridian to-night at 10 o'clock, for instance, will to-morrow night arrive at it 3′ 56″ sooner, or at 56′ 4″ past nine, and so on each succeeding evening; thus anticipating continually the motion of the sun, which regulates the length of the day. A star which passes the meridian to-day with the sun, will to-morrow pass 3′ 56″ sooner; so that it appears to revolve with a quicker or accelerated motion. It is in reality the sun, however, moving continually backwards among the stars which causes in them this apparent acceleration.

*Acceleration of the Planets* denotes that accelerated motion with which they all, as well as the earth, advance from the perigee to the apogee of their orbits. This acceleration is most readily observed by comparing the successive diurnal motions of the planet in its orbit. When the actual diurnal motion exceeds the mean diurnal motion, the planet is accelerated; and, on the other hand, when it falls short of it, it is retarded, as takes place between the apogee and perigee.

*Acceleration of the Moon* is a remarkable increase which has been discovered in the moon's motion in her orbit, which has been going on increasing from age to age by a gradation so imperceptible, that it was only discovered or suspected by Dr Halley, on comparing the ancient eclipses observed at Babylon and others with those of his own time. The quantity of this acceleration was afterwards determined by Mr Dunthorne from more accurate data regarding the longitudes of Alexandria and Babylon, and from the most authentic eclipse of which any good account remains, observed at Babylon in the year 721 before Christ. The beginning of this eclipse, as observed at that time, was about an hour and three quarters sooner than he found it would have been by computation; and hence he found the mean acceleration, or what has since been termed the moon's secular equation, about 10″ of a degree each century. According to Laplace, it amounts to 11·135″. This remarkable fact had long excited the attention of astronomers; as, along with several others of the same kind among the heavenly bodies, it seemed to betray imperfection; exhibiting inequalities which were continually increasing, instead of correcting themselves or being somehow compensated by that admirable design which prevailed in every other part of the system. At last, however, it was discovered, by the application of a refined analysis, that these inequalities were not perpetual; that they actually terminate in the lapse of ages, and again return in the opposite direction, thus preserving entire the harmony of the celestial motions. This fine discovery, which observation alone could never have disclosed, we owe to the genius of Laplace. See Astronomy in this work; also *Phil. Trans.* No. 204, 218, and vol. xlvi. 1749, 1750, 1777; *Mém. de l'Acad. Par.* 1757, 1763, 1786; *Mém. de l'Acad. Berlin*, 1773, 1782; *Connoissances des Temps*, 1779, 1782, 1790; Newton's *Principia*, second edition; Say's *Astronomy;* Vince's *Astronomy;* *Astronomie*, par Lalande, &c. (J. B.)



Acceleration *of Bodies on inclined Planes.* The same general law obtains here as in bodies falling perpendicularly: the effect of the plane is to make the motion slower; but the inclination being everywhere equal, the retardation arising therefrom will proceed equally in all parts, at the beginning and the ending of the motion.

ACCENDENTES, a lower order of ministers in the Romish church, whose office is to light and trim the candles.

ACCENDONES, in Roman antiquity, a kind of gladiators, whose office was to excite and animate the combatants during the engagement. The orthography of the word is contested: the first edition of Tertullian, by Rhenanus, has it *accedones;* an ancient manuscript, *accendones.* Aquinas adheres to the former, Pitiscus to the latter. The origin of the word, supposing it *accendones*, is from *accendo*, I kindle; supposing it *accedones*, from *accedo*, I accede, am added to. The former places their distinguishing character in enlivening the combat by their exhortations and suggestions: the latter supposes them to be much the same with what among us are called *seconds*, among the Italians, *patroni;* excepting that these latter only stand by to see the laws of the sword duly observed, without intermeddling to give advice or instruction.

ACCENSI, in the Roman armies, certain supernumerary soldiers, designed to supply the place of those who should be killed or anywise disabled. They were thus denominated, *quia accensebantur*, or *ad censum adjiciebantur.* Vegetius calls them *supernumerarii legionum.* Cato calls them *ferentarii*, in regard they furnished those engaged in battle with weapons, drink, &c. Nonnius suggests another reason of that appellation, viz. because they fought with stones, slings, and weapons, *quæ feruntur*, such as are thrown, not carried in the hand. They were sometimes also called *velites*, and *velati*, because they fought clothed, but not in armour; sometimes *adscriptitii*, and *adscriptivi;* sometimes *rorarii.* The *accensi*, Livy observes, were placed in the rear of the army, because little was expected from them: they were taken out of the fifth class of citizens.

Accensi, in antiquity, denotes an inferior order of officers, appointed to attend the Roman magistrates, somewhat in the manner of ushers, serjeants, or tipstaves among us. They were thus called from *accire*, to send for; one part of their office being to call assemblies of the people, summon parties to appear and answer before the judges, &c.

Accensi was also an appellation given to a kind of adjutants, appointed by the tribune to assist each centurion and decurion; in which sense *accensus* is synonymous with *optio.* In an ancient inscription, given by Torre, we meet with Accensus Equitum Romanorum; an office nowhere else heard of. That author suspects it for a corruption; and instead thereof reads, A Censibus.

ACCENSION, the action of setting a body on fire: thus the accension of tinder is effected by striking fire with flint and steel.

ACCENT, in *reading* or *speaking*, an inflection of the voice, which gives to each syllable of a word its due pitch in respect of height or lowness. See Reading. The word is originally Latin, *accentus;* a compound of *ad*, to, and *cano*, to sing. *Accentus quasi adcantus*, or *juxta cantum.* In this sense, accent is synonymous with the Greek τονος; the Latin *tenor*, or *tonor;* and the Hebrew טעם, *gustus*, taste.

Accent, among grammarians, is a certain mark or

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character placed over a syllable to direct the stress of its pronunciation. We generally reckon three grammatical accents in ordinary use, all borrowed from the Greeks, viz. the *acute accent* ('), which shows when the tone of the voice is to be raised; the *grave accent* (`), when the note or tone of the voice is to be depressed; and the *circumflex accent* (^), which is composed of both the acute and the grave, and points out a kind of undulation of the voice. The Latins have made the same use as the Greeks of these three accents.

The Hebrews have a grammatical, a rhetorical, and a musical accent; though the first and last seem, in effect, to be the same, both being comprised under the general name of *tonic accents*, because they give the proper tones to syllables; as the rhetorical accents are said to be euphonic, because they tend to make the pronunciation more sweet and agreeable. There are four euphonic accents, and twenty-five tonic: of these some are placed above, and others below the syllables; the Hebrew accents serving not only to regulate the risings and fallings of the voice, but also to distinguish the sections, periods, and members of periods, in a discourse, and to answer the same purposes with the points in other languages. Their accents are divided into *emperors, kings, dukes,* &c. each bearing a title answerable to the importance of the distinction it makes. Their emperor rules over a whole phrase, and terminates the sense completely; answering to our point. Their king answers to our colon; and their duke to our comma. The king, however, occasionally becomes a duke, and the duke a king, as the phrases are more or less short. It must be noted, by the way, that the management and combination of these accents in Hebrew poetry differ from their management and combination in prose. The use of the tonic or grammatical accents has been much controverted; some holding that they distinguish the sense, while others maintain that they are only intended to regulate the music or singing, alleging that the Jews sing rather than read the Scriptures in their synagogues.[1] Be this, however, as it will, it is certain the ancient Hebrews were not acquainted with these accents. The opinion which prevails amongst the learned is, that they were invented about the sixth century, by the Jewish doctors of the school of Tiberias, called the *Massorets*.

[1] Cooper, *Dom. Mosaic. Clav.* p. 31.

As to the Greek accents, now seen both in manuscripts and printed books, there has been no less dispute about their antiquity and use than about those of the Hebrews. But, apart from the bewildering discussions of modern scholars, more erudite than wise, the man who with a clear knowledge of the phenomena of the living voice, shall draw his ideas on this subject directly from the ancient grammarians and rhetoricians will find the following things to be undoubted:—(1.) That by *accent* (προσωδία, τόνος) the Greeks understood the elevation or falling of the voice on a particular syllable of a word, either absolutely, or in relation to its position in a sentence, accompanied with an *intension* or *remission* of the vocal utterance on that syllable (ἐπίτασις, ἄνεσις,) occasioning a marked predominance of that syllable over the other syllables of the word. The predominance thus given, however, had no effect whatever on the quantity —long or short—of the accented syllable. The accented syllable in Greek as in English, might be long or it might be short; elevation and emphasis of utterance being one thing, and prolongation of the vocal sound quite another thing, as any one acquainted with the first elements of music will at once perceive. The difficulty which many modern scholars have experienced in conceiving how a syllable could be accented and not lengthened, has arisen partly from a complete want of distinct ideas on the nature of the elements of which human speech is composed, and partly also from a vicious practice which has long prevailed in the British schools, of reading Greek, not according to the laws of its own accentuation, but according to the accent of Latin handed down to us through the Roman Catholic church. For the rules of Latin accentuation are, as Quintilian and Cicero, and the grammarians expressly mention, very different from the Greek; and the long syllable of a word has the accent in Latin in a hundred cases, where the musical habit of the Greek ear placed it upon the short. There is besides a vast number of words in Greek accented on the last syllable (like *voluntee'r, ambusca'de,* in English), of which not a single instance occurs in the Latin language. Partly, however, from ignorance, partly from carelessness, and partly from stupidity, our scholastic men transferred the pronunciation of the more popular learned language to that which was less known; and with the help of time and constant usage, so habituated themselves to identify the accented with the long syllable, according to the analogy of the Latin, that they began seriously to doubt the possibility of pronouncing otherwise, and even wrote learned works disavowing the doctrine of accent altogether, as an element of spoken speech among the classical Greeks. But since the appearance of a more philosophical spirit in philology, under the guidance of Hermann, Boeckh, and other masterminds among the Germans, the confused discussions arising from these misunderstandings have ceased; and all our best grammarians now recognise the importance of this element of ancient Hellenic enunciation, while not a few carry out their principles into a consistent practice. The only circumstance, indeed, that prevents our English scholars from practically recognising the element of accent in classical teaching, is the apprehension that this would interfere seriously with the practical inculcation of quantity; an apprehension in which they are certainly justified by the practice of the modern Greeks, who have given such a predominance to accent, as altogether to subordinate, and in many cases completely overwhelm quantity; and who also, in public token of this departure from the classical habit of pronunciation, regularly compose their verses with a reference to the spoken accent only, leaving the quantity—as in modern language generally—altogether to the discretion of the poet. But as experiment will teach any one, that there is no necessity whatever in the nature of the human voice, for this confusion of two essentially different elements, it is not unlikely that British scholars will soon follow the example of the Germans, and read Greek prose at least systematically according to the laws of classical speech, as handed down to us by the grammarians of Alexandria and Byzantium. In the recitation of classical verse, of course, as it was not constructed on accentual principles, the skilful reader will naturally allow the musical accent, or the emphasis of the rhythm to overbear, to a great extent, or altogether to overwhelm, the accent of the individual word; though with regard to the recitation of verse, it will always remain a problem how far the ancients themselves did not achieve an "*accentuum cum quantitate apta conciliatio*," such as that which Hermann (*De emendanda ratione, &c.*) describes as the perfection of a polished classical enunciation.

The subject of Greek accent has been frequently handled by distinguished scholars both in this country and abroad; but it may be sufficient to refer the reader for more minute information to a paper in the *Classical Museum*, vol. i. p. 338; to Pennington's work on Greek pronunciation, Cambridge, 1844; and to a work on the same subject by Blackie, Edinburgh, 1853; and to the German work on Greek accent by Göttling. (English.) London, 1831.

The use of accents to prevent ambiguities is most remarkably perceived in some eastern languages, particularly the Siamese and Chinese. Among the people of China, every word, or, which is the same thing, every syllable, admits of five accents, according as it is spoken more acutely or remissly; and thus stands for many different things. The same sound *ya*, according to the accent affixed to it, signifies *God*, *a wall*, *excellent*, *stupidity*, and a *goose*. The Chinese have but 330 spoken words in their language; but these being multiplied by the different accents or tones which affect the vowels, furnish a language tolerably copious. By means of accents, their 330 simple sounds come to denote 1650 things; but this being hardly sufficient, they are increased further by aspirates added to each word, to double the number. The Chinese only reckon four *accents*, for which the missionaries use the following marks, *aá*, *â*, *à*, *a* ; to which they have added a fifth, thus *ã*. They make a kind of modulation, wherein, prolonging the duration of the sound of the vowel, they vary the tone, raising and sinking it by a certain pitch of voice; so that their talking is a sort of music or singing. Attempts have been made to determine the quantity of the rise or fall on each accent by means of musical notes; but this is hard to effect, as being different in different persons. Hence the great difficulty of the language to foreigners, who are forced to sing most scrupulously; for if they deviate ever so little from the accent, they say quite a different thing from what was intended. Thus, meaning to compliment the person you are talking of with the title *Sir*, you call him a beast with the same word, only a little varied in the tone. Magalhon, however, makes the language easier to learn on this account. The Siamese are also observed to sing rather than to talk. Their alphabet begins with six characters, all only equivalent to a K, but differently accented. For though in the pronunciation the accents are naturally on the vowels, yet they have some to diversify such of their consonants as are in other respects the same.

Accent, in *Music*. See Music, § *Melody*.

ACCEPTANCE, in *Commerce*, is the subscribing, signing, and making one's self debtor for the sum contained in a bill of exchange or other obligation.

ACCEPTER, or Acceptor, the person who accepts a bill of exchange, &c.

ACCEPTILATION, among civilians, an acquittance or discharge given by the creditor to the debtor without the payment of any value.

ACCESSION, a coming to, applied where one object comes into conjunction with another, as the *accession* of a dynasty to a throne, an *accession* of a field to an estate.

In *Law*, it is a method of acquiring property, by which, in things that have a close connection or dependence upon one another, the property of the principal draws after it the property of the accessory: thus, the owner of a cow becomes likewise the owner of the calf. It sometimes likewise signifies consent or acquiescence. Thus, in the bankrupt law of Scotland, when there is a settlement by a trust-deed, it is accepted on the part of each creditor by a deed of accession.

The most important application of the term is its historical and constitutional, in reference to monarchical government. The beginning of every monarch's reign may be called his accession, but it is generally said of a monarch that he "succeeds," and the term is more distinctively applied to the epoch of a new dynasty, as the accession of the House of Capet in France, of the House of Austria or of Bourbon in Spain, and of the House of Stuart or of Hanover in England. Such accessions are very frequent in European history. In France alone, besides late changes, we have the accession of the Carlovingian dynasty in Pepin (752), of the Capetian in Hugh Capet (987), of the House of Valois in Philip VI. (1328), and of the House of Bourbon in Henry IV. (1485). A fixed principle of succession by which the heir of a childless monarch is indicated with certainty, is a great preservative of peace among monarchies. The most desolating wars have arisen from disputed successions. In Oriental despotisms, even the first step in certainty—the indication of the particular son who shall succeed his father—is often wanting, and it has been usual to put to death or mutilate the brethren of the selected one, to prevent contention. Even in this country it was long ere the principle of succession was so well established, as to apply with certainty to distant relations. The great war of independence in Scotland arose from the question, whether a grandchild by the eldest child had any preference over a younger. The same difficulty created the great wars of the Roses. Edward III. had three sons, the Black Prince, Lionel Duke of Clarence, and John of Gaunt, Duke of Lancaster. On the death of Richard II., the son of the Black Prince, the descendant of his elder uncle, the Duke of Clarence, should have succeeded by scientific principles of descent, but Henry IV., the son of John of Gaunt, made good his accession.

The highest perfection in peaceful constitutional accession is reached when the legislature of a country requires to change the line of monarchs, and fixes beforehand on another line, which, by virtue of the selection, has a peaceful accession. This has been only accomplished in our own country, when it was twice effected within a very short interval, when at the Revolution the crown was settled on William and Mary, and the Princess Anne and her heirs. On the death of her last child it was necessary to make a new settlement, and going back to the descendants of King James I., the grandson of his daughter the Queen of Bohemia, was selected and made the accession of the House of Hanover.

ACCESSORY, or Accessary, something that accedes, or is added to another more considerable thing; in which sense it is opposed to principal.

In *Common Law*, it is applied to a person guilty of a felonious offence, not principally, but by participation; as by advice, command, or concealment. There are two kinds of *accessories; before* the fact, and *after* it. The first is he who commands or procures another to commit felony, and is not present himself; for if he be present he is a principal. The second is he who receives, assists, or comforts any man that has done murder or felony, whereof he has knowledge. A man may also be accessory to an accessory, by aiding, receiving, &c. an accessory in felony.

*Accessory Nerves*, a pair of nerves which arise from the medulla in the vertebræ of the neck, ascend and enter the skull, and pass out of it again with the par vagum.

Accessory, among painters, an epithet given to such parts of a history-piece as serve chiefly for ornament.

ACCIAIUOLI, Donato, a native of Florence, was born in 1428, and was famous for his learning and the honourable employments which he held. He wrote a Latin translation of some of Plutarch's Lives; Commentaries on Aristotle's Ethics and Politics; and the lives of Hannibal, of Scipio, and of Charlemagne. He was sent to France by the Florentines, to solicit aid from Louis XI. against Pope Sixtus IV., but on his journey died at Milan in 1478: his body was carried to Florence, and buried in the church of the Carthusians at the public expense. The small fortune he left his children is a proof of his probity and disinterestedness. His daughters, like those of Aristides, were portioned by his fellow-citizens, as an acknowledgment of his services. His funeral eulogium was spoken by Christopher Landini; and an elegant epitaph, by Politian, was inscribed on his tomb.

ACCIDENT, in *Grammar*, implies a property attached to a word, without entering into its essential definition. See Grammar.

Accident, in *Heraldry*, an additional point or mark in a coat of arms, which may be either omitted or retained without altering the essence of the armour; such as abatement, difference, and tincture.

Accident, among *Logicians*, is used in a threefold sense. 1. Whatever does not essentially belong to a thing; as the clothes a man wears, or the money in his pocket. 2. Such properties in any subject as are not essential to it: thus, whiteness in paper is an accidental quality. 3. In opposition to substance, all qualities whatever are called accidents; as sweetness, softness, &c.

ACCIDENTAL, in *Philosophy*, is applied to that effect which flows from some cause intervening by accident, without being subject, or at least without any appearance of being subject, to general laws or regular returns. In this sense *accident* is opposed to *constant* and *principal*. Thus the sun's place is, with respect to the earth, the constant and principal cause of the heat in summer and the cold in winter; whereas winds, snows, and rains, are the accidental causes which often alter and modify the action of their principal cause.

*Accidental Colours* are those which depend upon the affections of the eye, in contradistinction to those which belong to light itself. The impressions made upon the eye by looking stedfastly on objects of a particular colour are various, according to the single colour or combination of colours in the object; and they continue for some time after the eye is withdrawn, and give a false colouring to other objects. M. Buffon has endeavoured to trace the connections which these accidental colours have with such as are natural, in a variety of instances. The subject has also been considered by De la Hire and M. Æpinus. M. d'Arcy has contrived a machine for determining the duration of those impressions on the eye; and from the result of several experiments, he inferred, that the effect of the action of light on the eye continued about eight thirds of a minute.

*Accidental Point*, in *Perspective*, is that point in the horizontal line where the projections of two lines parallel to each other meet the perspective plane.

ACCIPITER, among the Romans, signified a hawk, which, from its being very carnivorous, they considered as a bird of bad omen:

> Odimus accipitrem, quia semper vivit in armis. Ovid.

Pliny however tells us, that in some cases, particularly in marriage, it was esteemed a bird of good omen, because it never eats the hearts of other birds; intimating thereby, that no differences in a married state ought to reach the heart. The accipiter was worshipped as a divinity by the inhabitants of Tentyra, an island in the Nile, being considered by them as the image of the sun; and hence we find that luminary represented, in hieroglyphics, under the figure of a hawk.

In the Linnæan system this name is given to the first order of birds.

ACCISMUS denotes a feigned refusal of something which a person earnestly desires. The word is Latin; or rather Greek, ακκισμος; supposed to be formed from *Acco*, the name of a foolish old woman noted in antiquity for an affectation of this kind.

ACCIUS, Lucius, a Latin tragic poet, the son of a freedman, and, according to St Jerome, born in the consulship of Hostilius Mancinus and Attilius Serranus, in the year of Rome 583; but there appears somewhat of confusion and perplexity in this chronology. He made himself known before the death of Pacuvius by a dramatic piece, which was exhibited the same year that Pacuvius brought one upon the stage; the latter being then eighty years of age, and Accius only thirty. We do not know the name of this piece of Accius's, but the titles of several of his tragedies are mentioned by various authors. He wrote on the most celebrated stories which had been represented on the Athenian stage; as Andromache, Andromeda, Atreus, Clytemnestra, Medea, Meleager, Philoctetes, the civil wars of Thebes, Tereus, the Troades, &c. He did not always, however, take his subjects from the Grecian story; for he composed one dramatic piece wholly Roman: it was entitled *Brutus*, and related to the expulsion of the Tarquins. It is affirmed by some that he wrote also comedies; which is not unlikely, if he was the author of two pieces, the Wedding, and the Merchant, which have been ascribed to him. He did not confine himself to dramatic writing; for he left other productions, particularly his Annals, mentioned by Macrobius, Priscian, Festus, and Nonnius Marcellus. He has been censured for writing in too harsh a style, but in all other respects has been esteemed a very great poet. He was so much esteemed by the public, that a comedian was punished for only mentioning his name on the stage. Cicero speaks with great derision of one Accius who had written a history; and, as our author had written annals, some insist that he is the person censured: but as Cicero himself, Horace, Quintilian, Ovid, and Paterculus, have spoken of our author with so much applause, we cannot think it is the same person whom the Roman orator censures with so much severity.

Accius, a poet of the 16th century, to whom is attributed *A Paraphrase of Æsop's Fables*, on which Julius Scaliger bestows great encomiums.

ACCLAMATION, a confused noise or shout of joy, by which the public express their applause, esteem, or approbation.

Acclamation, in a more proper sense, denotes a certain form of words, uttered with extraordinary vehemence, and in a peculiar tone somewhat resembling a song, frequent in the ancient assemblies. Acclamations were usually accompanied with applauses, with which they are sometimes confounded, though they ought to be distinguished; as acclamation was given by the voice, applause by the hands: add, that acclamation was also bestowed on persons absent, applause only on those present. Acclamation was also given by women, whereas applause seems to have been confined to men.

Acclamations are of various kinds; ecclesiastical, military, nuptial, senatorial, synodical, scholastical, theatrical, &c. We meet with loud acclamations, musical and rhythmical acclamations; acclamations of joy and respect, and even of reproach and contumely. The former, wherein words of happy omen were used, were also called *Laudationes et bona vota*, or good wishes; the latter, *Execrationes et convicia*. Suetonius furnishes an instance of this last kind in the Roman senate, on occasion of the decree for demolishing the statues of Domitian, when the fathers, as the historian represents it, could not refrain from contumelious acclamations of the deceased. The like were shown after the death of Commodus, where the acclamations run in the following strain:—*Hosti patriæ honores detrahantur, parricidæ honores detrahantur; hostis statuas undique, parricidæ statuas undique, gladiatoris statuas undique*, &c. The formula, in acclamations, was repeated sometimes a greater, sometimes a lesser number of times. Hence we find in Roman writers, *acclamatum est quinquies, et vicies*; five times, and twenty times; sometimes also *sexagies*, and even *octuagies*; sixty and eighty times.

Acclamations were not unknown in the theatres in the earliest ages of the Roman commonwealth; but they were artless then, and little other than confused shouts. Afterwards they became a sort of regular concerts. That mentioned by Phædrus, *Lætare incolumis, Roma, salvo Prin-*

*cipe*, which was made for Augustus, and proved the occasion of a pleasant mistake of a flute-player called *Princeps*, shows that musical acclamations were in use in that emperor's reign. *Revertentem ex provincia modulatis carminibus prosequebantur*, says Suetonius, who gives another instance in the time of Tiberius: a false report of Germanicus's recovery being spread through Rome, the people ran in crowds to the Capitol with torches and victims, singing, *Salva Roma, Salva Patria, Salvus est Germanicus.* Nero, passionately fond of music, took special care to improve and perfect the music of acclamations. Charmed with the harmony with which the Alexandrians, who came to the games celebrated at Naples, had sung his praises, he brought several over to instruct a number of youth, chosen from among the knights and people, in the different kinds of acclamations practised in Alexandria. These continued in use as long as the reign of Theodoric. But the people did not always make a single chorus; sometimes there were two, who answered each other alternately: thus, when Nero played in the theatre, Burrhus and Seneca, who were on either hand, giving the signal by clapping, 5000 soldiers, called *Augustals*, began to chant his praise, which the spectators were obliged to repeat. The whole was conducted by a music-master, called *mesochorus* or *pausarius*. The honour of acclamations was chiefly rendered to emperors, their children, and favourites; and to the magistrates who presided at the games. Persons of distinguished merit also sometimes received them, of which Quintilian gives us instances in Cato and Virgil. The most usual forms were, *Feliciter, Longiorem vitam, Annos felices.* The actors themselves, and they who gained the prizes in the games of the circus, were not excluded the honour of acclamations.

To theatrical acclamations may be added those of the soldiery and the people in time of triumph. The victorious army accompanied their general to the Capitol; and, among the verses they sung in his praises, frequently repeated Io TRIUMPHE, which the people answered in the same strain. It was also in the way of acclamation that the soldiers gave their general the title of *Imperator*, after some notable victory; a title which he only kept till the time of his triumph.

The acclamations of the senate were somewhat more serious than the popular ones, but arose from the same principle, viz. a desire of pleasing the prince or his favourites; and aimed likewise at the same end, either to express the general approbation and zeal of the company, or to congratulate him on his victories, or to make him new protestations of fidelity. These acclamations were usually given after a report made by some senator, to which the rest all expressed their consent by crying, OMNES, OMNES; or else, ÆQUUM EST, JUSTUM EST. Sometimes they began with acclamations, and sometimes ended with them, without other debates. It was after this manner that all the elections and proclamations of emperors, made by the senate, were conducted; something of which practice is still retained at modern elections of kings and emperors, where *Vivat Rex*, and *Long live the King*, are customary forms of acclamation.

The Greeks borrowed the custom of receiving their emperors in the public places from the Romans. Luitprand relates, that at a procession where he was present, they sung to the Emperor Nicephorus, πολλα ετεα; that is, *many years;* which Coddin expresses thus, by το ψαλλειν το πολυχρονιον, or by το πολυχρονιζειν; and the wish or salutation by πολυχρονισμα. And at dinner, the Greeks then present wished with a loud voice to the emperor and Bardas, *Ut Deus annos multiplicet*, as he translates the Greek. Plutarch mentions an acclamation so loud, upon occasion of Flaminius's restoring liberty to Greece, that the very birds fell from heaven with the shout. The Turks practise something like this, on the sight of their emperors and grand viziers, to this day.



For the acclamations with which authors, poets, &c. were received, who recited their works in public; it is to be observed, the assemblies for this purpose were held with great parade in the most solemn places, as the Capitol, temples, the Athenæum, and the houses of great men. The chief care was that the acclamations might be given with all the order and pomp possible. Men of fortune who pretended to wit, kept able applauders in their service, and lent them to their friends. Others endeavoured to gain them by presents and treats. Philostratus mentions a young man named Vavus, who lent money to the men of letters, and forgave the interest to such as applauded his exercises. These acclamations were conducted much after the same manner as those in the theatre, both as to the music and the accompaniments: they were to be suited both to the subject and to the person. There were particular ones for the philosophers, for orators, for historians, and for poets. It would be difficult to rehearse all the forms of them; one of the most usual was *Sophos*, which was to be repeated three times. Martial comprehends several other usual forms in this verse:

*Graviter, Cito, Nequiter, Euge, Beate.*

Neither the Greeks nor Romans were barren on this head. The names of gods and heroes were given to those whom they would extol. It was not enough to do it after each head of discourse, chiefly after the exordium; but the acclamations were renewed at every fine passage, frequently at every period.

The acclamations with which the spectators honoured the victories of the athletæ, were a natural consequence of the impetuous motions which attended the gymnastic games. The cries and acclamations of the people, sometimes expressing their compassion and joy, sometimes their horror and disgust, are strongly painted by different poets and orators.

Acclamations made also a part of the ceremony of marriage. They were used for the omen's sake, being the *Læta Omina* sometimes spoken of before marriage in Roman writers.

Acclamations, at first practised in the theatre, and passing thence to the senate, &c. were, in process of time, received into the acts of councils, and the ordinary assemblies of the church. The people expressed their approbation of the preacher variously; the more usual forms were, *Orthodox! Third Apostle*, &c. These acclamations being sometimes carried to excess, and often misplaced, were frequently prohibited by the ancient doctors, and at length abrogated; though they appear to have been in some use about the time of St Bernard.

*ACCLAMATION MEDALS*, among *Antiquaries*, such as represent the people expressing their joy in the posture of acclamation.

ACCLIVITY, the rise or ascent of a hill, in opposition to the declivity or descent of it. Some writers on fortification use it for the talus of a rampart.

ACCOLA, among the Romans, signified a person who lived *near* some place; in which sense it differed from *incola*, the *inhabitant* of such a place.

ACCOLADE, a ceremony anciently used in the conferring of knighthood.

Antiquaries are not agreed wherein the accolade properly consisted. The generality suppose it to be the embrace or kiss which princes anciently gave the new knight, as a token of their affection: whence the word accolade; q. d. a clasping, or taking round the neck. Others will rather have it to be a blow on the chine of the neck, given on the same occasion. The Accolade is of some antiquity, in whichsoever of the two senses it be taken. Gregory of Tours writes, that the kings of France, even of the first race, in conferring the gilt shoulder-belt, kissed the knights on the left cheek. For the *accolée*, or blow, John of Salisbury assures us it was in use among the ancient Normans; by this it was that William the Conqueror conferred the honour of knighthood on his son Henry. At first it was given with the naked fist, but was afterwards changed into a blow with the flat of the sword on the shoulder of the knight.

ACCOLÉE, sometimes synonymous with ACCOLADE. It is also used in various senses in heraldry: sometimes it is applied to two things joined; at other times, to animals with crowns, or collars about their necks, as the lion in the Ogilvys' arms; and lastly to keys, batoons, maces, swords, &c., placed saltierwise behind the shield.

ACCOLTI, BENEDICT, better known among jurists by the name of ARETINUS, was born at Arezzo in 1415. He became a professor of law at Florence; and having been admitted a citizen, was elected chancellor of the republic in 1459. His death took place in 1466. He wrote in Latin a treatise concerning the war which the Christians carried on against the infidels to recover Judea and the holy sepulchre. This work is the ground-plot of Tasso's *Jerusalem Delivered.* It only includes, however, the history of the first crusade. He also wrote an account of the *Excellent Personages of his Time*, in the form of a dialogue.

ACCOLTI, *Francis*, brother of Benedict. See P. ARETINO.

ACCOMAC, a county in the *Tidewater* district of Virginia, U.S., North America, containing in 1850 a population of 17,861.

ACCOMMODATION, the application of one thing, by analogy, to another; or the making two or more things agree with one another. To know a thing by *accommodation*, is to know it by the idea of a similar thing referred thereto.

A prophecy of Scripture is said to be fulfilled in various ways: properly, as when a thing foretold comes to pass; and improperly, or by way of *accommodation*, when an event happens to any place or people, like to what fell out some time before to another. Thus, the words of Isaiah, spoken to those of his own time, are said to be fulfilled in those who lived in our Saviour's, and are *accommodated* to them: "Ye hypocrites, well did Esaias prophesy of you," &c.; which same words St Paul afterwards *accommodates* to the Jews of his time.

The primitive church *accommodated* multitudes of Jewish, and even Heathen ceremonies and practices, to Christian purposes; but the Jews had before done the same by the Gentiles: some will even have circumcision, the tabernacle, brazen serpent, &c. to have been originally of Egyptian use, and only *accommodated* by Moses to the purposes of Judaism.[1] Spencer maintains, that most of the rites of the old law were in imitation of those of the Gentiles, and particularly of the Egyptians; that God, in order to divert the children of Israel from the worship they paid to their false deities, consecrated the greater part of the ceremonies performed by those idolators, and had formed out of them a body of the ceremonial law; that he had indeed made some alterations therein, as barriers against idolatry; and that he thus *accommodated* his worship to the genius and occasions of his ancient people. To this condescension of God, according to Spencer,[2] is owing the origin of the tabernacle, and particularly that of the ark. These opinions, however, have been controverted by later writers.

ACCOMMODATION PAPER. See EXCHANGE.

[1] Saurin, *Diss. O. T* tom. i.

[2] *De Legibus Hebr.* diss. 1. l. 3. p. 32.



ACCOMPANIMENT, ACCOMPAGNAMENTO, ACCOMPAGNATURA, in *Music.* See MUSIC.

ACCOMPANIMENT, in *Painting*, denotes such objects as are added, either by way of ornament or fitness, to the principal figures; as dogs, guns, game, &c. in a hunting piece.

ACCOMPANIMENT, in *Heraldry*, any thing added to a shield by way of ornament; as the belt, mantling, supporters, &c. It is also applied to several bearings about a principal one; as a saltier, bend, fesse, chevron, &c.

ACCOMPLICE, one that has a hand in a business, or is privy in the same design or crime with another. The Council of Sens, and the statutes of several other synods, expressly prohibit the revealing of *accomplices.*

ACCOMPLISHMENT, the entire execution or fulfilling of any thing.

ACCORD, in *Painting*, is used to express the harmony that reigns among the lights and shades of a picture. See the article PAINTING.

ACCORDION, a musical instrument. For its principle see MUSIC.

ACCORSO (in Latin *Accursius*), FRANCIS, an eminent lawyer, born at Florence about 1182. He began the study of law at a late period of life; but such were his assiduity and proficiency, that he soon distinguished himself. He was appointed professor at Bologna, and became a very eminent teacher. He undertook the great work of uniting and arranging into one body the almost endless comments and remarks upon the Code, the Institutes, and Digests, all which tended to involve the subjects in obscurity and contradiction. When he was employed in this work, it is said that, hearing of a similar one proposed and begun by Odofred, another lawyer of Bologna, he feigned indisposition, interrupted his public lectures, and shut himself up, till he had, with the utmost expedition, accomplished his design. His work has the vague title of the *Great Gloss.* The best edition of it is that of Godefroi, published at Lyons in 1589, in 6 vols. folio. Accursius was greatly extolled by the lawyers of the twelfth and thirteenth centuries, but those of the fourteenth and of the sixteenth formed a much lower estimate of his merits. There can be no doubt that he has disentangled with much skill the sense of many laws; but it is equally undeniable that his ignorance of history and antiquities has often led him into absurdities, and been the cause of many defects in his explanations and commentaries. He is said to have lived in opulence, and died at Bologna in 1260, in the seventy-eighth year of his age. His eldest son, Francis, who filled the chair of law at Bologna with great reputation, was invited to Oxford by King Edward I., and in 1275 or 1276 read lectures on law in that university. In 1280 he returned to Bologna, where he died in 1321.

ACCORSO, or ACCURSIUS, *Mariangelo*, a learned and ingenious critic, was a native of Aquila, in the kingdom of Naples, and lived about the beginning of the sixteenth century. To a perfect knowledge of Greek and Latin he added an intimate acquaintance with several modern languages. Classical literature was much improved and promoted by his labours. In discovering and collating ancient manuscripts he displayed uncommon assiduity and diligence. His work entitled *Diatribæ in Ausonium, Solinum, et Ovidium*, printed at Rome, in folio, in 1524, is a singular monument of erudition and critical skill. He bestowed, it is said, unusual pains on Claudian, and made above seven hundred corrections on the works of that poet, from different manuscripts. Unfortunately the world has been deprived of the advantage of these criticisms, for they were never published. An edition of *Ammianus Marcellinus*, which he published at Augsburg in 1533, contains five books more than any former one. He was the first editor of the *Letters of Cassiodorus*, with his *Treatise on the Soul.* The affected use of antiquated terms, introduced by some of the Latin writers of that age, is humorously ridiculed by him, in a dialogue published in 1531, entitled *Osco, Volsco, Romanaque Eloquentia Interlocutoribus, Dialogus Ludis Romanis actus.* It was republished at Rome in 1574, in 4to, with his name. He was also the author of a poem entitled *Protrepticon ad Corycium*, published in a scarce collection named *Coryciana*, printed at Rome in 1524. Accorso had been accused of plagiarism in his notes on Ausonius; and the solemn and determined manner in which he repelled this charge of literary theft, presents us with a singular instance of his anxiety and care to preserve his literary reputation unstained and pure. It is in the following oath: "In the name of gods and men, of truth and sincerity, I solemnly swear, and if any declaration be more binding than an oath, I in that form declare, and I desire that my declaration may be received as strictly true, that I have never read or seen any author from which my own lucubrations have received the smallest assistance or improvement; nay, that I have even laboured, as far as possible, whenever any writer has published any observations which I myself had before made, immediately to blot them out of my own works. If in this declaration I am forsworn, may the pope punish my perjury; and may an evil genius attend my writings, so that whatever in them is good, or at least tolerable, may appear to the unskilful multitude exceedingly bad, and even to the learned trivial and contemptible; and may the small reputation I now possess be given to the winds, and regarded as the worthless boon of vulgar levity."

ACCOUNT, or ACCOMPT, in a general sense, a computation or reckoning of any thing by numbers.—Collectively, it is used to express the books which merchants, traders, bankers, &c. use for recording their transactions in business.

ACCOUNTS, *Chamber of*, in the French polity, a sovereign court of great antiquity, which took cognizance of and registered the accounts of the king's revenue; nearly the same with the English *Court of Exchequer*.

ACCOUNTANT, or ACCOMPTANT, in the most general sense, is a person skilled in accounts. In a more restricted sense, it is applied to a person or officer appointed to keep the accounts of a public company or office.

ACCOUNTANT-GENERAL, an officer in the court of chancery, appointed by Act of Parliament to receive all moneys lodged in court, instead of the masters, and convey the same to the Bank of England for security. There is also an accountant-general in the Irish Chancery, and one in Scotland, who has charge of the accounts of the Court of Session.

ACCRETION, among civilians, the property acquired in a vague or unoccupied thing, by its adhering to or following another already occupied: thus, if a legacy be left to two persons, one of whom dies before the testator, the legacy devolves to the survivor by right of accretion.

ACCROCHE, in *Heraldry*, denotes a thing's being hooked with another.

ACCUBATION, a posture of the body, between sitting and lying. The word comes from the Latin *accubare*, compounded of *ad*, to, and *cubo*, I lie down. *Accubation*, or *Accubitus*, was the table posture of the Greeks and Romans; whence we find the words particularly used for the lying, or rather (as we call it) sitting down to meat. The Greeks introduced this posture. The Romans, during the frugal ages of the republic, were strangers to it; but as luxury got footing, this posture came to be adopted, at least by the men; for as to women, it was reputed an indecency in them to lie down among the men, though afterwards this too was got over. Children did not lie down, nor servants, nor soldiers, nor persons of meaner condition. They took their meals sitting, as a posture less indulgent. The Roman manner of disposing themselves at table was this:—A low round table was placed in the *cænaculum*, or dining-room, and about this, usually three, sometimes only two, beds or couches; and, according to their number, it was called *biclinium* or *triclinium*. These were covered with a sort of bedclothes, richer or plainer, according to the quality of the person, and furnished with quilts and pillows, that the guests might lie the more commodiously. There were usually three persons on each bed; to crowd more was esteemed sordid. In eating, they lay down on their left sides, with their heads resting on the pillows, or rather on their elbows. The first lay at the head of the couch, with his feet extended behind the back of the second; the second lay with the back of his head towards the navel of the first, only separated by a pillow, his feet behind the back of the third; and so of the third or fourth. The middle place was esteemed the most honourable. Before they came to table, they changed their clothes, putting on what they called *cænatoria vestis*, the dining garment; and pulled off their shoes, to prevent soiling the couch. In the time of the emperors, couches higher and softer than the *triclinia*, called *accubita*, came into use, the clothes and pillows of which were termed *accubitalia*. Accubation at meals was also a Jewish practice, as we learn from Josephus, and from a passage in the gospel of St John xiii. 24, 26.



ACCUBITOR, an ancient officer of the court of Constantinople, who lay near the emperor. He was the head of the youth of the bed-chamber, and had the *cubicularius* and *procubitor* under him.

ACCUMULATION, in a general sense, the act of heaping or amassing things together. Among lawyers it is used in speaking of the concurrence of several titles to the same thing, or of several circumstances to the same proof.

ACCUMULATION *of Degrees*, in a university, is the taking of several of them together, or at shorter intervals than usual, or than is allowed by the rules of the university.

ACCUMULATION *of Wealth*. See POLITICAL ECONOMY.

ACCURSED, something that lies under a curse, or sentence of excommunication.—In the Jewish idiom, *accursed* and *crucified* were synonymous. Among them, every one was accounted *accursed* who died on a tree. This serves to explain the difficult passage in Rom. ix. 3, where the apostle Paul wished himself *accursed after the manner of Christ, i.e.* crucified, if happily he might, by such a death, save his countrymen. The preposition απο, here made use of, is used in the same sense, 2 Tim. i. 3, where it obviously signifies *after the manner of*.

ACCUSATION, the charging of any person with a criminal action, either in one's own name or in that of the public. The word is compounded of *ad*, to, and *causari*, to plead.

Writers on politics treat of the benefit and the inconveniences of public accusations. Various arguments are alleged both for the encouragement and discouragement of accusations against great men. Nothing, according to Machiavel, tends more to the preservation of a state than frequent accusations of persons intrusted with the administration of public affairs. This, accordingly, was strictly observed by the Romans in the instance of Camillus, accused of corruption by Manlius Capitolinus, &c. Accusations, however, in the judgment of the same author, are not more beneficial than calumnies are pernicious; which is also confirmed by the practice of the Romans. Manlius, not being able to make good his charge against Camillus, was cast into prison.

By the Roman law, there was no public accuser for public crimes; every private person, whether interested in the crime or not, might accuse, and prosecute the accused to punishment or absolution. Cato, the most innocent person of his age, had been accused 42 times, and as often absolved.

But the accusation of *private* crimes was never received but from the mouths of those who were immediately interested in them: None (*e. g.*) but the husband could accuse his wife of adultery.

The ancient Roman lawyers distinguished between *postulatio, delatio*, and *accusatio*. For, first, leave was desired to bring a charge against one, which was called *postulare:* then he against whom the charge was laid was brought before the judge, which was called *deferre*, or *nominis delatio:* lastly, the charge was drawn up and presented, which was properly the *accusatio*. The accusation properly commenced, according to Pedianus, when the *reus* or party charged, being interrogated, denied he was guilty of the crime, and subscribed his name to the *delatio* made by his opponent.

In Britain, by Magna Charta, no man shall be imprisoned or condemned on any accusation, without trial by his peers or the law; none shall be vexed with any accusation, but according to the law of the land; and no man shall be molested by petition to the king, &c. unless it be by indictment or presentment of lawful men, or by process at common law. Promoters of suggestions are to find surety to pursue them, and if they do not make them good, shall pay damages to the party accused, and also a fine to the king. No person is obliged to answer upon oath to a question whereby he may accuse himself of any crime.

ACCUSATIVE, in *Latin Grammar*, is the fourth case of nouns, and signifies the relation of the noun on which the action implied in the verb terminates; and hence, in such languages as have cases, these nouns have a particular termination, called *accusative*, as, *Augustus vicit Antonium*, Augustus vanquished Antony. Here *Antonium* is the noun on which the action implied in the word *vicit* terminates, and therefore must have the accusative termination. See Grammar.

ACELDAMA, the field purchased with the money for which Judas betrayed Christ, and which was appropriated as a place of burial for strangers. It was previously a "potter's field." The field now shewn as Aceldama lies on the slope of the hills beyond the valley of Hinnom, south of Mount Zion. This is obviously the spot which Jerome points out (*Onomast. s. v.* "Acheldamach,") and which has since been mentioned by almost every one who has described Jerusalem.

ACENTETUM, or Acenteta, in *Natural History*, a name given by the ancients to the purest and finest kind of rock-crystal.

ACEPHALA, Cuvier's class of *Mollusca*, so called from the animals' having no head (α, and κεφαλη).

ACEPHALI, or Acephalitæ, a term applied to several sects who refused to follow some noted leader. Thus, the persons who refused to follow either John of Antioch or St Cyril, in a dispute that happened in the Council of Ephesus, were termed *Acephali*, without a head or leader. Such bishops, also, as were exempt from the jurisdiction and discipline of their patriarch, were styled *Acephali*.

Acephali, the levellers in the reign of King Henry I., who acknowledged no head or superior. They were reckoned so poor, that they had not a tenement by which they might acknowledge a superior lord.

ACEPHALOUS, or Acephalus, in a general sense, without a head. The term is more particularly used in speaking of certain nations or people, represented by ancient naturalists and cosmographers, as well as by some modern travellers, as formed without heads; their eyes, mouth, &c. being placed in other parts. Such are the Blemmyes, a nation of Africa, near the head of the Niger, represented thus by Pliny and Solinus: *Blemmyis traduntur capita abesse, ore et oculis pectori affixis.* Ctesias and Solinus mention others in India, near the Ganges, *sine cervice, oculos in humeris habentes.* Mela also speaks of people, *quibus capita et vultus in pectore sunt.* And Suidas, Stephanus Byzantinus, Vopiscus, and others after them, relate the like. Some modern travellers have pretended to find acephalous people in America.

Acephalus, an obsolete term for the tænia or tapeworm, which was long supposed to be acephalous. The first who gave it a head was Tulpius, and after him Fehr: the former even makes it *biceps*, or two-headed.

Acephalus is also used to express a verse defective in the beginning.

ACER, the Maple Tree, a genus of trees; of which *A. campestre*, the maple, and *A. saccharinum*, are the best known. *A. pseudoplatanus* is a lofty tree, which is chiefly found native in the south of Europe, but several varieties grow in Britain.

ACERB, a sour rough astringency of taste, such as that of unripe fruit.

ACERENZA, a town of the kingdom of Naples, in the province of Basilicata, 80 miles east from Naples, containing 3600 inhabitants; anciently *Acherontia.—Hor. Carm. l.* 3. iv.

ACERINA, in *Ichthyology*, a name given by Pliny and other old naturalists to the fish we call the *ruffe*.

ACERNO, a town of Italy, in the citerior principality of Naples, with a bishop's see, and 2500 inhabitants. It is situated 14 miles north-east of Salerno, in Long. 15. 4. E. Lat. 40. 45. N.

ACERRA, in *Antiquity*, an altar erected among the Romans, near the bed of a person deceased, on which his friends daily offered incense till his burial. The real intention probably was to overcome any offensive smell that might arise about the corpse. The Chinese have still a custom like this: they erect an altar to the deceased in a room hung with mourning, and place an image of the dead person on the altar, to which every one that approaches it bows four times, and offers oblations and perfumes.

The *acerra* also signified a little pot, wherein were put the incense and perfumes to be burnt on the altars of the gods and before the dead. It appears to have been the same with what was otherwise called *thuribulum* and *pyxis*.

The Jews had their *acerræ*, in our version rendered *censers;* and the Romanists still retain them under the name of *incense pots*. In Roman writers we frequently meet with *plena acerra*, a full acerra; to understand which, it is to be observed, that people were obliged to offer incense in proportion to their estate and condition; the rich in larger quantities, the poor only a few grains: the former poured out full *acerræ* on the altar, the latter took out two or three bits with their fingers.

Acerra, a town of Italy, in the kingdom of Naples, and in the Terra di Lavoro, seated on the river Agno, 7 miles north-east of Naples; anciently *Acerræ*. It contains 6300 inhabitants. Long. 14. 23. E. Lat. 40. 55. N.

ACESAS, of Salamis in Cyprus, was famed for his skill in weaving and embroidery; but especially so for the peplus or mantle which, with the assistance of his son Helicon, he made for the Athena Polias. This peplus is mentioned by Euripides (*Hecuba*, 468.), and by Plato (*Euthyphron*, § 6.) See Athenæus, ii.

ACESCENT, a word used to denote any thing which is turning sour, or which is slightly acid. It is only applied properly to the former of these two meanings. The second may be expressed by either of the two words *acidulous* or *sub-acid*.

ACESINES, in *Ancient Geography*, a large and rapid river of India, which Alexander passed in his expedition into that country. The kingdom of Porus, which was conquered by Alexander, lay between the Hydaspes and this river, which, uniting with the former and other considerable rivers, pours its waters into the Indus. According to Major Rennell, the modern Chunab is the Acesines of the ancients.

ACESIUS, a bishop of Constantinople in the reign of Constantine, was a rigid adherent to the Novatian doctrines, according to which those whom persecutions had shaken from the faith, or who were guilty of any mortal sin after baptism, could not be admitted to the communion of the church, even after exhibiting the most convincing proofs of sincere repentance. Constantine, who was extremely displeased with the severity of this rigid sect, in discouraging and rejecting repentance, is said to have thus expressed himself: "Then, Acesius, make a ladder for yourself, and go up to heaven alone."

ACESTES, son of Egesta, or Segesta, and the river-god Crimisus, the reputed founder of the town of Segesta, and the entertainer of Æneas on his arrival in Sicily.

ACESTOR, surnamed Sacas, a tragic poet at Athens, of Thracian or Mysian origin, contemporary with Aristophanes.

Acestor, a sculptor of Cnossus mentioned by Pausanias, vi. 17.

Acestor, a surname of Apollo, as patron of the healing art; derived from ἀκέομαι, to heal.

ACETABULUM, in antiquity, a measure used by the ancients, equal to one-eighth of our pint. It seems to have acquired its name from a vessel in which acetum or vinegar was brought to their tables, and which probably contained about this quantity.

Acetabulum, in *Anatomy*, a cavity in any bone for receiving the protuberant head of another, and thereby forming that species of articulation called Enarthrosis.

Acetabulum, in *Botany*, the trivial name of a species of the peziza, or cup peziza, a genus belonging to the cryptogamia fungi of Linnæus. It has got the name of *acetabulum* from the resemblance its leaves bear to a cup.

ACETAL, the basis of Acetous Acid or vinegar, consisting of eight atoms of carbon, nine of hydrogen, and three of oxygen. The compounds of Acetic Acid with various bases are termed Acetates. It is the Acetic Acid of chemists. See Chemistry.

ACETARY. Grew, in his *Anatomy of Plants*, applies this term to a pulpy substance in certain fruits, *e. g.* the pear, which is inclosed in a congeries of small calculous bodies towards the base of the fruit, and is always of an acid taste.

ACETOMETER, a barbarous word used by chemists for an instrument to determine the strength of vinegar. It should be *Oxometer*.

ACETOSA, Sorrel; by Linnæus joined to the genus *Rumex*.

ACETOSELLA, in *Botany*, a species of Oxalis.

ACHÆA, in *Ancient Geography*, a town of the island of Rhodes, in the district of Ialysus, and the first and most ancient of all; said to be built by the Heliades, or grandsons of the sun.

ACHÆANS, the inhabitants of Achaia Propria, a Peloponnesian state. This republic was not considerable, in early times, for the number of its troops, nor for its wealth, nor for the extent of its territories; but it was famed for its probity, its justice, and its love of liberty. Its high reputation for these virtues was very ancient. The Crotonians and Sybarites, to re-establish order in their towns, adopted the laws and customs of the Achæans. After the famous battle of Leuctra, a difference arose betwixt the Lacedemonians and Thebans, who held the virtue of this people in such veneration, that they terminated the dispute by their decision. The government of the Achæans was democratical. They preserved their liberty till the time of Philip and Alexander; but in the reign of these princes, and afterwards, they were either subjected to the Macedonians, who had made themselves masters of Greece, or oppressed by domestic tyrants. The Achæan commonwealth consisted of twelve inconsiderable towns in Peloponnesus. Towards the 124th Olympiad, about the time when Ptolemy Soter died, and when Pyrrhus invaded Italy, the republic of the Achæans recovered its old institutions and unanimity. This was the renewal of the ancient confederation, which subsequently became so famous under the name of the Achæan League; having for its object, not as formerly a common worship, but a substantial political union. Though dating from the year B.C. 280, its importance may be referred to its connection with Aratus of Sicyon about 30 years later,—as it was further augmented by the splendid abilities of Philopœmen. Thus did this people, so celebrated in the heroic age, once more emerge from comparative obscurity, and become the greatest among the states of Greece in the last days of its national independence. The inhabitants of Patræ and of Dymæ were the first assertors of ancient liberty. The tyrants were banished, and the towns again made one commonwealth. A public council was then held, in which affairs of importance were discussed and determined. A register was appointed to record the transactions of the council. This assembly had two presidents, who were nominated alternately by the different towns. But instead of two presidents, they soon elected but one. Many neighbouring towns, which admired the constitution of this republic, founded on equality, liberty, the love of justice, and of the public good, were incorporated with the Achæans, and admitted to the full enjoyment of their laws and privileges.—*Thirlwall, Hist. of Greece. Helwing, Geschichte der Achaïschen Bundes.*



ACHÆMENES, the ancestor of the Persian kings, and founder of the Achæmenidæ, which was the most illustrious family of the Pasargadæ, the noblest of the Persian tribes. He is said to have been nourished by an eagle. The unbroken line of succession of this family of kings is given in Herodotus, lib. vii. 11, where Xerxes declares himself sprung "from Darius, son of Hystaspes, son of Arsames, son of Ariaramnes (Αρμνεώς), son of Teïspes, son of Cyrus, son of Cambyses, son of Teïspes, son of Achæmenes." The adjective *Achæmenius* is sometimes used by the Roman poets in the sense of *Persian.—Hor. od.* iii. 44. *Epod.* xiii. 8.

Achæmenes, son of Darius I. king of Persia, and brother of Xerxes, had the government of Egypt bestowed on him, after Xerxes had forced the Egyptians to return to their allegiance. He some time after commanded the Egyptian fleet in the celebrated expedition which proved so fatal to all Greece. The Egyptians having again taken up arms after the death of Xerxes, Achæmenes was sent into Egypt to suppress the rebellion, but was vanquished by Inarus, chief of the rebels, succoured by the Athenians.

ACHÆUS, cousin-german to Seleucus Ceraunus and Antiochus the Great, kings of Syria, became a very powerful monarch, and enjoyed the dominions he had usurped for many years; but at last he was punished for his usurpations in a dreadful manner, in the year B.C. 214, as related by Polybius.[1]

[1] Lib. iv. 2; viii. 18.

Achæus, son of Xuthus, the mythical ancestor of the Achæans.

Achæus of Eretria, a tragic poet, born B.C. 484. In the satirical drama he displayed considerable abilities. The fragments of his pieces were published at Bonn, 1834.

ACHAIA, a name taken for that part of Greece which Ptolemy calls *Hellas*, the younger Pliny *Græcia*; afterwards called *Livadia*, now *Hellas Proper*.

*Achaia Propria*, anciently a small district in the north of Peloponnesus, running 65 miles along the bay of Corinth, and bounded on the west by the Ionian Sea, on the south by Elis and Arcadia, and on the east by Sicyonia. Its inhabitants were the *Achæans*, properly so called; its metropolis *Patræ*. It now forms part of the kingdom of Greece.

ACHAIA also denoted all those countries that joined in the Achæan league, reduced by the Romans to a province. Likewise the Peloponnesus.

ACHAIÆ *Presbyteri*, or the Presbyters of Achaia, were those who were present at the martyrdom of St Andrew the apostle, A.D. 59; and are said to have written an epistle in relation to it. Bellarmin, and several other eminent writers in the church of Rome, allow it to be genuine; while Du Pin and some others expressly reject it.

ACHAICUS, a follower of the apostle Paul. He, with Stephanas and Fortunatus, was the bearer of the First Epistle to the Corinthians. (1 Cor. xvi.)

ACHAIUS, king of Scotland, A.D. 788. See SCOTLAND.

ACHALALACTLI, a species of king-fisher.

ACHAN, the son of Carmi, of the tribe of Judah, at the taking of Jericho, concealed two hundred shekels of silver, a Babylonish garment, and a wedge of gold, contrary to the express command of God. This sin proved fatal to the Israelites, who were repulsed at the siege of Ai. In this dreadful exigence, Joshua prostrated himself before the Lord, and begged that he would have mercy upon his people. Achan was discovered by casting lots, and he and his children were stoned to death. This expiation being made, Ai was taken by stratagem. (Josh. vii. viii.)

ACHANE, an ancient Persian corn measure, containing 45 Attic medimni.

ACHARACA, anciently a town of Lydia, situate between Tralles and Nysa; in which were the temple of Pluto and the cave Charonium, where patients slept in order to obtain a cure.

ACHARD, CARL FRANZ, a Prussian chemist, born at Berlin, in 1754, who is chiefly known now by his process for extracting sugar from *beet-root*, in which Margraff had before detected its existence. In 1800 the French Institute voted him thanks for his paper, but considered his process of little value; until it was taken up by Napoleon in 1812, and tried at Rambouillet; since which it has been extensively carried on in France; but it is doubtful if it can ever compete with the produce of the sugar-cane, in a free market, though the sugar manufactured from it is very white, and belongs to the same kind of sugar as that from the sugar-cane. His other works are physico-chemical experiments on the adhesion of different bodies. Achard died in 1821.

ACHARNÆ, the principal demus of Atticæ, sixty stadia north of Athens, inhabited by the tribe Œneis. The Acharnians carried on an extensive traffic in charcoal, which they prepared from the wood of Mount Parnes, not far distant. The district was fertile, and the population warlike. One of the plays of Aristophanes is entitled 'The Acharnians.'—See LEAKE'S *Attica, p.* 35.

ACHAT, in *Law*, implies a purchase or bargain. And hence probably purveyors were called *Achators*, from their making bargains.

ACHATES, the faithful friend and companion of Æneas, celebrated in Virgil's Æneid.

ACHATES, in *Natural History*, the same as AGATE.

ACHATES, in *Ancient Geography*, a river in Sicily, now the *Dirillo;* which runs from north to south, almost parallel with the Gela, and not far from the ancient Selinus. *Plin.* It gave name to the achates, or agate, said to be first found there.

ACHAZIB, or ACHZIB, in *Ancient Geography*, a town of Galilee, in the tribe of Asher, nine miles from Ptolemais. —Also a town in the more southern parts of the tribe of Judah.

ACHEEN, an independent native state of Sumatra, in the Eastern Archipelago, situate on the north-western part of the island, and extending about 50 miles to the south-east. It is bounded by Tamiang on the eastern, and by the Sinkel river on the western coast of Sumatra. A commercial intercourse with Acheen has subsisted from the earliest period of British connection with the East. It was then a flourishing and extensive state, but subsequently declined from its importance, having become a prey to anarchy, from the contests of petty chiefs. Acheen is esteemed comparatively healthy, being more free from woods and swamps than most other portions of the island; and the fevers and dysenteries to which these are supposed to give occasion, are there said to be uncommon. The soil is light and fertile, and produces a variety of the finest fruits and vegetables; also rice and cotton in great plenty and perfection. Cattle are abundant, and reasonable in price. Though no longer the great mart of eastern commodities, it still carries on a considerable trade with the natives of that part of the continent of India termed the coast of Coromandel, who supply it with the cotton goods of their country, and receive in return gold dust, sapan wood, betel-nut, patch-leaf, a little pepper, sulphur, camphor, and benzoin. The country is supplied with Bengal opium, and also with iron, and many other articles of merchandise, by the European traders. Gold dust is collected in the mountains near Acheen, but the greater part is brought from the southern ports of Nalaboo and Soosoo. Sulphur is gathered from a volcanic mountain in the neighbourhood, which supplies their own consumption for the manufacture of gunpowder, and admits of a large exportation.

In their persons the Achenese differ from the rest of the Sumatrans, being taller, stouter, and of a darker complexion. They do not appear to be a distinct people, but are thought, with great appearance of reason, to be a mixture of Battas, Malays, and Moors from the west of India. In their dispositions they are more active and industrious than their neighbours; they possess more penetration and sagacity; have more general knowledge; and, as merchants, they deal upon a more extensive and liberal footing. Their religion is Mahometanism; and having a great number of mosques and priests, its forms and ceremonies are strictly observed. They speak a mixed language of Malay and Batta, with all the other jargons used by the eastern Mahommedans. In writing, they use the Malay character.

The monarchy is hereditary, and the king usually maintains a guard of 100 sepoys about his palace. When Acheen was a flourishing state, he ruled with despotic authority. There was, however, according to Mr Marsden, a grand council of the nation, which consisted of the sultan at its head; of four chief counsellors, and eight of a lower degree, who sat on the king's right hand; and of sixteen others who sat on his left. How far this council shares or controls the royal prerogative, does not seem to be ascertained. "At the king's feet," says Mr Marsden, "sits a woman, to whom he makes known his pleasure; by her it is communicated to an eunuch, who sits next to her; and by him to an officer, who then proclaims it aloud to the assembly. There are also present two other officers, one of whom has the government of the *bazaar* or market, and the other the superintending and carrying into execution the punishment of criminals. All matters relative to commerce and the customs of the port come under the jurisdiction of another functionary, who performs the ceremony of giving the *chap* or licence for trade; which is done by lifting a golden-hafted *kris* over the head of the merchant who arrives, and without which he dares not to land his goods. Presents, the value of which is become pretty regularly ascertained, are then sent to the king and his officers. If the stranger be in the style of an ambassador, the royal elephants are sent down to carry him and his letters to the monarch's presence; these being first delivered into the hands of an eunuch, who places them in a silver dish, covered with rich silk, on the baek of the largest elephant, which is provided with a machine for that purpose. Within about an hundred yards of an open hall where the king sits, the cavalcade stops, and the ambassador dismounts, and makes his obeisance by bending his body and lifting his joined hands to his head. When he enters the palace, if an European, he is obliged to take off his shoes; and having made a second obeisance, is seated upon a carpet on the floor, where *betel* is brought to him." The crown revenues, which fluctuate considerably, are derived from import and export duties levied on all goods. Monopolies, the approved resource of despotism, also afford a revenue. These are managed by the officer who has the superintendence of commerce, and who frequently uses his power as an instrument of extortion.

Acheen was first visited by Portuguese adventurers in 1509, after they had discovered the passage to the East Indies by the Cape of Good Hope. Hostilities immediately commenced with the inhabitants, and continued with various success, until the Portuguese lost Malacca in 1641. About the year 1586 the monarchy of Acheen attained to its greatest height of power and prosperity. It had a flourishing commerce; and the port of Acheen was crowded with vessels from all the Asiatic countries, which were allowed to carry on their trade with the most perfect security. About the year 1600, when the Dutch navigators had penetrated to these seas, some of their vessels which had entered the port of Acheen were nearly cut off by the treachery of the inhabitants. It was in 1602 that Acheen was first visited by the English ships under Captain Lancaster, where they were well received. In 1607, the reigning sultan having greatly extended his dominions on every side, assumed the title of sovereign. He had some correspondence with King James; and in answering one of his letters, he takes the title of King of Sumatra, and intimates to the king of England his wish that he would send out to him one of his countrywomen for a wife. The French visited Acheen in 1621 under Commodore Beaulieu. The Dutch were now become the powerful rivals of the Portuguese in the eastern seas. They succeeded in 1640, by the aid of their allies the Achenese, in wresting from them Malacca, which they had so long maintained. They afterwards commenced their encroachments on the Achenese, and reduced the extent of their ancient dominion, which, joined to the weakness of the government, occasioned the decline of the Achenese power. In 1641, the sultan Peducka Siri, who, though of a cruel disposition, was a powerful sovereign, died; and the Achenese monarchy continued in the female line till 1700, when a priest found means to acquire the supreme power. The country was agitated during the whole of the eighteenth century by anarchy, and the most sanguinary revolutions. In 1813, the state of Acheen, formerly so flourishing, was found with hardly any form of civil order existing, every port and village being occupied by petty usurpers, who subsisted by piracy and smuggling. At length, in 1815, the reigning monarch, Johawir Allum Shah, was deposed, and Syful Allum Shah, the son of a wealthy merchant of Prince of Wales Island, raised to the throne. But in 1818, the ex-king recovered his principality, and, in the following year, concluded a treaty of friendship and alliance with the East India Company. In 1824, the British government agreed to cede all their possessions in Sumatra to the King of the Netherlands, and entirely to withdraw British authority from the island. But in taking this step they were not unmindful of the interests of their ally, and in the course of the preliminary negotiations, a confident expectation had been expressed by the British plenipotentiaries, that no measures hostile to the king of Acheen would be adopted by the new possessor of Fort-Marlborough. The appeal was met in a liberal spirit on the part of the Dutch authorities, and an assurance frankly given that the Netherlands government would so regulate its relations with Acheen as to ensure uninterrupted security to the merchant and the sailor, and at the same time to preserve unimpaired the independence of the native state.



Acheen, the capital of the above state, is situate on a river at the north-western extremity of Sumatra, and about a league from the sea, where a road is formed, in which the shipping may be secure under the shelter of several islands. The town is indifferently built of bamboos and rough timber, and raised some feet from the ground on account of the overflow of the river in the rainy season. Its appearance and the nature of the buildings resemble the generality of the Malay bazaars, excepting that the superior wealth of this place has occasioned a great number of public edifices, which do not however possess the smallest pretensions to magnificence. The sultan's palace, which is the chief public building, is a very rude and uncouth piece of architecture, designed to resist the force of an enemy, and surrounded with a moat and strong walls, but without any regular plan, or any view to the modern system of military defence. Several pieces of ordnance are planted near the gate, some of which are Portuguese; but two were sent from England by James I., on which the founder's name and the date are still legible. Under the conditions of the treaty of 1819, already noticed, the British government were bound to furnish the king of Acheen with four brass field-pieces and a specified quantity of arms and military stores. The river on which the town is situate is not large; and the stream being divided into several channels, is rendered shallow at the bar. In the dry season it will not admit boats of any burden, much less large vessels, which lie without in the road formed by the islands off the point. The chief exports are, brimstone, betel-nut, ratans, benzoin, camphor, gold dust, pepper, and horses; the imports, opium, salt, piece-goods, muslin, &c. The town is estimated to contain about 8000 houses. Long. 95. 45. E. Lat. 5. 35. N. Marsden's *Sumatra*, Forrest's *Voyage*, Hamilton's *East India Gazetteer*, *Treaties and Engagements with Native Princes in Asia. Note addressed by British to the Netherlands Plenipotentiaries.* (E. T.)

ACHELOUS, in *Fabulous History*, wrestled with Hercules, for no less a prize than Dejanira, daughter of King Œneus; but as Achelous had the power of assuming all shapes, the contest was long dubious. At last, as he took that of a bull, Hercules tore off one of his horns, so that he was forced to submit, and to redeem it by giving the conqueror the horn of Amalthea, the same with the cornucopia, or horn of plenty; which Hercules, having filled with a variety of fruits, consecrated to Jupiter. Strabo interprets this fable as referring to the river Achelous, whose stream was so rapid, that it roared like a bull, and overflowed its banks; but Hercules, by confining it with embankments, broke off one of the horns, and so restored plenty to the country. *Tauriformis* is an ancient poetical epithet for rivers. See the next article.

Achelous, a river of Acarnania, which rises in Mount Pindus, and dividing Ætolia from Acarnania, falls into the Ionian Sea. It was formerly called *Thoas* from its impetuosity, and *king of rivers* (Homer), being the largest in Greece. It has a course of 130 miles. The epithet *Acheloius* is used for *Aqueus* (Virgil), the ancients calling all water *Achelous*, especially in oaths, vows, and sacrifices, according to Ephorus. It is now called *Aspro Potamo.* There was also a river in Arcadia, and another in Thessaly, of the same name.

ACHENWALL, Gottfried, a German writer, who obtained considerable celebrity from having first reduced statistics to a regular branch of study, and excited much of the attention of others to the subject. He was born at Elbing, in East Prussia, in October 1719. He studied, according to the custom of Germany, in several universities; and was at Jena, Halle, and Leipsic, before he took a degree at the last of those cities. He removed to Marburg in 1746, where he continued during two years to read lectures on history, and on the law of nature and of nations, and commenced those inquiries in statistics by which his name became known. In 1748 he removed to Göttingen, where he resided till his death in 1772. He was married in 1752 to a lady named Walther, who obtained some celebrity by a volume of poems published in 1750.

ACHER, a river in the grand duchy of Baden, rising in the Mummel lake, and falling into the Rhine between Lichtenau and Greffern.

ACHERN, the chief city of the bailiwick of the same name, in the Grand Duchy of Baden, on the river Acher, with 1750 inhabitants. Near this place a monument marks the spot where Marshall Turenne was killed by a random shot, in 1675.

ACHERNER, or ACHARNER, a star of the first magnitude, in the southern extremity of the constellation ERIDANUS, but invisible in our latitude.

ACHERON, feigned by the poets to have been the son of Ceres, whom she hid in hell for fear of the Titans, and turned into a river, over which souls departed were ferried on their way to Elysium.

ACHERON, in *Ancient Geography*, a river of Thesprotia, in Epirus; which, after forming the lake Acherusia, at no great distance from the promontory of Chimerium, falls into the sea opposite to the isle of Paxo.

ACHERON, or ACHEROS, a river of Bruttii in Italy, running from east to west, where Alexander, king of Epirus, was slain by the Lucani, being deceived by the oracle of Dodona, which bade him beware of Acheron.

ACHERSET, an ancient measure of corn, conjectured to be the same with our quarter, or eight bushels.

ACHERUSIA PALUS, a lake between Cumæ and the promontory Misenum, now *Il Lago della Collucia.* (Cluverius.) Some confound it with the *Lacus Lucrinus*, and others with the *Lacus Averni;* but Strabo and Pliny distinguish them.—Also a lake of Epirus, through which the Acheron runs.—There is also a cave of the same name, through which Hercules is fabled to have descended to hell to drag forth Cerberus.—A small lake, near Hermione, in Argolis, bore the same name; and mention is made of another Acherusian lake near Memphis in Egypt.

ACHERY, JEAN-LUC D', a learned Benedictine of the congregation of St Maur, was born at St Quentin, in Picardy, in 1609, and made himself famous by printing several works, which till then were only in manuscript: particularly, the Epistle attributed to St Barnabas; the Works of Lanfranc, archbishop of Canterbury; a collection of scarce and curious pieces, under the title of *Spicilegium, i. e.* Gleanings, in 13 volumes quarto. The prefaces and notes which he annexed to many of these pieces, show him to have been a man of genius and abilities. There was an edition of this valuable work published in 1725, in three volumes folio; but the editor appears to have taken some unwarrantable liberties with the learned prefaces of his author. Achery had some share in the pieces inserted in the first volumes of the Acts of the Saints of the order of St Benedict; the title whereof acquaints us that they were collected and published by him and Father Mabillon. After a very retired life, till the age of 76, he died at Paris the 29th of April 1685, in the abbey of St Germain in the Fields, where he had been librarian.

ACHIAR is a Malayan word, which signifies all sorts of fruits and roots pickled with vinegar and spice. The Dutch import from Batavia all sorts of achiar, but particularly that of BAMBOO, a kind of cane, extremely thick, which grows in the East Indies. It is preserved there, while still green, with very strong vinegar and spice; and is called *bamboo achiar.* The name changes according to the fruit with which the achiar is made.

ACHIAS, a Cuvierian and Fabrician genus of Dipterous insects.

ACHICOLUM is used express the *fornix, tholus,* or *sudatorium* of the ancient baths; which was a hot room where they used to sweat. It is also called *architholus.*

ACHILLA, ACHOLLA, or ACHULLA, an ancient town on the eastern coast of Africa Propria. Its site is now occupied by the ruins known as *El Aliah*, of a late date, but very extensive, among which has been found a curious bilingual inscription, in Phœnician and Latin. Barth, *Wanderungende*, vol. i. p. 176. Gesenius, *Monum. Phœnic.* p. 139.

ACHILLÆA, YARROW, MILFOIL, NOSEBLEED, or SNEEZEWORT.

ACHILLES, one of the greatest heroes of ancient Greece, was the son of Peleus and Thetis. He was a native of Phthia, in Thessaly. His mother, it is said, in order to consume every mortal part of his body, used to lay him every night under live coals, anointing him with ambrosia, which preserved every part from burning but one of his lips, owing to his having licked it. She dipped him also in the waters of the river Styx; by which his whole body became invulnerable, except that part of his heel by which she held him. But this opinion is not universal, nor is it a part of his character as drawn by Homer; for in the Iliad (B. xxi. 161.) he is actually wounded in the right arm by the lance of Asteropæus, in the battle near the river Scamander. Peleus afterwards intrusted him to the care of the centaur Chiron, who, to give him the strength necessary for martial toil, fed him with honey and the marrow of lions and wild boars. To prevent his going to the siege of Troy, she disguised him in female apparel, and hid him among the maidens at the court of King Lycomedes; but Ulysses discovering him, persuaded him to follow the Greeks. Achilles distinguished himself by a number of heroic actions at the siege. Being disgusted, however, with Agamemnon for the loss of Briseïs, he retired from the camp; but returning to avenge the death of his friend Patroclus, he slew Hector, fastened his corpse to his chariot, and dragged it round the walls of Troy. At last Paris, the brother of Hector, wounded him in the heel with an arrow, while he was in the temple treating about his marriage with Polyxena, daughter of King Priam. Of this wound he died, and was interred on the promontory of Sigæum; and after Troy was taken, the Greeks sacrificed Polyxena on his tomb, in obedience to his desire, that he might enjoy her company in the Elysian fields. It is said that Alexander, seeing this tomb, honoured it by placing a crown upon it; at the same time crying out, that "Achilles was happy in having, during his life, such a friend as Patroclus, and, after his death, a poet like Homer." Achilles is supposed to have died 1183 years before the Christian era.

ACHILLES *Tatius.* See TATIUS.

*TENDO-ACHILLIS*, in *Anatomy*, is a strong tendinous cord formed by the tendons of several muscles, and inserted into the os calcis. It has its name from the fatal wound Achilles is said to have received in that part from Paris, the son of Priam.

ACHILLEUS CURSUS (Ἀχιλλειος δρομος), in *Ancient Geography*, a narrow tongue of land near the mouth of the Borysthenes, where Achilles is said to have instituted races. Opposite to it was the celebrated ACHILLES INSULA, or LEUCE (*Serpent's Isle*), with a temple sacred to that hero. *Eurip. Iphig. in Taur.* 438.

ACHILLINI, ALEXANDER, was born at Bologna in 1463. He was celebrated as a lecturer both in medicine and philosophy, and was styled the Great Philosopher. Achil-

Achiotte || Achmet.

lini died in 1512. His philosophical works were printed in one volume folio, at Venice, in 1508, and reprinted with considerable additions in 1545, 1551, and 1568.

ACHIOTTE, or ACHIOTE, a foreign drug, used in dyeing, and in the preparation of chocolate. It is the same with the substance more usually known as ARNOTTO.

ACHIROPOETOS (α, χειρ, and ποιεω), a name given by ancient writers to certain miraculous pictures of Christ and the Virgin, supposed to have been made without hands. The most celebrated of these is the picture of Christ preserved in the church of St John Lateran at Rome; said to have been begun by St Luke, but finished by angels.

ACHLYS ('Αχλύς), in *Pagan Mythology*, the eternal night, more ancient than Chaos; described in Hesiod (*Scut. Herc.* 264,) as the personification of misery and sadness.

ACHMET, son of Seirim, an Arabian author, who wrote a book on the interpretation of dreams, which was translated into Greek and Latin. The original was supposed to be lost: but it seems probable that Achmet is the same person as Abú Bekr Mohammed Ben Sírín, who lived in the 7th century, and whose 'Ονειροκριτικά in Arabic is extant in the Royal Library at Paris.

ACHMET I., emperor of the Turks, the third son and successor of Mahomet III., ascended the throne before he reached the age of 15. During his reign, the Turkish empire underwent great reverses. The Asiatic rebels, who took refuge in Persia, involved the two empires in a war, during which the Turks lost Bagdad, to recover which every effort proved unsuccessful. In his reign, Transylvania and Hungary were the scenes of war between the Turks and Germans. In addition to the calamities and distresses of war abroad, and internal tumults and broils, a pretender to his throne disturbed his repose, and made attempts on his life. He was much devoted to amusements, and spent his time chiefly in the harem and in the sports of the field. He expended great sums of money in building, and particularly on the magnificent mosque which he erected in the Hippodrome. Achmet was less cruel than some of his predecessors, but he was haughty and ambitious. He died in 1617, at the age of 29.

ACHMET II., emperor of the Turks, son of Sultan Ibrahim, succeeded his brother Solyman in 1691. The administration of affairs during his reign was feeble and unsettled. The Ottoman territory was overrun by the imperialists; the Venetians seized the Morea, took the isle of Chios, and several places in Dalmatia; and the Arabs attacked and plundered a caravan of pilgrims, and even laid siege to Mecca. Though inefficient as a ruler, Achmet in private life was mild, devout, and inoffensive, fond of poetry and music, and amiable to those about his person. He died in 1695, at the age of 50.

ACHMET III., emperor of the Turks, son of Mahomet IV., succeeded his brother Mustapha II., who was deposed in 1703. After he had settled the discontents of the empire, his great object was to amass wealth. With this view he debased the coin, and imposed new taxes. He received Charles XII. of Sweden, who took refuge in his dominions after the battle of Pultowa in 1709, with great hospitality; and, influenced by the sultana mother, he declared war against the Czar Peter, Charles's formidable rival. Achmet recovered the Morea from the Venetians; but his expedition into Hungary was less fortunate, for his army was defeated by Prince Eugene at the battle of Peterwaradin in 1716. As the public measures of Achmet were influenced by ministers and favourites, the empire during his reign was frequently distracted by political struggles and revolutions. The discontent and sedition of his soldiers at last drove him from the throne. He was deposed in 1730, and succeeded by his nephew Mahomet V. He died in 1736, at the age of 74.

Achmet || Achromatic.

ACHMET GEDUC, a famous Turkish general in the fifteenth century. When Mahomet II. died, Bajazet and Zezan both claimed the throne. Achmet sided with the former, and by his bravery and conduct fixed the crown on his head. Bajazet, in accordance with the usual policy of tyrants, rewarded his too conspicuous merits by taking away his life.

ACHMIM, AKMIM, or ECHMIM, a town of Upper Egypt, situate in a very fertile district. The streets are better than is usual in Egypt, though, being built only of unburnt brick, they have a gloomy appearance. The Greeks have a church, which they hold in great veneration, and which is adorned with granite pillars from the ruins of the city of Chemnis or Panopolis. Pop. 3000.

ACHMITE (ἀκμή, a point), a mineral found in Norway, near Konigsberg, a silicate of soda and peroxide of iron.

ACHOR, a valley of Jericho, between it and Ai; so called from Achan, who was there stoned to death.

ACHOR, in *Medicine*, a species of HERPES.

ACHOR, in *Mythology*, the god of flies; to whom, according to Pliny, the inhabitants of Cyrene offered propitiatory sacrifices.

ACHRAS, a genus of plants, natural order *Sapoteæ*.

ACHRAY, a small but wildly picturesque lake in Perthshire, near Loch Katrine, 15 miles N.W. from Stirling.

ACHROMATIC, an epithet expressing want of colour. The word is Greek, being compounded of α privative, and χρωμα, *colour*.

*ACHROMATIC Telescopes* are telescopes contrived to remedy the aberrations in colours. The invention of the telescope, by which the powers of vision are extended to the utmost boundaries of space, forms an epoch in the history of science. The human intellect had at last emerged from the long night of error, and begun to shine with unclouded lustre. The age of erudition, which arose on the revival of letters, had been succeeded by the age of science and philosophy. The study of the ancient classics had infused some portion of taste and vigour. But men did not long remain passive admirers; they began to feel their native strength, and hastened to exert it. A new impulsion was given to the whole frame of society; the bolder spirits, bursting from the trammels of authority, ventured to question inveterate opinions, and to explore, with a fearless yet discerning eye, the wide fields of human knowledge. Copernicus had partly restored the true system of the world; Stevinus had extended the principles of mechanics; the fine genius of Galileo had detected and applied the laws of motion; the bold excursive imagination of Kepler had, by the aid of immense labour, nearly completed his discovery of the great laws which control the revolutions of the heavenly bodies; and our countryman Napier had just rendered himself immortal by the sublime discovery of logarithms. At this eventful period, amidst the fermentation of talents, the refracting telescope was produced by an obscure glass-grinder in Holland,—a country then fresh from the struggle against foreign oppression, and become the busy seat of commerce and of the useful arts. Yet the very name of that meritorious person, and the details connected with his invention, are involved in much obscurity. On a question of such peculiar interest we shall afterwards endeavour to throw some light, by comparing together such incidental notices as have been transmitted by contemporary writers. In the mean time, we may rest assured that the construction of the telescope was not, as certain authors would insinuate, the mere offspring of chance, but was, like other scientific discoveries, the fruit of close and patient observation of facts, directed with skill, and incited by an ardent curiosity. A new and perhaps incidental

Invention of the telescope.

Achromatic Glasses.

appearance, which would pass unheeded by the ordinary spectator, arrests the glance of genius, and sets all the powers of fancy to work. But the inventor of the telescope, we are informed, was acquainted besides with the elements of geometry, which enabled him to prosecute his views, and to combine the results with unerring success. No sooner was this fine discovery—admirable for the very simplicity of its principle—whispered abroad, than it fixed the attention of the chief mathematicians over Europe. Kepler, with his usual fertility of mind, produced a treatise on *Dioptrics*, in which he investigated at large the distinct effects of the combinations of different lenses.[1] Galileo, from some very obscure hints, not only divined the composition of the telescope, but actually constructed one, with a concave eye-glass, which still bears his name. This telescope is shorter, but gives less light than another one proposed by Kepler, and called the astronomical telescope, which inverts the objects, and consists likewise of only two lenses, that next the eye being convex. With such an imperfect instrument—the same, indeed, though of rather higher magnifying power, with our modern opera-glass—did the Tuscan artist, as our great poet quaintly styles the philosopher, venture to explore the heavens.[2] He noticed the solar spots, surveyed the cavernous and rocky surface of the moon, observed the successive phases of the planet Venus, and discovered the more conspicuous of Jupiter's satellites. The truths thus revealed shook the inveterate prejudices of the learned, and furnished the most triumphant evidence to the true theory of the universe.

It is painful to remark, that the application of the first telescope in the country which had given it birth was directed to a very different purpose. The maker, after having finished one, judging it of singular use in the military profession, was naturally induced, by the hope of patronage, to present it to the younger Prince Maurice, whose bravery and conduct had so beneficially contributed to the independence of the United Provinces. But at this moment a bloody tragedy was acting in Holland. The chief of the republic, not content with that high station which the gratitude of his fellow-citizens had conferred upon him, sought to aggrandize his power by crushing all opposition. In the prosecution of his ambitious designs, he artfully gained the favour of the undiscerning populace, and joining his intrigues to the violence of the Calvinistic clergy, he succeeded in preferring the charge of a plot against the more strenuous supporters of the commonwealth, which involved them in ruin. Not only was the celebrated Grotius condemned to the gloom of perpetual imprisonment, but the aged senator Barneveldt, whose wise and upright counsels had guided the state amidst all the troubles of a long revolutionary conflict, was led to the scaffold, on the 14th of May 1619, while his persecutor, ashamed to approach the spectacle of his sufferings, beheld at a distance, with the coolness of a tyrant, from the windows of his palace, and *by help of a telescope*, the gesture and aspect of the venerable patriot, and all the melancholy circumstances attending the decollation.[3]

Improvers of the telescope.

The skill and ingenuity of artists and mathematicians were now exerted in attempts to improve the construction of an instrument so fortunately contrived. The perfection of the telescope would require the union, as far as they are capable of being conjoined, of three different qualities,—distinctness of vision, depth of magnifying power, and extent of field. Of these requisites, the first two are evidently the most important, and to attain them was an object of persevering research. For the condition of amplitude and clearness, it was necessary that the principal image, or the one formed by the eye-glass, should be large, bright, and well defined. On the supposition then generally received, that, in the passage of light through the same media, the angle of incidence bears a constant ratio to the angle of refraction, which is very nearly true in the case of small angles, it followed, as a geometrical consequence, that the spherical figure would accurately collect all the rays into a focus. To obtain the desired improvement of the telescope, therefore, nothing seemed to be wanting but to enlarge sufficiently its aperture, or to employ for the eye-glass a more considerable segment of the sphere. On trial, however, the results appeared to be at variance with the hasty deductions of theory, and every sensible enlargement of aperture was found to occasion a corresponding glare and indistinctness of vision. But a discovery made soon afterwards in optics led to more accurate conclusions. Willebrord Snell, a very ingenious Dutch mathematician, who was snatched away at an early age, traced out by experiment, about the year 1629, the true law that connects the angles of incidence and of refraction; which the famous Descartes, who had about this time chosen Holland for his place of residence, published, in 1637, in his *Dioptrics*, under its simplest form, establishing, that the sines of those angles, and not the angles themselves, bore a constant ratio in the transit of light between the same diaphanous media. It hence followed, that the lateral rays of the light which enter a denser medium, bounded by a spherical surface, in the direction of the axis, will not meet this axis precisely in the same point, but will cross it somewhat nearer the surface. In short, the constant ratio or index of refraction will be that of the distances of the actual focus from the centre of the sphere, and from the point of external impact. Since an arc differs from its sine by a quantity nearly proportioned to its cube, the deviation of the extreme rays from the correct focus, or what is called the spherical aberration,

Snell.

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[1] Kepler explained the construction of the astronomical telescope with two convex lenses; he likewise proposed a third glass to restore the inverted image. But Scheiner first employed the astronomical telescope, and described his observations with it in 1630. Father Rheita placed the third lens of Kepler near the primary focus, and thus enlarged the field of view. Such is the arrangement in the common spy-glass, which he gave in 1665.

[2] ..................... like the moon, whose orb
Through optic glass the Tuscan artist views
At evening from the top of Fesolé,
Or in Valdarno, to descry new lands,
Rivers, or mountains, on her spotty globe. (*Paradise Lost*, book i. 286–290.)

[3] The discovery of the telescope, from the mystery at first practised, is involved in considerable uncertainty. The most probable statement, however, ascribes the invention so early as 1590 to Zachary Jansen, an intelligent spectacle-maker at Middleburg. This intelligent person, led by accident to exercise his ingenuity on the subject, appears to have in private matured the execution of that wonderful though simple instrument. In a short time, however, the secret had transpired; and Laprey or Lippersheim, a townsman of the same profession, produced telescopes for sale between the years 1600 and 1610. But, in 1608, Jansen likewise constructed the compound microscope; and both instruments, by the activity of trade, were now spread quickly over Europe. The telescope was copied, and perhaps improved, by Adrian Metius, son of the celebrated mathematician. It was publicly sold at Frankfort in 1608, and in the following year the instruments were brought by Drebbel for sale to London.

must likewise proceed in that ratio, and consequently will increase with extreme rapidity, as the aperture of the telescope is enlarged. It was now attempted to modify the figure of the object-glass, and to give it those curved surfaces which an intricate geometrical investigation marks out as fitted to procure a perfect concentration of all the refracted rays. Various contrivances were accordingly proposed for assisting the artist in working the lenses into a parabolic or spheroidal shape, and thus obtaining the exact surfaces generated by the revolution of the different conic sections. All those expedients and directions, however, were found utterly to fail in practice, and nature seemed, in this instance, to oppose insurmountable barriers to human curiosity and research. Philosophers began to despair of effecting any capital improvement in dioptrical instruments, and turned their views to the construction of those depending on the principles of catoptrics, or formed by certain combinations of reflecting specula. In 1663, the famous James Gregory, who in many respects may be regarded as the precursor, and in some things even the rival of Newton, published his *Optica Promota;* a work distinguished by its originality, and containing much ingenious research and fine speculation. In this treatise, a complete description is given of the reflecting telescope now almost universally adopted, consisting of a large perforated concave reflector combined with another very small and deep speculum placed before the principal focus. But such was still the low state of the mechanical arts in England, that no person was found capable of casting and polishing the metallic specula with any tolerable delicacy, and the great inventor never enjoyed the satisfaction and transport of witnessing the magic of his admirable contrivance. It was after the lapse of more than half a century, that Hadley—to whom we likewise owe another instrument scarcely less valuable, the quadrant, or sextant, known by his name—at last succeeded in executing the reflecting telescope. In the first attempt, silvered mirrors had been substituted for the specula; nor did the reflectors come to obtain much estimation, till, about the year 1733, the ingenious Mr Short distinguished himself by constructing them in a style of very superior excellence.

Gregory.

Hadley.

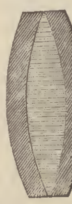
But though thus late in guiding the efforts of artists, the optical treatise of Gregory proved the harbinger of that bright day which soon arose to illumine the recesses of physical science. The capacious mind of Newton, nursed in the calm of retirement and seclusion, was then teeming with philosophical projects. In 1665, when the tremendous visitation of the plague raged in London, and threatened Cambridge and other places communicating with the capital, this sublime genius withdrew from the routine of the university to his rural farm near Grantham, and devoted himself to most profound meditation. Amidst his speculations in abstruse mathematics and theoretical astronomy, Newton was induced to examine the opinions entertained by the learned on the subject of light and colours. With this view he had recently procured from the Continent some prisms of glass, to exhibit the phenomena of refraction. Having placed the axis of the prism or glass wedge at right angles to a pencil of light from the sun, admitted through a small hole of the window-shutter in a darkened room, he contemplated the glowing image or spectrum now formed on the opposite wall or screen. This illuminated space was not round, however, as the young philosopher had been taught to expect, but appeared very much elongated, stretching out five times more than its breadth, and marked by a series of pure and brilliant colours. It was therefore obvious that the colours were not confined to the margin of the spectrum, nor could proceed from any varied intermixture of light and shade; and the conclusion seemed hence irresistible, that the white pencil, or solar beam, is really a collection of distinct rays, essentially coloured and differently refracted; that the ray, for instance, which gives us the sensation of the violet, is always more bent aside from its course by refraction than the ray which we term green,—and that this green ray again is more refracted than the red. When the spectrum was divided, by interposing partially a small screen, and each separate parcel of rays made to pass through a second prism, they still retained their peculiar colour and refractive property, but now emerged in parallel, and not in diverging lines as at first. The sun's light is thus decomposed by the action of the prism into a set of primary coloured rays; and these rays, if they be afterwards recombined in the same proportions, will always form a white pencil. It was hence easy to discern the real cause of the imperfection of dioptrical instruments, which is comparatively little influenced by the figure of the object-glass or spherical aberration, but proceeds mainly from the unequal refraction of light itself. The focal distance of the red ray being, in the most favourable case, about one fortieth part shorter than that of the violet ray, the principal image is necessarily affected with mistiness, and its margin always encircled by a coloured ring; for each point of the remote object from which the light arrives is not represented by a corresponding point in the image, but by a small circle composed of graduating colours, the centre being violet and the circumference red. This radical defect seemed at that time to be altogether irremediable. Newton had recourse, therefore, to the aid of catoptrics, and contrived his very simple though rather incommodious reflecting telescope, consisting of a concave speculum, with a small plane one placed obliquely before it, to throw the image towards the side of the tube. This instrument he actually constructed; and with all its rudeness, it promised essential advantages to astronomy. The Newtonian reflector, after having been long neglected, was lately revived by Dr Herschel; and from its great simplicity and moderate dissipation of light, it is perhaps on the whole not ill calculated for celestial observations.

Newton.

These unexpected and very important discoveries, which entirely changed the face of optics, were soon communicated to the Royal Society, and published in the *Philosophical Transactions* for 1672. They were not received however by the learned with that admiration to which they were justly entitled, but gave occasion to so much ignorant opposition and obstinate controversy, that the illustrious author, thoroughly disgusted at such unmerited reception, henceforth, pursuing his experimental researches in silence, made no disclosure of them to the world till more than thirty years afterwards, when his fame being mature, and his authority commanding respect, he suffered his *Treatise on Optics* to appear abroad. This celebrated production has long been regarded as a model of pure inductive science. The experiments which it relates appear ingeniously devised; the conclusions from them are drawn with acuteness, and pursued with exquisite skill; and the whole discourse proceeds in a style of measured and elegant simplicity. Though the researches were conducted by a process of strict analysis, the composition of the work itself is cast into the synthetical or didactic form, after the manner followed in the elementary treatises of the ancient mathematicians. But with all its beauty and undisputed excellence, it must be confessed that the treatise of optics is not exempt from faults, and even material errors. We should betray the interests of science, if we ever yielded implicit confidence even to the highest master. It is the glory of Newton to have led the way in sublime discovery, and to have impressed whatever he touched with the stamp of profound and original genius. The philosopher paid the debt of human infirmity, by imbibing some tincture of the mystical spirit of the age, and taking a slight bias from the character of his studies. The difficult art of experimenting was still in its infancy, and inquirers had not attained that delicacy and circumspection which, in practice, are indispensable for obtaining accurate results. Most of the speculations in the second and third books of Newton's *Optics*, as we shall afterwards have occasion to observe, are built on mistaken or imperfect views of some facts, which the admixture of extraneous circumstances had accidentally disguised. The very ingenious, but hasty, and often untenable hypotheses, which are subjoined, under the modest and seemingly hesitating title of *Queries*, have, on the whole, been productive of real harm to the cause of science, by the splendid example thus held forth to tempt the rashness of loose experimenters, and of superficial reasoners. Even in the first book of *Optics*, some of the capital propositions are affected by hasty and imperfect statements. The term *refrangibility*, applied to the rays of light, is at least unguarded; it conveys an indistinct conception, and leads to inaccurate conclusions. The different refractions which the primary rays undergo are not absolute properties inherent in these rays themselves, but depend on the mutual relation subsisting between them and the particular diaphanous medium. When the medium is changed, the refraction of one set of rays cannot be safely inferred from that of another. Nay, in the passage among certain media, those rays which are designated as the most refrangible will sometimes be the least refracted. To ascertain correctly, therefore, the index of refraction, it becomes necessary, in each distinct case, to examine the bearing or disposition of the particular species of rays; since the principle, that the refraction of the extreme rays is always proportioned to that of the mean rays, involves a very false conclusion.

When Newton attempted to reckon up the rays of light decomposed by the prism, and ventured to assign the famous number *seven*, he was apparently influenced by some lurking disposition towards mysticism. If any unprejudiced person will fairly repeat the experiment, he must soon be convinced, that the various coloured spaces which paint the spectrum slide into each other by indefinite shadings; he may name four or five principal colours, but the subordinate divisions are evidently so multiplied as to be incapable of enumeration. The same illustrious mathematician, we can hardly doubt, was betrayed by a passion for analogy, when he imagined, that the primary colours are distributed over the spectrum after the proportions of the diatonic scale of music, since those intermediate spaces have really no precise and defined limits. Had prisms of a different kind of glass been used, the distribution of the coloured spaces would have been materially changed. The fact is, that all Newton's prisms being manufactured abroad, consisted of plate or crown glass, formed by the combination of soda, or the mineral alkali, with silicious sand. The refined art of glass-making had only been lately introduced into England, and that beautiful variety called crystal, or flint-glass, which has so long distinguished this country, being produced by the union of a silicious material with the oxyde of lead, was then scarcely known. The original experimenter had not the advantage, therefore, of witnessing the varied effects occasioned by different prisms, which demonstrate, that the power of refraction is not less a property of the peculiar medium than of the species of light itself. He mentions, indeed, prisms formed with water confined by plates of glass; but the few trials which he made with them had evidently been performed with no sufficient attention. In spite of his habitual circumspection, he could not always restrain the propensity so natural to genius, that of hastening to the result, and of trusting to general principles more than to any particular details. But the same indulgent apology will not be conceded to some later authors. It is truly astonishing that systematic writers on optics, in obvious contradiction to the most undoubted discoveries related by themselves, should yet repeat with complacency the fanciful idea of the harmonical composition of light.

Admitting the general conclusion which Newton conceived himself entitled to draw from analogy and concurring experiment, that "the sine of incidence of every ray considered apart, is to the sine of refraction in a given ratio;" it was strictly demonstrable, that no contrary refractions whatever, unless they absolutely restored the pencil to its first direction, could collect again the extreme rays, and produce, by their union, a white light. Thus, let the ratios of the sines of the angles of incidence and refraction of the violet rays in their transit from air to other two denser mediums, be expressed by $1 : M$ and $1 : m$; and the like ratios of the red rays under the same circumstances, by $1 : N$ and $1 : n$; where $M\ m$ and $N\ n$ respectively denote the refracting indices of those extreme rays. It is manifest that the refracting indices, corresponding to the passage of the violet and red rays from the first to the second medium, will be represented by $M–N$, and $m–n$. But by hypothesis, $M : m :: N : n$, and consequently $M : m :: M–N : m–n$; so that the extreme rays would not be still separated and dispersed in proportion to the mean extent of the final refraction. The great philosopher appears to have contemplated with regret the result of his optical principle; and he had the penetration to remark, that if a different law had obtained, the proper combination of distinct refracting media would have corrected the spherical aberration. With this view, he would propose for the object-glass of a telescope, a compound lens, consisting of two exterior meniscuses of glass, their outsides being equally convex, and their insides of similar but greater concavity, and having the interior space filled with pure water, as in the figure annexed.



He gives a rule, though without demonstration, and evidently disfigured or imperfect, for determining the curvature of the two surfaces: "And by this means," he subjoins, "might telescopes be brought to sufficient perfection, were it not for the different refrangibility of several sorts of rays. But, by reason of this different refrangibility, I do not see any other means of improving telescopes by refractions alone, than that of increasing their lengths."

These remarks appeared to preclude all attempts to improve the construction of the refracting telescope. Brightness and range of sight were sacrificed to distinctness. Instead of enlarging the aperture, recourse was had to the expedient of increasing the length of the focus. For nice astronomical observations, telescopes were sought of the highest magnifying powers, and their tubes had by degrees been extended to a most enormous and inconvenient size. But the famous Dutch mathematician Huygens contrived to supersede the use of these in certain cases, by a method which required, however, some address. Many years afterwards the reflecting, or rather catadioptric telescope, of the Gregorian construction, was executed with tolerable perfection. But a long period of languor succeeded the brilliant age of discovery. Not a single advance was made in the science of light and colours, till thirty years after the death of

Huygens.

Achromatic Glasses.

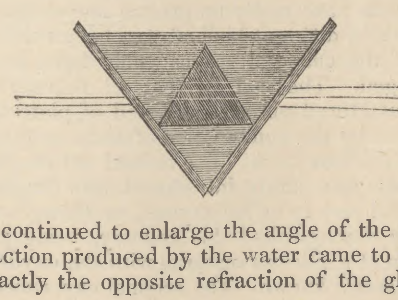
Newton.[1] His immortal *Principia* had not yet provoked discussion, and philosophers seemed inclined to regard the conclusions in the *Treatise of Optics* with silent and incurious acquiescence. This memorable fact not only evinces the danger of yielding, in matters of science, implicit confidence even to the highest authority, but shows, amidst all the apparent bustle of research, how very few original experiments are made, and how seldom these are repeated with the due care and attention.

The impossibility of correcting the colours in object-glasses of telescopes was therefore a principle generally adopted; though some vague hopes, grounded chiefly on the consideration of final causes, were still at times entertained of removing that defect. As the eye consists of two distinct humours, with a horny lens or cornea interposed, it was naturally imagined that such a perfect structure should be imitated in the composition of glasses. This inviting idea is concisely mentioned by David Gregory, the nephew of James, in his little tract on *Dioptrics*. It has also been stated that a country gentleman, Mr Hall of Chesterhall, in Worcestershire, discovered, about the year 1729, the proper composition of lenses by the united segments of crown and flint-glass, and caused a London artist, in 1733, to make a telescope under his directions, which was found on trial to answer extremely well. But whatever might be the fact, no notice was taken of it at the time, nor indeed till very long after, when circumstances had occurred to call forth public attention.

The Newtonian principle was first openly rejected, and a discussion excited, which eventually led to a most valuable discovery in optics, by a foreign mathematician of great celebrity and transcendent talents. Leonard Euler was one of those rare mortals who arise, at distant intervals, to shed unfading lustre on our species. Endowed with a penetrating genius and profound capacity, he was capable of pursuing his abstruse investigations with unremitting ardour and unwearied perseverance. To him the modern analysis stands chiefly indebted for its prodigious extension; and he continued to enrich it in all its departments with innumerable improvements and fine discoveries, during the whole course of a most active, laborious, and protracted life. Unfortunately the philosophical character of Euler did not correspond to his superlative eminence as a geometer. Bred in the school of Leibnitz, he had imbibed the specious but delusive metaphysics of the *sufficient reason*, and of the necessary and absolute constitution of the laws of nature. He was hence disposed in all cases to prefer the mode of investigating *a priori*, and never appeared to hold in due estimation the humbler yet only safe road to physical science, by the method of experiment and induction. Euler expressed the indices of refraction by the powers of a certain invariable root, and fancied that the exponents of those powers are proportional for the several rays in different media. Instead of making, in short, the numbers themselves proportional, as Newton had done, he assigned this property to their logarithms. In the *Berlin Memoirs* for 1747, he inserted a short paper, in which he deducted from his optical principle, by a clear analytical process, conducted with his usual skill, the composition of a lens formed after certain proportions with glass and water, which should remove entirely all extraneous colours, whether occasioned by the unequal refraction of the several rays, or by spherical aberration; and in concluding, he remarked, with high satisfaction, the general conformity of his results with the wonderful structure of the eye.

John Dolland.

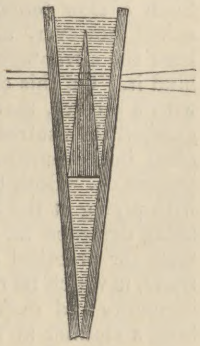
But this paper met with opposition in a quarter where it could have been least expected. John Dolland, who had afterwards the honour of completing one of the finest and most valuable discoveries in the science of optics, was born in 1706, in Spitalfields, of French parents, whom the revocation of the edict of Nantes had compelled to take refuge in England, from the cruel persecution of a bigoted and tyrannical court. Following his father's occupation, that of a silk-weaver, he married at an early age; and being fond of reading, he dedicated his leisure moments to the acquisition of knowledge. By dint of solitary application, he made some progress in the learned languages; but he devoted his main attention to the study of geometry and algebra, and the more attractive parts of mixed or practical mathematics. He gave instructions in these branches to his son Peter, who, though bred to the hereditary profession, soon quitted that employment, and commenced the business of optician, in which he was afterwards joined by his father. About this time the volume of the *Berlin Memoirs*, containing Euler's paper, fell into the hands of the elder Dolland, who examined it with care, and repeated the calculations. His report was communicated by Mr Short to the Royal Society in 1752, and published in their Transactions for that year. Dolland, as might well be expected, could detect no mistake in the investigation itself, but strenuously contested the principle on which it was built, as differing from the one laid down by Newton, which he held to be irrefragable. "It is, therefore," says he, rather uncourteously, and certainly with little of the prophetic spirit, "it is, therefore, somewhat strange that any body now-a-days should attempt to do that which so long ago has been demonstrated impossible." The great Euler replied with becoming temper, but persisted in maintaining that his optical principle was a true and necessary law of nature, though he frankly confessed that he had not been able to reduce it yet to practice. The dispute now began to provoke attention on the Continent. In 1754, Klingenstierna, an eminent Swedish geometer, demonstrated that the Newtonian principle is in some extreme cases incompatible with the phenomena, and therefore ought not to be received as an undoubted law of nature. Thus pressed on all sides, Dolland at length had recourse to that appeal which should have been made from the beginning,—to the test of actual experiment. He constructed a hollow wedge with two plates of glass, ground parallel, in which he laid inverted a common glass prism, and filled up the space with clear water, as in the annexed figure.



He now continued to enlarge the angle of the wedge, till the refraction produced by the water came to counterbalance exactly the opposite refraction of the glass, which

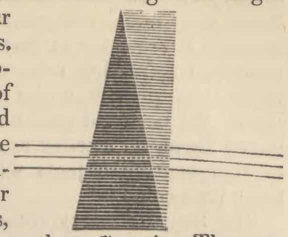
[1] The fine discovery of the apparent aberration of the fixed stars, made by our countryman Dr Bradley in 1729, cannot be justly deemed an exception to this remark. It belongs more to astronomy than to optics, and is indeed merely the result, however important, of the progressive motion of light, detected near sixty years before by the Danish philosopher Roemer, combined with the revolution of the earth in her orbit.

must obtain whenever an object is seen through the compound prism, without change of direction, in its true place. But, contrary to what he so firmly expected, the external objects appeared glaringly bordered with coloured fringes; as much, indeed, as if they had been viewed through a glass prism with an angle of thirty degrees. It was therefore quite decisive that Newton had not performed his experiment with scrupulous accuracy, and had trusted rather too hastily to mere analogical inference. But to remove every shadow of doubt from the subject, Mr Dolland, finding that large angles were inconvenient for observation, ground a prism to the very acute angle of nine degrees, and adjusted, by careful trials, a wedge of water to the same precise measure of refraction. Combining the opposite refractions as before, he beheld, on looking through the apparatus (as here represented), their various objects real position, but distinctly marked with the prismatic colours. In these experiments, although the mean ray pursues the same undeviating course, the extreme rays which enter parallel with it emerge from the compound prism, spreading out on both sides.

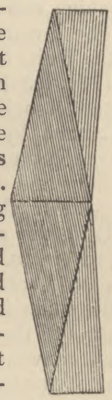


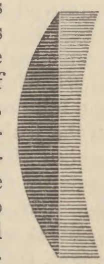
The capital point being completely ascertained, Dolland next tried so to adapt the opposite refractions as to destroy all extraneous colour. This effect he found to take place when the angle of the wedge had been further increased, till the refracting power of the water was to that of the glass in the ratio of five to four. His conclusive experiments were made in 1757, and he lost no time in applying their results to the improvement of the object-glasses of telescopes. Following the proportion just ascertained, he conjoined a very deep convex lens of water with a concave one of glass. In this way he succeeded in removing the colours occasioned by the unequal refraction of light; but the images formed in the foci of the telescopes so constructed, still wanted the distinctness which might have been expected. The defect now proceeded, it was evident, merely from spherical aberration; for the excess of refraction in the compound lens being very small, the surfaces were necessarily formed to a deep curvature.

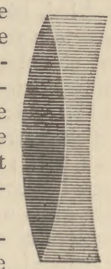
But this partial success only stimulated the ingenious artist to make further trials. Having proved that the separation of the extreme rays, or what has been since termed the *dispersive power*, is not proportioned to the mean refraction in the case of glass and water, he might fairly presume that like discrepancies must exist among other diaphanous substances, and even among the different kinds of glass itself. The charm of uniformity being once dispelled, he was encouraged to proceed, with the confident hope of ultimately achieving his purpose. His new researches, however, were postponed for some time by the pressure of business. But on resuming the inquiry, he found the English crown-glass and the foreign yellow or straw-coloured, commonly called the Venice glass, to disperse the extreme rays almost alike, while the crystal, or white flint-glass, gave a much greater measure of dispersion. On this quarter, therefore, he centred his attention. A wedge of crown and another of flint-glass were ground till they refracted equally, which took place when their angles were respectively 29 and 25 degrees, or the indices of refraction were nearly as 22 to 19; but on being joined in an inverted position, they produced, without changing the general direction of the pencil, a very different divergence of the compound rays of light. He now reversed the experiment, and formed wedges of crown and flint-glass to such angles as might destroy all irregularity of colour by their opposite dispersions. When this condition was obtained, the refractive powers of those wedges of crown and flint-glass were nearly in the ratio of three to two, and consequently the sines of half their angles, or the angles themselves, if small, were as 33 to 19, or nearly as 7 to 4. The rays which enter parallel now escape likewise parallel, but all of them deflected equally from their course.



The appearance was rendered still more conspicuous by repeating the combination of the glass wedges, as in the figure here adjoined. It will be perceived that the pencils of rays which enter at equal distances on both sides of the common junction, must nearly meet in the same point of the axis; for in small arcs the chords are almost proportional to the arcs themselves. This arrangement, indeed, with the projecting wedge of crown-glass in front, represents actually the composition of an object-glass formed of two distinct and opposing lenses, which would produce a similar effect. It was only required to apply a semi-convex lens of crown-glass before a semi-concave one of flint-glass, such that the curvature of the former be to that of the latter nearly as 7 to 4; but with some modifications in this ratio, according to the peculiar qualities of the glass. [The figure annexed represents this combination.] But the depth of the lenses might be diminished, by giving them curvature on both sides. Thus, if a double convex of crown-glass were substituted, of the same power, and consequently with only half the curvature on each side; the lens of flint-glass adapted to it having, therefore, their common surface of an equal concavity, would need, in order to produce the former quantity of refraction, and consequently to maintain the balance of opposite dispersions, a concavity eight times less than before on the other surface. Or if a double concave of flint-glass with half its first depth were used, the front convexity of the lens of crown-glass would be five-sevenths of the former curvature, as here represented. The surface where the two lenses are united may hence have its curvature changed at pleasure; but every alteration of this must occasion corresponding changes in the exterior surfaces.





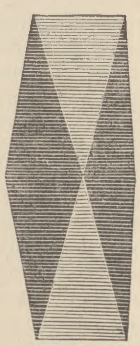


In all these cases, the refraction of the convex pieces being reduced to one-third by the contrary refraction of the concave piece, the focal distance of the compound glass must be triple of that which it would have had singly. But a most important advantage results from the facility of varying the adaptation of the lenses; for, by rightly proportioning the conspiring and counteracting curvatures, it was possible to remove almost entirely the errors arising from spherical aberration. This delicate problem Mr Dolland was the better prepared to encounter, as he had already, in 1753, improved the telescope materially, by introducing no fewer than six eye-glasses, disposed at proper distances, to divide the refraction. The research itself, and the execution of the compound lens, presented peculiar difficulties; but the ingenuity and toilsome exertions of the artist were at length, in 1758, rewarded with complete success. " Notwithstanding," says he, in concluding his paper, "so many difficulties as I have enumerated, I have, after numerous trials, and a resolute perseverance, brought the matter at last to such an issue, that I can construct refracting telescopes, with such apertures and magnifying powers, under limited lengths, as, in the opinion of the best and undeniable judges, who have experienced them, far exceed any thing that has been produced, as representing objects with great distinctness, and in their true colours."

The Royal Society voted to Mr Dolland, for his valuable discovery, the honour of the Copley medal. To this new construction of the telescope Dr Bevis gave the name of *Achromatic* (from *α* privative, and *χρωμα, colour*), which was soon universally adopted, and is still retained. The inventor took out a patent, but did not live to reap the fruits of his ingenious labours. He died in the year 1761, leaving the prosecution of the business to his son and associate Peter Dolland, who realized a very large fortune by the exclusive manufacture, for many years, of achromatic glasses, less secured to him by the invidious and disputed provisions of legal monopoly, than by superior skill, experience, and sedulous attention. In 1765, the younger Dolland made another and final improvement, to which his father had before advanced some steps. To correct more effectually the spherical aberration, he formed the object-glass of three instead of two lenses, by dividing the convex piece; or he inclosed a concave lens of flint-glass between two convex lenses of crown-glass, as exactly represented in the figure here annexed. He showed a telescope of this improved construction, having a focal length of three feet and a half, with an aperture of three inches and three quarters, to the celebrated Mr Short, who tried it with a magnifying power of one hundred and fifty times, and who, superior to the jealousy of rivalship, and disposed to patronise rising merit, most warmly recommended it, and declared that he found "the image distinct, bright, and free from colours."

Peter Dolland.

What were the curvatures of those distinct component lenses, Dolland has not mentioned, and perhaps he rather wished to conceal them. The Duke de Chaulnes was enabled, however, by means of a sort of micrometer, to ascertain the radii of the several surfaces, in the case of one object-glass of the best composition. He found these radii, beginning with the front lens, to be respectively 311½, 392; 214, 294; 294 and 322½, in French lines, which corresponded, in English inches, to 32·4, 40·8; 22·2, 30·6; 30·6 and 33·5. If these measures were correct, however, it would follow, that the middle lens of flint-glass was not perfectly adapted to the curvature of the lens of crown-glass placed immediately before it. Similar admeasurements have been repeated by others, but the results differ considerably, and no general conclusion can be safely drawn. There is no doubt that the artist varied his practice, according to the nature of the glass which he was obliged to use. The more ordinary proportions for the curvatures of the component lenses would be represented by a truncated prism, formed with a double cluster of wedges, the outer ones having angles of 25° 53′, and 14° 27′, and consisting of crown-glass, and the inner one made of flint-glass, with an inverted angle of 27° 3′. These two wedges of crown-glass would produce the same refraction, it might be shown, as a single one having an angle of 40° 54′; wherefore this refraction will be diminished, by the opposite influence of the wedge of flint glass, in the ratio of 49 to 16, or reduced to nearly one-third.



Thus was achieved, and fully carried into practical operation, the finest and most important detection made in optics since the great discovery of the unequal refraction of the several rays of light. It was drawn forth by a long series of trials, directed with judgment and ingenuity, but certainly very little aided by the powers of calculation. Such a slow tentative procedure was perhaps the best suited, however, to the habits of an artist, and it had at least the advantage of leaving no doubt or hesitation behind it. On this occasion, we cannot help being struck with a remark, that most of those who have ever distinguished themselves in the philosophical arts by their original improvements, were seldom regularly bred to the profession. Both the Dollands, we have seen, began life with plying at the loom; Short had a liberal education, being designed for the Scotish church, but, indulging a taste for practical optics, he afterwards followed it as a trade, in which he rose to pre-eminence; Ramsden, whose ingenuity and exquisite skill were quite unrivalled, was bred a clothier in Yorkshire; Tassie, who revived or created among us the nice art of casting gems, was originally a stone-mason at Glasgow; and Watt, who, by his very happy applications of mechanics, and his vast improvements on the steam-engine, has, more than any other individual perhaps, contributed to the great national advancement, was early an ivory-turner in that same city, and still found pleasure, in his declining years, with the amusement of the lathe. We might easily enlarge this catalogue; but enough has been said to prove the justness of the observation, and it suggests reflections which are not favourable to fixed and systematic plans of education.

Subsequent improvements.

The theory of achromatic telescopes, embraced in all its extent, opened a field of abstruse and difficult investigation. But the English mathematicians at that period, though they might appear to be especially invited to the discussion, very generally neglected so fine an opportunity for the exercise of their genius. They coldly suffered the artists to grope their devious way, without offering to guide their efforts by the lights of science. On the Continent the geometers of the first order were all eager to attempt the solution of problems at once so curious and important. For several years subsequent to 1758, the Transactions of the foreign academies were filled with memoirs on the combination of achromatic lenses, displaying the resources and refinements of the modern analysis, by Euler, Clairaut, and D'Alembert,—by Boscovich, Klingenstierna, Kæstner, and Hennert. On this, as on other occasions, however, we have to regret the want of close union between artists and men of science. Those profound investigations are generally too speculative for any real use; they often involve imperfect or inaccurate data; and the results appear wrapped in such comprehensive and intricate formulæ, as to deter the artist from endeavouring to reduce them into practice. We should have thought it preferable, on the whole, not to load the solution of the main problem with minute conditions, but to aim at a few general rules, which could afterwards be modified in their application according to circumstances. All this might have been accomplished, without scarcely travelling beyond the limits of elementary geometry.

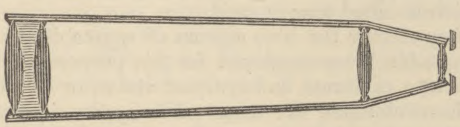
Euler.

Euler and his adherents at Berlin were still not disposed to abandon his favourite optical hypothesis. It was even pretended that Dolland must have owed his success to a nice correction of spherical aberration, and not to any really superior dispersive power belonging to the flint-glass. But that candid philosopher afterwards yielded to the force of reason and testimony; and, collecting his various optical papers, he published, in the successive years 1769, 1770, and 1771, a complete treatise on *Dioptrics*, occupying three quarto volumes, which contain a store of ingenious and elegant disquisitions.

Clairaut. D'Alembert.

The last memoir which Clairaut ever wrote related to achromatic glasses. D'Alembert prosecuted the subject with diligence and ardour; and the volumes of his *Mathematical Opuscules*, published between the years 1761 and 1767, contain some elaborate dioptrical investigations. Among other conclusions which he deduced from his multiplied researches, he proposed a new composition for the object-glass of a telescope, to consist of three lenses, the outmost one being a meniscus of crown-glass, or having a convex and a concave surface, then a meniscus of flint-glass in the middle, and adapted to this, on the inside, a double convex of crown-glass. Of all the continental works, however, which treat of achromatic combinations, the tracts of Boscovich, who possessed a very fine taste for geometry, may be held as the simplest and clearest. We cannot help noticing, by the way, a curious theorem of his concerning the form and arrangement of eye-glasses, which would be free from irregular colours. It is, that the correction will be produced by means of two lenses of the same kind of glass, if separated from each other by an interval equal to half the sum of their focal distances. This principle furnishes a very simple construction for the common astronomical telescope, through which the objects are seen inverted. In the annexed figure, the object-

Boscovich.



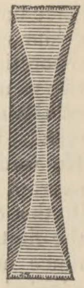
glass, as usual, is achromatic, being composed of two convex lenses of crown-glass, with a concave one of flint-glass fitted between them; but the eye-glass consists of two distinct lenses of crown-glass, both of them convex, and exactly similar, the first having every dimension triple that of the other, and their mutual distance double the focal length of the smaller.

Supposing, however, that the errors occasioned by spherical aberration were completely removed, the principle of achromatic combination is yet far from being so perfect as it has often been represented. Although the opposite dispersions of the flint and of the crown-glass should bring together the extreme rays, we are not, from this coincidence, warranted to infer that the several intermediate rays would likewise be accurately blended. In fact, a wedge of flint-glass not only separates all the rays much more than a similar one of crown-glass, but divides the coloured spaces after different proportions. While the combined lenses formed of those two kinds of glass give an image entirely free from the red and violet borders, they may still introduce secondary shades of green or yellow, sufficient to cause a certain degree of indistinctness. The mode of correcting this defect would be, to produce a counterbalance of colours, by conjoining several media endued with different refractive and dispersive powers. In these qualities, crown-glass itself admits of some variation, owing to the measure of saline ingredient; but flint-glass differs widely with regard to its optical properties, owing chiefly to the diversified proportion of minium or oxyde of lead which enters into its composition, and partly to the variable admixture of manganese employed to discharge the yellow tint occasioned by the lead. Manifest advantages, therefore, would result from a choice combination of three or more varieties of glass, since both the primary and the secondary deviations of colour would be corrected. Without pretending to any theoretical perfection, every thing really wanted in practice would be thus attained. A series of nice experiments on the optical relations of glass could not fail, by their results, to reward the assiduity of the ingenious artist. He would trace and determine the separate influence exerted on the refractive and dispersive powers by soda in the crown-glass, and by minium and manganese in the flint-glass. It is highly probable, that with perseverance he might discover a vitreous composition better adapted than any yet known for achromatic purposes. It is very generally believed, that the achromatic telescopes now manufactured in London are not of the same excellence with those first made by Peter Dolland. This declension of such a beautiful art has frequently been imputed to the baneful operation of a severe and oppressive system of excise. Whether the new mode of charging the duty on glass at the annealing arch has produced any beneficial effects, we are still to learn.

Achromatic Glasses.

Dr Blair

An extensive and ingenious set of experiments on the dispersive powers of different liquids, was undertaken, about the year 1787, and successfully prosecuted for some time afterwards, by Dr Robert Blair, for whom there had been recently created, under royal patronage, the chair of practical astronomy in the University of Edinburgh; one of the very few professorships in that distinguished seminary which have been suffered to remain inefficient and merely nominal. Of these experiments, a judicious account was, in 1790, communicated by their author to the Royal Society of Edinburgh, in a paper drawn up with evident ability, but rather too diffuse, and unnecessarily digressive. Dr Blair had a very small brass prism perforated with a hole, which he filled with a few drops of the liquid to be examined, and confined each end by a plate of glass with parallel surfaces. He then applied, inverted to the prism in succession, a number of glass wedges which he had provided of different angles, and observed, when the bars of the window, seen through this compound prism, appeared colourless, the angle of the wedge now expressed the relative dispersive power of the liquid. This way of experimenting was sufficiently simple, but a more accurate and expeditious method might have easily been devised. For instance, if the prism, furnished with a graduated arch, had remained fixed, and a single glass wedge made to turn upon it, and present successive inclinations to the observer, the refracting angle at which the irregular colours were united could be deduced by an easy calculation. Dr Blair found, by his trials, that muriatic acid, in all its combinations, but particularly with antimony and mercury, shows a very great dispersive power. The essential oils stood the next with regard to that property, though differing considerably among themselves. In Dr Blair's first attempts to improve the achromatic telescope, he conjoined two compound lenses; the one formed with a double concave of crown-glass and a semi-convex of essential oil, and the other composed of a double convex filled with essential oil, of great dispersive power, and of a semi-concave, likewise containing essential oil, but less apt for dispersion. This very complex arrangement seemed, however, to produce the desired effect, not only discharging from the image the extreme fringes of red and violet, but excluding also the intermediate shades of green or yellow. A simpler combination was afterwards used, requiring merely one liquid, composed of muriatic acid joined with antimony, or the triple salt of that acid united in certain proportions to ammonia and mercury. This liquid, being accurately prepared, was inclosed between two thin glass shells, to form a double convex lens: on the front was applied a semi-convex of crown-glass, and a meniscus of the same material behind, the whole being secured by a glass ring.



An object-glass so constructed seemed to perform its office with great perfection, effectually correcting both the primary and the secondary admixture of colours. This kind of eye-glass Dr Blair proposed to denominate *aplanatic* (from α privative, and πλαναω, to *err* or *wander*), and he obtained a patent for his invention. The late George Adams, optician in Fleet Street, was intrusted with the fabrication and sale of the telescopes thus constructed. Some of them were said to answer extremely well; but, whether from want of activity on the part of the tradesman, or from defect of temper in the patentee, these instruments never acquired much circulation. It was alleged that the liquid by degrees lost its transparency. Indeed we suspect that there is no combination in which liquids are concerned, which can be judged sufficiently permanent for optical purposes. It seems hardly possible to preclude absolutely the impression of the external air; the liquid must, therefore, have a tendency both to evaporate and to crystallize; and, in the course of time, it will probably, by its activity. corrode the surfaces of the glass.



The manufacture of achromatic telescopes in England furnished, for a long period, a very profitable article of exportation. Even after the introduction of those instruments was prohibited by several foreign governments, the object-glasses themselves, in a more compendious form, were smuggled abroad to a large amount. In fact, no flint-glass of a good quality was then made on the Continent. A very material alteration, however, in that respect, has taken place, at least in France, where the stimulus impressed by the revolution has worked so many changes, and where ingenuity and science, in most of the mechanical arts, have so visibly supplied the scantiness of capital. The French now construct achromatic telescopes, equal, if not superior, to any that are made in England. (J. L.)

French achromatic telescopes.

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ACHTEL (literally an eighth part), a measure of capacity, used in Germany. Eight *Achtels* make an *Eimer*, but the scale varies in different parts of the country.

ACHTYRKA, a city of Russia, the capital of the circle of the same name. It contains eight churches, one of which, with an image of the Virgin, attracts many pilgrims: 1338 houses; and 16,205 inhabitants, who are employed in making woollen cloth, and some other articles. It is situate in Long. 34. 50. E. Lat. 50. 23. N.

ACHYR, a strong town and castle of the Ukraine, subject to the Russians since 1667. It stands on the river Uorsklo, near the frontiers of Russia, 127 miles west of Kiow. Long. 36. 0. E. Lat. 49. 32. N.

ACICANTHERA, in *Botany*, the trivial name of a species of Rhexia.

ACICULÆ, the small spikes or prickles of the hedgehog, *echinus marinus*, &c.

ACIDALIUS, Valens, would, in all probability, have been one of the greatest critics of modern times, had he lived longer to perfect those talents which nature had given him. He was born at Witstock, in Brandenburg; and having visited several academies in Germany, Italy, and other countries, where he was greatly esteemed, he afterwards took up his residence at Breslaw, the metropolis of Silesia. Thuanus tells us, that his excessive application to study was the occasion of his untimely death. He died on the 25th of May 1595, having just completed his 28th year. He wrote a Commentary on Quintus Curtius; also, Notes on Tacitus, on the twelve Panegyrics, besides speeches, letters, and poems. His poetical pieces are inserted in the *Deliciæ* of the German poets, and consist of epic verses, odes, and epigrams. M. Baillet has given him a place among his *Enfans Célèbres;* and says, that he wrote a comment upon Plautus when he was but 17 or 18 years old, and composed several Latin poems at the same age.

Acidalius, a fountain near Orchomenus, a city of Bœotia, in which the Graces, who are sacred to Venus, bathed. Hence the epithet *Acidalia*, given to Venus.

ACIDITY, that quality which renders bodies acid.

ACIDOTON, in *Botany*, the trivial name of a species of Adelia.

ACIDS, in *Chemistry*, a class of substances which are distinguished by the following properties:—

1. When applied to the tongue, they excite that sensation which is called *sour* or *acid*.

2. They change the blue colours of vegetables to a red. The vegetable blues employed for this purpose are generally tincture of litmus, and syrup of violets or of radishes, which have obtained the name of *re-agents* or *tests*. If these colours have been previously converted to a *green* by alkalies, the acids restore them.

3. They unite with water in almost any proportion.

4. They combine with all the alkalies, and most of the metallic oxides and earths, and form with them those compounds which are called *salts*.

It must be remarked, however, that every acid does not possess all these properties; but all of them possess a sufficient number of them to distinguish them from other substances. And this is the only purpose which artificial definition is meant to answer. See Chemistry.

ACIDULÆ. Mineral waters that are brisk and sparkling, without the action of heat, are thus named; but if they are hot also, they are called Thermæ.

ACIDULATED, a name given to medicines that have an acid in their composition.

ACIDULOUS denotes a thing that is slightly *acid:* it is synonymous with the word *sub-acid*.

ACILIUS GLABRIO, Marcus, consul in the year of Rome 562, and 191 years before the Christian era, distinguished himself by his bravery and conduct in gaining a complete victory over Antiochus the Great, king of Syria, at the Straits of Thermopylæ in Thessaly, and on several other occasions. His son built the temple of Piety at Rome, in consequence of a vow the father made before this battle. He is mentioned by Pliny, Valerius Maximus, and others.

ACINACES, an ancient Persian sword, short and straight, and worn, contrary to the Roman fashion, on the right side, or sometimes in front of the body, as shewn in the bas-reliefs found at Persepolis. Among the Persian nobility they were frequently made of gold, being worn as a badge of distinction. The acinaces was an object of religious worship with the Scythians and others.—*Herod.* iv. 62.

ACINODENDRUM, in *Botany*, the trivial name of a species of Melastoma.

ACINOS, in *Botany*, the trivial name of a species of Thymus.

ACINUS, or Acini, the small protuberances of mulberries, strawberries, &c., and by some applied to grapes. Generally it is used for those small grains growing in bunches, after the manner of grapes, as *ligustrum*, &c.

ACIPENSER, Sturgeon. For the living species, see Ichthyology; for the fossil species, see the *Ganoïd* fishes of Agassiz.

ACI REALE, a city on the coast of Catania, at the base of Ætna. It is well built, clean, and healthy, with a delicious climate. Pop. about 15,000: they are industrious, and carry on a considerable trade in the wines of the adjacent fertile territory, fruit, cotton, flax, linen, silk, cutlery, and jewellery. Several small contiguous towns also bear the name of Aci; as Aci Castello, Aci Terra, Aci Santa Lucia, &c.

ACIS, in *Mythology*, the son of Faunus and the nymph Symæthis, was a beautiful shepherd of Sicily, who being beloved by Galatea, Polyphemus the giant was so enraged, that he crushed his rival with a rock; and his blood, gushing forth from under the rock, was metamorphosed into the river bearing his name. *Ovid. Met.* xiii. 750., *Sil. Ital.* xiv. 221. This river, now *Fiume di Jaci*, or *Acque Grandi*, rises under a bed of lava, on the eastern base of Ætna, and passing Aci Reale, after a rapid course of one mile, falls into the sea. The waters of the stream, once celebrated for their purity, are now sulphureous.—*Cluverii Sicil.*; *Brydone's Sicily*; *Smyth's Sicily.*

ACKERMANN, John Christian Gottlieb, a very learned physician and professor of medicine, was born at Zeulenrode in Upper Saxony, in the year 1756. Having acquired the rudiments of his medical education under the tuition of his father, who was also a physician, he proceeded to Jena and to Göttingen, and studied under Baldinger and Heyne. On quitting the latter university, he established himself in practice at Stendal, the numerous manufactories of which place enabled him to contribute many important observations to the translation of Rammazzini's *Treatise of the Diseases of Artificers*, which he published in 1780–83. After practising here several years, he was appointed public professor in ordinary of medicine in the university of Altorf in Franconia, which office he continued to fill with great repute to the time of his death, which took place in 1801. All Dr Ackermann's works display great erudition. To the history of medicine he contributed many valuable articles; the disquisitions, in particular, on the lives and writings of Hippocrates, Galen, Theophrastus, Dioscorides, Aretæus, and Rufus Ephesius, which he furnished to Harles's edition of Fabricius's *Bibliotheca Græca*, are justly esteemed as masterpieces of critical research. As a practitioner he appears to have possessed no mean talents for observation; though he has been accused, and, it must be acknowledged, not without reason, of betraying occasionally a predilection for antiquated hypotheses. Besides various translations of English, French, and Italian medical authors, which were published, for the most part, previously to his removal to Altorf, he is the author of 13 different original works on different branches of medicine, between the years 1775 and 1800.

ACKNOWLEDGMENT, in a general sense, is a person's owning or confessing a thing; but more particularly, is the expression of gratitude for a favour.

*Acknowledgment-Money*, a certain sum paid by tenants in several parts of England, on the death of their landlords, as an acknowledgment of their new lords.



ACLIDES, in *Roman Antiquity*, a kind of missile weapon with a thong affixed to it, by which it was drawn back. Most authors describe it as a sort of dart or javelin; but Scaliger makes it roundish or globular, and full of spikes, with a slender wooden stem to poise it by. Each warrior was furnished with two.

ACLOWA, in *Botany*, a barbarous name of a species of Colutea. It is used by the natives of Guinea to cure the itch: they rub it on the body as we do unguents.

ACME, the top or height of any thing. It is usually applied to the maturity of an animal just before it begins to decline; and physicians have used it to express the utmost violence or crisis of a disease.

ACMELIA, in *Botany*, the trivial name of a species of Spilanthus.

ACNIDA, Virginian Hemp.

ACNUA, in *Roman Antiquity*, signified a certain measure of land, about an English rood and a quarter.

ACOEMETÆ, or Acoemeti, from ἀκοιμητος, sleepless; a set of monks who chanted the divine service night and day in their places of worship. They divided themselves into three bodies, who alternately succeeded one another, so that the service in their churches was never interrupted. This practice they founded upon the precept, *Pray without ceasing.* They flourished in the East about the middle of the fifth century. There are a kind of acoemeti still subsisting in the Romish church, viz., the religious of the holy sacrament, who keep up a perpetual adoration, some one or other of them praying before the holy sacrament day and night.

ACŒTES, the son of a poor fisherman of Mæonia, who followed the occupation of a pilot. Being once on a voyage to Delos, the ship touched at Naxos (frequently called *Dia*), where the sailors carried on board with them a beautiful boy, whom they had found on shore overcome with sleep and wine. Acœtes recognising the youth to be more than mortal, endeavoured to dissuade them from their purpose, but without effect. On awaking, the boy, who was no other than the god Bacchus, desired to be carried back to Naxos. The crew agreed to do so, but kept the ship's head in the opposite direction, in spite of the entreaties of the god and the remonstrances of Acœtes. Suddenly the offended deity put forth his power, and the ship stood motionless in the water. The crew in vain plied the oar: vine-wreaths twined around them, and shot in tangles through the rigging. Tigers, lynxes, and panthers, bestrode the deck, and Bacchus himself appeared in his true form, armed with his terrible *thyrsus.* The sailors incited to madness, leaped into the sea, and were immediately changed into fishes. Acœtes alone was saved, and became a priest of Bacchus at Naxos.—*Ovid. Met.* iii. 582.

ACOLUTHI, or Acoluthists (ἀκολουθοι, from α, copulative, and κελευθος, a way), in *Antiquity*, was an appellation given to those persons who were steady and immovable in their resolutions; and hence the Stoics, because they would not forsake their principles nor alter their resolutions, acquired the title of *acoluthi.*

Acoluthi, *Acolytes*, among the ancient Christians, were a peculiar order of the inferior clergy in the Latin church, for they were unknown to the Greeks for above 400 years. They were next to the subdeacon; and we learn from the fourth council of Carthage, that the archdeacon, at their ordination, put into their hands a candlestick with a taper, giving them thereby to understand that they were appointed to light the candles of the church; as also an empty pitcher, to imply that they were to furnish wine for the eucharist. The name and office still exist in the Romish church.

ACOLYTHIA, in the *Greek church*, denotes the office or order of divine service; or the prayers, ceremonies, hymns, &c., whereof the Greek service is composed.

ACOMINATUS, NICETAS, was secretary to Alexius Comnenus and to Isaacus Angelus successively. He wrote a history from the death of Alexius Comnenus in 1118, where Zonaras ended his, to the year 1206, which has gone through many editions, and has been much applauded by the best critics.

ACONCROBA, in *Botany*, the indigenous name of a plant which grows wild in Guinea, and is in great esteem among the natives for its virtues in the small-pox. They give an infusion of it in wine. The leaves of this plant are opaque, and as stiff as those of the phillyrea; they grow in pairs, and stand on short foot-stalks; they are small at each end, and broad in the middle; and the largest of them are about three inches in length, and an inch and a quarter in breadth in the middle. Like those of our bay, they are of a dusky colour on the upper side, and of a pale green underneath.

ACONITI, in *Antiquity*, an appellation given to some of the Athletæ, but differently interpreted. Ἀκονιτι, adv. signifies literally *without dust* (α, priv. and κόνις); and probably was used of a victory obtained without difficulty, or when none dared to oppose an athlete on account of his strength and skill. *Paus.* vi. 7, § 2; *Hor. Epist.* i. 1. 51.

ACONITUM, ACONITE, WOLFSBANE, or MONKS-HOOD. It yields the alkaloid *aconitine*, which is a deadly poison; but has been used in medicine as an external anodyne remedy in acute pains, and also in minute doses internally.

ACONTIAS, in *Zoology*, an obsolete name of the *anguis jaculus*, or dart-snake, belonging to the order of *Ophidians;* and Cuvier employs it to designate a sub-genus of *anguis*.

ACONTIUM, ακοντιον, in Grecian antiquity, a kind of dart or javelin, resembling the Roman spiculum.

ACONTIUS, a young man of the island Cea, who having gone to Delos to see the sacred rites which were performed there by a crowd of virgins in the temple of Diana, fell violently in love with Cydippe, the daughter of a noble Athenian; but not daring to ask her in marriage, on account of the superiority of her rank, he insidiously threw down at her feet an apple, on which were inscribed these words,

> Me tibi nupturam (felix eat nomen) Aconti,
> Juro, quam colimus, numina magna deæ.

Or, according to others,

> Juro tibi sanctæ per mystica sacra Dianæ,
> Me tibi venturam comitem, sponsamque futuram.

The virgin having taken up the apple, inadvertently read the words, and thus apparently bound herself by a promise; for by law, everything uttered in that temple was held to be ratified. When her father, a little after, ignorant of what had happened, betrothed her to another man, she was suddenly seized with a fever; whereupon Acontius sent her a letter (expressed by Ovid, *Heroid.* 20.) to persuade her that her fever was caused by Diana for not having fulfilled the promise which she had made to him in the temple of that goddess. Cydippe therefore resolved to comply with the wishes of Acontius, even against the inclination of her father. Her answer is the subject of Ovid's 21st *Epist. Heroid.* (ADAM'S *Clas. Biog.*)

ACONTIUS, properly ACONCIO, *James*, a philosopher, civilian, and divine, born at Trent in the sixteenth century. He embraced the reformed religion; and coming into England in the reign of Queen Elizabeth, he was favourably received and much honoured by that princess, which he acknowledges in a book dedicated to her. This work is his celebrated *Collection of the Stratagems of Satan*, which has been often translated, and passed through many editions.

ACORIS, a king of Egypt, who flourished about B.C. 385.

ACORN, the fruit of the oak-tree.



ACORN, in sea language, a little ornamental piece of wood, fashioned like a cone, and fixed on the uppermost point of the spindle, above the vane, on the mast-head. It is used to keep the vane from being blown off from the spindle in a whirlwind, or when the ship leans much to one side under sail.

ACORUS, CALAMUS, AROMATICUS, SWEET FLAG, or SWEET RUSH. It belongs to the natural order of *Aroides*.

ACORUS, in the *Materia Medica*, a name sometimes given to the great galangal.

ACORUS, in *Natural History*, blue coral. The true sort is very scarce; some, however, is fished on the coasts of Africa, particularly from Rio del Rey to the river of the Camarones. This coral is part of the merchandise which the Dutch trade for with the Camarones: that of the kingdom of Benin is also very much esteemed. It grows in form of a tree on a rocky bottom.

ACOSTA, JOSEPH D', a celebrated Spanish author, was born at Medina del Campo about the year 1539. In 1571, he went to Peru as a Provincial of the Jesuits, having entered into that society in his fourteenth year. After a residence in America of seventeen years, he returned to his native country, and became in succession visitor for his order of Aragon and Andalusia, superior of Valladolid, and rector of Salamanca; in which city he died in February 1600.

About ten years before his death, he published at Seville, in one volume quarto, his valuable work entitled *Historia Natural y Moral de las Indias*. The first two books of this history were written during his residence in Peru, and were published separately after his return to Spain, in the Latin language, with this title: *De Natura Novi Orbis, libri duo*. He afterwards translated them into Spanish, and added to them other five books, the whole composing a connected work, under the first-mentioned title. This work, which has been translated into all the principal languages of Europe, is written on a regular and comprehensive plan. Dr Robertson pronounces Acosta "an accurate and well-informed writer." Among other things, he treats the subject of climate in a more philosophical manner than could have been expected in a writer of that age, and of his order. "He was the first philosopher," says the eminent author just quoted, "who endeavoured to account for the different degrees of heat in the old and new continents, by the agency of the winds which blow in each;"—a theory which was afterwards adopted by Buffon, and supported with his usual powers of copious and eloquent illustration. In the course of these discussions, Acosta frequently comments upon the opinion of Aristotle and other ancient philosophers, that the middle zone of the earth was so much scorched by the rays of the sun as to be destitute of moisture and verdure, and totally uninhabitable. This notion seems to have held its ground in the Schools, even after the discovery of South America had disclosed the magnificent scenery and stupendous rivers of the tropical regions. It appears to have been thought a sort of impiety to question a dogma of such ancient date, and sanctioned by the assent of all the school divines. We learn, from a curious passage in Osborne's *Miscellany of Essays, Paradoxes, and Letters*, that the exposing of this ancient error in geography was one of the circumstances which brought upon the famous Sir Walter Raleigh the charge of general scepticism and atheism. Acosta mentions, that, when he went to America, his mind was deeply imbued with frightful notions of this supposed burning zone, and that his surprise was great when he beheld it so different from what it had been represented in the "ancient and received philosophy." "What could I do then," says he, "but laugh at Aristotle's meteors and his philosophy?"

Having said thus much in regard to one of the most curious and valuable of the earlier accounts of the new world, it may be proper to add, that, in speaking of the conduct of his countrymen, and the propagation of their faith, Acosta is in no respect superior to the other prejudiced and fanatical writers of his country and age. Though he acknowledges that the career of Spanish conquest was marked by the most savage cruelty and oppression, he yet represents this people as the chosen instruments of the Deity for spreading the truths of the gospel among the nations of America, and recounts a variety of miracles, as a proof of the constant interposition of Heaven, in favour of these merciless and rapacious invaders.

Besides his History, Acosta wrote the following works: 1. De Promulgatione Evangelii apud Barbaros. 2. De Christo Revelato. 3. De Temporibus Novissimis, libri vi. 4. Concionum, tomi iii.

Acosta, *Uriel d'*, a Portuguese of noble family, a Jew by descent, was born at Oporto towards the close of the sixteenth century. Brought up in the Roman Catholic faith, and naturally of a religious disposition, he was a strict observer of the rites of the church till the course of his inquiries led him, after much painful doubt, to abandon the religion of his youth. Apparently ignorant of any other form of Christianity, he sought refuge in Judaism, and passing over to Amsterdam, was received into the synagogue, after undergoing the rite of circumcision, and having his name changed from Gabriel to Uriel. He soon discovered, however, that those who sat in Moses' seat were shameful perverters of his law; and his bold protests served only to exasperate the rabbis, who finally punished his contumacy with the greater excommunication. Persecution seemed only to stimulate his temerity, and he soon after published a defence, in which he not merely exposed the departures of the Jewish teachers from the law, but combated the doctrine of a future life, in which he held himself supported by the silence of the Mosaic Books. For this he was imprisoned and fined, besides incurring public odium as a blasphemer and atheist. Nothing deterred, he pursued his speculations, which ended in his repudiating the divine authority of the law of Moses. Wearied, however, by his melancholy isolation, and longing for the benefits of society, he was driven, in the inconsistency of despairing scepticism, to seek a return to the Jewish communion. Having recanted his heresies, he was re-admitted after an excommunication of 15 years. He soon made himself again obnoxious to discipline, and was excommunicated a second time. After seven years of miserable exclusion, he once more sought admission, and after passing through a humiliating penance was again received. These notices of his singular and unhappy life are taken from his *Exemplar Humanæ Vitæ*, published and refuted by Limborch. He died by his own hand, after an ineffectual attempt on the life of his most bitter persecutor.



ACOSTAN, a mountainous island in the north seas, between Asia and America, observed by Captain Cook.

ACOUSMATICI, sometimes also called *Acoustici*, in Grecian antiquity, such of the disciples of Pythagoras as had not completed their five years' probation.

ACOUSTIC, in general, denotes any thing that relates to the ear, the sense of hearing, or the doctrine of sounds.

*Acoustic Disciples*, among the ancient Pythagoreans, those more commonly called Acousmatici.

*Acoustic Ducts*, in *Anatomy*, the same with *meatus auditorius*, or the external passage of the ear.

*Acoustic Vessels*, in the ancient theatres, were a kind of vessels made of brass, shaped in the bell fashion, which being of all tones within the pitch of the voice, or even of instruments, rendered the sound more audible, so that the actors could be heard through all parts of theatres which were even 400 feet in diameter.

# ACOUSTICS.

ACOUSTICS, that branch of Natural Philosophy which treats of the nature of Sound, and the laws of its production and propagation. It is a subject extremely curious and interesting, and has at all times excited much attention among philosophers. In treating it here, it was at first our intention to embody the original article in this Encyclopædia with that which was contributed for the last Supplement by Professor Leslie. On considering, however, that the latter embraces in itself a general outline of the whole science;—that it is distinguished, like all the other productions of that philosopher, by soundness, depth, and striking originality; and that any changes even in the arrangement might destroy its peculiar character;—we have thought it best to preserve this valuable essay entire. It accordingly forms the *Second* Part of this Treatise; the *First* being devoted to the explanation of the more elementary principles; and the *Third* to some details supplemental to those contained in the Second.

## Part I.

Nature of sound.

In regard to the nature of sound, the slightest attention is sufficient to convince us, that this sensation is not owing to the action of any peculiar substance or power, like Heat, Light, or Electricity, but arises merely from a certain mechanical action; a sort of concussion or agitation which takes place among the bodies from which the sound is emitted. Every noise or sound with which we are acquainted is accompanied with some action of this kind. The report of a cannon, for example, produces a concussion which shakes the ground under and to a great distance around it. In the same manner the rushing of waters, the roar of the sea, the whistling of the wind as it breaks on the trees or other obstacles which oppose it; the rattling of carriages, and that infinite diversity of sounds which arises in general from the percussion of one object against another: in all these cases there is a sensible and indeed violent agitation among the bodies from which the sound proceeds. In musical sounds, which are of a softer nature, we still also observe an agitation, which is often felt communicating itself to the surrounding bodies. If, for example, we stand under or near a pianoforte when it is sounding, we feel a sensible tremor in the floor of the apartment. If we lay the finger or hand on the instrument, or touch any other, such as a violin, when it is sounding, or a bell, we feel the same sort of tremor in every part of them; and this is well observed in the case of any glass vessel, such as a tumbler or large cup. If we strike it so as to make it sound, and then touch the mouth of it with the finger, we feel a sensible tremor in the glass; and when this internal agitation is stopped, as it generally is by the contact with the finger, then the sound ceases along with it. If there be any water in the glass, the tremor is observed communicating itself to the water, and putting the whole mass in motion. This is particularly well observed when we make the glass sound by rubbing the edge of it with the finger, as is done in the musical glasses. When the sound is brought fully out, the water is violently agitated; and as the sound declines, the agitation declines along with it. Such agitation then, in the sounding body, being

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the constant accompaniment of sound, ceasing when it ceases, and again beginning when the sound recommences; and there being no other circumstance which can be discovered accompanying the sound in this manner; there can be no doubt that this is in some way or other the cause of the sensation.

Transmitted through the medium of the air.

But how can any mere agitation or imperceptible tremor among bodies, and these at a distance, affect the organ of hearing? It is through the medium of the surrounding air. We have seen how the tremor of the piano-forte is communicated to the floor of the apartment, and is there felt under our feet. This communication can only take place through the legs of the instrument, which form the only connection between it and the floor. Through these, therefore, it is somehow conveyed; and in the same manner every tremor of this kind creates an agitation in the surrounding air, through which it is conveyed from the centre of agitation in all directions until it reaches the ear, and there striking or agitating the organ, produces the sensation of sound. That such agitation does take place in the air, we have a striking proof in the discharge of artillery, which often produces such an agitation as to shatter the glass in the windows of adjoining houses. The ear then forms merely a sort of organ of touch, but of such exquisite sensibility that it becomes affected by the slightest agitation in the fluid atmosphere by which it is surrounded. But this fluid is continually agitated, and in a thousand different ways, by the various motions and actions which are continually going on among the bodies on the surface of the earth. Every agitation of this kind communicates itself to the surrounding atmosphere; it is by it conveyed and propagated in all directions from the centre of agitation, somewhat like what we observe in a smooth surface of water when a stone is thrown into the middle of it;—a series of little waves are observed arising and propagating themselves in concentric circles from the centre of agitation on all sides. In a similar manner every agitation in the aërial medium propagates its influence in all directions, and from these varied impressions arise all those diversities of sound which affect the ear.

This idea of the process of hearing and of the cause of sound is certainly very remarkable, and well calculated to excite our surprise and curiosity, when we think of that infinite variety which we observe; single sounds, varying in intensity from the gentlest tap to the noise and violence of an explosion; continued sounds, from the ripple of waters to the roar of the cataract; strains of melody which enchant the ear, rising from grave to acute, and falling again to the lowest in the compass; or those harsher notes which only grate by their discord. Can it be possible that all these diversities arise from agitations in the air, differing only in the manner in which they strike the ear, in the force and quickness of their action, or in the regularity of their succession? What incredible sensibility in this organ, to perceive and be moved by such imperceptible shades of gradation, and to recognise such infinite diversities in kind! The powers of the eye in discriminating the minutest shades of colour justly excite our astonishment; but each colour presents a peculiar modification of light. The powers of the ear must appear still more extraordinary, if every sensation in it arises merely from a mechanical agitation of the same nature in every case, but only differing in the force of the impulse. Yet this is really the case; and the more we examine into the subject, the more clearly does it appear demonstrable by the laws of geometry and mechanics.

That the air is necessary for the production of sound, is clearly proved by the beautiful experiment of inclosing a bell within the receiver of an air-pump, and then exhausting the air. As the process of exhaustion proceeds, the sound is observed to become continually fainter and fainter, until at last it nearly dies away altogether. The bell, however, continues to ring, at least the hammer continues to strike, and thereby to agitate the bell as before; and yet no sound is emitted, plainly because there is no medium to convey the agitation to the ear. If the sound in this experiment cannot be altogether extinguished, this will be found to arise from the impracticability of exhausting the air altogether out of the receiver, and also of insulating completely the bell from the plate of the air-pump on which it stands, the support serving to convey the sound even after the air is exhausted. A very good mode of performing this experiment is, to have a bell with a small piece of clock-work attached to it, which strikes at regular intervals, and with a tone of uniform intensity.

Mode in which sound is propagated.

In order to conceive the mode in which sound is propagated through the air, let us consider what takes place when we move a series of balls ranged in a line on a table, or suspended by threads. If we strike the one end of the line by impelling a ball against it, it is only the ball at the other end which appears to be affected. This flies off from the rest, and leaves them almost stationary. The intermediate balls, therefore, serve merely to transmit the impulse from the one end to the other of the series. In the same manner it is that the agitation or impulse from which sound arises is transmitted through the air. This fluid, like every other body, consists of an infinite number of little particles; a single series of which may be represented to us by the balls in the above example. These particles are not even in contact with each other; they are separated by minute intervals, but are yet connected together by attractive and repulsive forces, which tend to retain them perpetually in equilibrio. In every case, therefore, there is in reality a chain of such particles reaching from the sounding body to the ear. The former by its agitation strikes that particle which is next it, the intermediate ones serve to convey the impression, and the last one, flying off, strikes the sentient organ of hearing. The process is exactly similar to that of impulse along a series of balls, only that in the case of the air, the intermediate particles, instead of remaining at rest, move each of them backwards and forwards by a very minute interval; the first communicating its motion to the second, the second to the third, and so on to the last; each performing a slight oscillatory movement, which advances from the beginning to the end of the series.

We now see at once the cause of a remarkable and well-known fact, that the propagation of sound is not instantaneous; it requires time to advance from the sounding body to the ear, as is daily observed and illustrated in the discharge of fire-arms. If the distance be at all considerable, a sensible interval is always observed to elapse between the flash and the report. The light flies almost instantaneously, but the report is retarded according to the distance; as is also seen in many other cases: when we observe the workmen, for example, cutting up large stones in any quarry; if we stand at a little distance, we see invariably and distinctly the blow of the hammer on the stone before the sound reaches the ear. These and other similar facts leave no doubt that sound advances only at a certain rate, and invariably requires time for its propagation; and the reason is, that each aërial particle in the chain of communication must have a certain time, minute no doubt, but still definite, to perform its oscillation, and communicate its motion to the rest; and thus the advance of the agitation and of the sound is retarded, and only sweeps with a regulated progression along the line.

Sound propagated on all sides.

It is not through one series of particles merely that the oscillatory motion is communicated. The sounding body having every part of it in a state of agitation, generally acts all round; but even though it were only to act in one direction, the impulse, once begun at the centre, is propagated in all directions; for though only one particle were originally affected, so intimately are they all connected together and united into a system by their mutual attractions and repulsions, that this cannot advance in any degree forwards without affecting the particles on each side: these affect what are before and around them; and thus the impulse is communicated, and diffuses itself on all sides. These lateral impressions would appear to be necessarily somewhat enfeebled, yet it is one remarkable characteristic of such oscillatory movements, that, like the vibrations of a distended cord, or the oscillations of a pendulum in a cycloid, they are all performed in the same time, however minute or however extended. The lateral impressions, therefore, though ever so feeble, are yet transmitted with the same rapidity as the direct; the sound may be weakened, and we often observe it so;—a speaker, for example, is always best heard in front; the report of a cannon is also loudest in that direction, but still the sound is heard at the very same instant all round.

It is owing to this diffusion of the agitation in all directions, the original impression being spread out, not merely in concentric circles like the little waves in a pool, but expanding continually, if we can conceive it, into a wider and wider concentric sphere.—it is owing to this that every sound decreases so rapidly as we recede from it, and at last dies away altogether in the distance. It requires a very loud sound to be heard at the distance of a mile, yet we have heard the guns of Edinburgh Castle at the distance of 20 miles; and the noise occasioned by the falls of Niagara is said to be often heard at 60 miles. That this diffusion of the agitating impression is the true cause of the diminution of the sound, is proved in a remarkable manner by confining the air on all sides, as in a tube. M. Biot, in his *Traité de Physique*, gives an account of some very interesting experiments made by himself in the train of cast-iron pipes used for the conducting of water into Paris, and which extended about 2860 feet, thus including in their interior a cylindrical column of air upwards of half a mile in length; at which distance a person standing at one end of the pipes, and speaking within, could be easily heard at the other. "The lowest voice," says he, "was heard at this distance so as to distinguish completely the words, and to establish a continued conversation. I wished to ascertain at how low a tone the voice ceased to become audible, and I could not reach it. Words spoken as low as when one whispers in the ear of another were heard and appreciated; so that if we wished to speak so as not to be understood, there was only one way of doing it, and that was not to speak at all." It is on this principle that depends the effect of those tubes which are now in such general use, as modes of communication between distant apartments, in houses and public offices. Hence, also, are performed many amusing tricks with statues or busts, situated in different parts of a room, answering questions, and speaking to one another; the figures being connected by tubes concealed under the walls or floor, or communicating with an apartment below, in which a speaker is stationed.

Velocity of sound.

In regard to the actual velocity with which the impulse of sound advances, it appears, from the most accurate experiments on the discharge of pieces of ordnance, and marking the interval between the flash and the report, at a distance carefully measured, that in ordinary circumstances this amounts to no less than 1130 feet each second, which is nearly equal to the velocity of a cannon ball the moment it issues from the piece. This last is very speedily retarded by the resistance of the air; but sound advances with undiminished velocity. Hence it will travel a mile in a little more than four seconds and a half, or $12\frac{3}{4}$ miles per minute. On this depends an easy method of determining in many cases our distance from objects, and which may often prove useful, particularly in military operations. We have only to observe, in seconds, the interval between the flash and report of the cannon or musket, and allow $4\frac{1}{2}$ seconds to every mile, or 1130 feet to every second. Thus, in a house in Lothian Street, directly opposite to the castle of Edinburgh, we have frequently observed a sensible interval elapse, as the sound of the guns travelled across the intermediate valley, we think about 2″ or more; and the distance in a straight line is about 760 yards, or a little less than half a mile. In the same manner, by observing the interval between the flash of lightning and the thunder, we can tell the distance of the point where the electric discharge takes place.

It is remarkable also, that all kinds of sound, strong or weak, acute or grave, advance with the same velocity; and this arises from the circumstance already noticed, that all the oscillatory movements in the air, however minute or however extended, are performed each in the very same interval of time. This effect was distinctly proved in the experiments made by Biot in the cast-iron pipes already noticed, by playing different airs on the flute at one of the extremities of the tube. Now, it is well known that a musical air is adapted to a certain measure or time, which regulates very nicely the intervals between the successive notes; consequently, if any of these were propagated more rapidly or more slowly than others, by the time they reached the ear these would have been confounded with what preceded or followed them; and the air would have appeared quite altered, in place of which it was uniformly regular, and in its natural time; whence it clearly followed, that all sounds are propagated with equal velocity.

Cause of echoes.

The above view of the propagation of sound explains at once the remarkable phenomenon of the echo, which arises in every case from obstacles opposing the progress of sound. The agitation in the air, however, though interrupted by such obstacles, is not destroyed: each aërial particle which strikes against the opposing surface is reflected from it like an elastic ball which strikes against any wall or table. The sound is thus reflected at an angle equal to the angle of incidence; and it is when a number of these reflected impressions are thrown back to the point whence the original sound issues, by the configuration of the opposing obstacles, as so frequently happens among rocks, walls, &c. that an echo is produced.

Air not the only vehicle of sound.

Hitherto we have considered the *air* only as the vehicle of sound, and, without doubt, it is the grand medium of its transmission. Other bodies, however, convey it in a similar manner, and some of them even with much greater rapidity and force. In the liquid element this is proved by the acuteness which fishes display to sounds made in the air, and by many experiments. Professor Robison related, that with his head plunged under water, he could hear the sound of a bell, rung also in the water, at the distance of 1200 feet. We have already seen how the tremor of the piano-forte is communicated to the floor of the apartment; and many other familiar facts show clearly that sound is transmitted through the most solid bodies. How readily do we hear from one apartment of a house, or from one floor to another. The scratch of a pin is easily heard from one end of a log to another. A well-known but striking experiment in illustration of the transmission of sound is, to suspend any sonorous body, as a bell, a glass, a silver spoon, or a tuning fork, from a thread, and putting with the finger the extremities of the thread one in each ear;—if the body be then struck against any obstacle, the apparent loudness and depth of the sound are quite surprising. Again, if we shut the ears altogether, we yet feel very sensibly the impression of any sound conveyed through the mouth, the teeth, or the head:—if we put a small stick or rod in the mouth, and touch with the other extremity a watch lying on the table, the beats will become quite audible, though the ears be actually shut. Every noise in the mouth or among the teeth is conveyed internally to the ear in the same manner. Sound, therefore, is transmitted through liquids and solids, as well as through the air; and indeed, when we consider that the former are quite similarly constituted with the air, being composed of an infinite number of little particles, combined into a system by the same species of attractive and repulsive forces, it is noway surprising that an impulse communicated to any of these bodies should in like manner be diffused throughout the mass; and this must be by the same species of internal oscillations among the particles.

Such being the nature and propagation of sound, and its actual velocity as determined by experiment, it has long been the study of philosophers to reconcile these effects with those physical properties of the air and of liquid bodies, which are known from other circumstances, and can be calculated by the laws of mechanics, aided by the powers of mathematical analysis. This subject is investigated in the following Part; written, as already mentioned, by Professor Leslie. (G. B.)

## Part II.

The doctrine of sound is unquestionably the most subtile and abstruse in the whole range of physical science. It has given occasion, in recent times, to much controversy and discussion, and has eventually called forth all the mighty resources of a refined and elaborate calculus. Yet an evident obscurity still remains to overcloud the subject. The discrepancies between theory and observation have been made entirely to disappear from astronomy, which has at last attained a degree of perfection befitting the sublimity of the science. But some latent suspicions pervade the structure of acoustics, sufficient to disturb that feeling of confidence which is calculated to invigorate our pursuits.

Sound conveyed by a certain tremor.

The impression of sound is conveyed by means of a certain tremor or internal agitation, which shoots, with more or less celerity and force, through any substance, whether solid or fluid. Nor is it requisite that the conducting medium should belong to the class of bodies which are commonly denominated elastic. In fact, all bodies whatever, in the minute and sudden alterations of their form, exert a perfect elasticity, and only seem to want this energy when they undergo such great changes that their component particles take a new *set* or arrangement, which prevents the full effect of re-action.

It is not every kind of tremulous motion, however, that will excite the sensation of sound. A certain degree of force and frequency in the pulsations appears always necessary to affect our sense of hearing. Yet the impression of sound is not confined to the mere external organ: the auditory nerves have a considerable expansion, and sympathize with those of taste and of smell. The only inlet of vision is by that very narrow aperture, the pupil of the eye; but the reception of sound partakes more of the character of the general sense of feeling, which, though most vivid at the extremities of the fingers, is likewise diffused over the whole surface of the body. The intimation of the ear is accordingly assisted by the consent of the palate, the teeth, and the nostrils. Fishes hear very acutely under water, though the organ itself lies so concealed in the head as to have long escaped the diligence of anatomists.

It was formerly supposed, that the transmission of impulse through a solid body is perfectly instantaneous. This formed, indeed, one of the Cartesian tenets, which Newton himself has tacitly admitted. But accurate observations have since proved, that motion is always really progressive, and propagated in succession. Professor Leslie has shown that the darting of impact through any substance, whether hard or soft, is accomplished by the agency of the same interior mechanism as that of sound, and has furnished the method of calculating, in some of the more difficult cases, the celerity of transmission.

All bodies essentially elastic.

All bodies may be considered as composed of physical points, without any sensible magnitude, but connected together by a system of mutual attraction and repulsion. When those integrant particles are compressed by external violence, a repulsive force is exerted to regain their first position; or if they be dilated, a corresponding attraction now draws them back to their neutral site of equilibrium. We may further presume, that in solids these constituent forces are confined to the proximate particles only, but that in the case of liquids or other fluids they embrace the particles in their near vicinity, and include a sphere of action varying in its extent. Hence, the former suffer disruption, without bending or giving way to powerful pressure; while the latter, acting by a sympathetic union, gently recede and take a new arrangement. In fact, the attribute of hardness applied to body is only a relative, and not an absolute quality; in the inferior degrees it relapses into softness, and softness again passes through interminable shades to the most yielding fluidity. The application of heat, by enlarging the system of internal connection, generally promotes softness, and heightens the degree of fluidity itself. The effect is conspicuous in the increased flow from a capillary syphon, when kept warm. But even liquids, when struck with a blow so rapid and sudden as to preclude the sympathy of their adjacent molecules, will assume all the character of the hardest substances. This fact has a familiar illustration in the play of duck and drake; but it is beautifully exemplified in the successive rebounds made by cannon-shot, from the surface of the sea.

In confirmation of the remark, we may quote a very singular and curious circumstance, mentioned by travellers, relative to the method of catching fish, which is successfully practised in some of the more northern countries. The hardy peasant, when the smaller lakes and rivers of Lapland or Siberia are completely frozen over, as soon as he observes, through the clear ice, a fish, perhaps at a considerable depth, but lying close to the bottom, strikes a smart blow against the firm surface, and the impulse sent through the vertical column of water instantly stuns or kills his prey, which he draws up by a large hook let down through the hole just made in the ice.

If we conceive a conducting substance to be struck at one extremity, the proximate particles, yielding at first to the impulsion, will again expand themselves, like the recoil of a spring, and press against the next particles in the chain. The vibratory commotion will thus be conveyed, by a successive transfer of impressions, along the whole series of physical points. Analogous also to the

Acoustics. oscillations of a spring or a pendulum, this multitude of concatenated internal pulses, whatever be the force or extent of agitation, will constantly be performed in the same instants of time. The celerity of transmission must depend on the elasticity of the medium compared with its gravity. This estimate is most readily obtained by determining what may be called the *modulus* of elasticity, or the height of a column of the same density as the conducting substance, whose weight would measure that elasticity; or, to speak more precisely, that the thousandth part of such a column, for instance, should be equivalent to the repulsive force corresponding to a condensation of one thousandth part in the vibrating body. It may be demonstrated from the principles of dynamics, that the celerity of the transmission of impulse or sound through any medium is equal to what a falling body would acquire in falling through half the height of the modulus of elasticity. Hence this celerity for each second will be expressed in English feet by multiplying the square root of half the modulus by 8, or by extracting the square root of the modulus multiplied by 32.

*Modulus of elasticity.*

Celerity of sound through different solid bodies.

Mr Leslie has pointed out a very simple method for ascertaining the modulus of elasticity in the case of solid rods or planks, by observing, when they are laid in a horizontal position, with their ends resting against two props, the *swag* or curvature which they take. By an experiment of this kind, he found that Memel fir had a modulus equal to 671,625 feet. Wherefore, an impulse would shoot through the substance of a deal-board with the velocity of 4,636 feet each second, or about four times the rapidity of sound. Professor Chladni, who has thrown so much curious light on the convoluted curves formed by vibrations spreading along the surface of solid bodies, inferred, from a very different procedure,—from the musical note which a bar of the substance emits when struck,—the celerity of the transmission of sound through iron and glass, which he reckoned for both at 17,500 feet, or above three miles each second, being more than fifteen times swifter than the ordinary communication through the atmosphere.

The rate with which the tremor of sound is transmitted through cast-iron, was very lately ascertained, from actual experiment, by the ingenious M. Biot. This philosopher availed himself of the opportunity of the laying of a system of iron pipes, to convey water to Paris. These pipes were about eight feet each in length, connected together by narrow leaden rings. A bell being suspended within the cavity, at one end of the train of pipes, on striking the clapper at the same instant against the side of the bell and against the internal surface of the pipe, two distinct sounds were successively heard by an observer stationed at the other extremity. In these observations M. Biot was often assisted by the late M. Malus, who has, too soon for the progress of science, been hurried away by death, after having opened the delicate discovery of the *polarization of light.* With a train of iron pipes of 2550 feet, or nearly half a mile in length, the interval between the two sounds was found, from a mean of two hundred trials, to be 2·79 seconds. But the transmission of sound through the internal column of air would have taken 2·5 seconds; which leaves ·29″ for the rapidity of the tremor conducted through the cast-iron. From other more direct trials, it was concluded that the exact interval of time during which the sound performed its passage through the substance of the train of pipes, amounted only to 26-100th parts of a second; being ten to twelve times less than the ordinary transmission through the atmosphere.

Except the observations of M. Hassenfratz, in the famous subterranean quarries which extend under almost the whole of Paris, we are not acquainted with any attempts that have been made to measure the elasticity of stone or brick. Yet sound is conveyed through these materials with great effect. The rattling of a carriage on the street spreads a very sensible tremor along the most solid buildings and the stateliest edifices. If a large stone be rubbed against the outside of the wall of a house, it will occasion within doors a strange rumbling noise. A miner will strike his pick against the side of a long gallery, when he wishes to give intimation to his companion, who listens at the other extremity. But stones or bricks, without being directly excited, may yet form a part of the chain which transmits sound, by receiving the tremulous impressions from the air on the one side, and delivering them again to that fluid on the other. We all know how easily the voice is heard through a thin partition. The mode of obstructing the passage of sound is, either to employ very thick masonry, or to interrupt the facility of communication and transfer, by means of subdivisions opposed. Hence another distinct use of lath and plaster. Experiments on the elasticity of stones and other articles of building are not only curious, but of real importance; for, in many cases, their efficient strength must depend on their fitness to resist incidental impressions. This consideration is peculiarly necessary in selecting and combining the materials employed in the construction of bridges.

Supposed incompressibility of water.

Respecting the elasticity of water and other liquids, our information is more satisfactory and complete. It was long held as an axiom, that the substance of water is absolutely incompressible. Yet the experiments on which this belief was grounded would, if weighed attentively, point to an opposite inference. On such a subject it were idle to cite Lord Bacon, whose credulity and ignorance of mathematical science betrayed him so often into false or shallow conclusions. The philosophers of the Florentine academy *del Cimento* tried the compression of water in three different ways, which are described in the account of their experiments printed in 1661. 1. Having provided two glass tubes terminated by hollow balls, they filled the one partly and the other to excess with pure water, and joined the tubes hermetically, so as to form one piece. Then applying heat to the first ball till the water boiled, they forced its vapour to press against the column in the other stem. But no contraction of the fluid took place, though a copper ball was afterwards substituted; and when the action of the heat was still farther urged, the tube at last burst with violence. 2. Into a glass tube, immediately above six pounds of water, they introduced eighty pounds of quicksilver, without causing any diminution of volume. 3. Their most noted experiment was, having filled a hollow silver ball with water by a small hole, afterwards soldered accurately, to give it a few smart blows with a hammer; when, far from suffering compression, the water was seen to ooze or spirt from the pores, as they imagined, of the silver.

Mr Boyle, whose practice it was generally to repeat the more striking experiments made on the Continent, had a round tin or pewter vessel filled carefully with water, and tightly plugged: the blow of a wooden mallet beat it flat, but on piercing the tin with the point of a small nail, the confined water instantly sprung to the height of two or three feet. About the year 1752, Dr Peter Shaw, who read public lectures in London, exhibited a stout copper ball of four inches in diameter, and filled with water by a small orifice, into which a screw was fitted, and forced to enter by turning an iron arm or lever: the globe was partly opened by this enormous

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Acoustics. squeeze, and the water spouted from the crevice as from a fountain.

These experiments all concur to show that water is capable of sustaining an immense pressure without undergoing any very sensible contraction; but they prove, at the same time, the actual existence of such a contraction, since the projecting of the water, after a crack has once begun in the vessel that confines it, could only proceed from the evolution of an internal repulsive force. Divers, accordingly, at considerable depths under water, hear distinctly the collision of two stones, or the remote ringing of a bell. Authentic instances are mentioned of sounds being transmitted audibly more than two miles through that fluid.

Compressibility of water demonstrated by Mr Canton.

The compressibility of water was first demonstrated by the ingenious Mr Canton in 1762, by a very simple and conclusive experiment. To a glass ball of rather more than an inch and half in diameter, he joined hermetically a tube about four inches long, and having a bore equal to the hundredth part of an inch. The relative capacity of this ball and of the stem he ascertained by introducing mercury, and weighing nicely its separate portions. The stem was then marked by the edge of a file into divisions, corresponding each to the hundred thousandth part of the whole capacity of the ball. This instrument was now filled with distilled water, carefully purged of its adhering air, and placed under the receiver of a pneumatic machine: on producing an exhaustion, the water appeared constantly to swell, rising four divisions and three-fifths in the stem, or a space nearly equal to the mercurial expansion corresponding to half a degree of heat on Fahrenheit's scale. In a condensing engine, the water sunk just as much, for each additional pressure of an atmosphere,—the bulb remaining always at the same temperature, or at the fiftieth degree of Fahrenheit. Since the stem was left open, the pressure exerted by the air, both on the inside and the outside of the instrument, must in all cases have been precisely the same; and consequently, the glass had no disposition to alter its figure, and modify the results. The contraction or expansion produced was, therefore, confined wholly to the body of water and to the thin shell of glass, of which indeed the influence might be rejected as insignificant. It was hence decided that the purest water suffers a visible concentration, or a diminution of its volume, under a powerful compression. But, in the course of his experiments, Mr Canton observed a curious circumstance, that water is more compressible in cold than in warm weather. Thus, the contraction, under a single incumbent atmosphere, amounted to 4·9 divisions when the thermometer stood at 34°, but was only 4·4 divisions when the heat rose to 64°. This singular fact might afford room for speculation; but it were better, in the mean while, to repeat the experiment again with more delicacy, and on a greater scale.

Compressibility of other fluids.

The compression of some other fluids was likewise measured in the same way. The contraction, under the weight of an atmosphere, and at the ordinary temperature, amounted, in millionth parts of the entire capacity of the ball, to sixty-six with alcohol, to forty-eight with olive oil, to forty with sea-water, and only to three when mercury was opposed. We may therefore estimate, in round numbers, the modulus of elasticity belonging to those different substances as under:

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|---|---|
| Alcohol | 580,000 English feet. |
| Distilled water | 700,000 |
| Olive oil | 730,000 |
| Sea-water | 780,000 |
| Mercury | 800,000 |

In liquids of so distinct a nature, we should have expected a greater diversity in their elastic power; nor is it easy to conceive on what conditions or habitudes that quality actually depends. The elasticity of a body, like its other constitutional properties, may result from the peculiar internal structure, or the arrangement of the integral molecules.

Some experiments on the compressibility of water have been since performed with more striking effect, but not equally exempt from all objections. In 1779, Professor Zimmerman of Brunswick printed a short account of some trials made by him and Abich, director of the salt-mines, with a press of a particular construction, consisting of a tight cylinder of very thick brass, with a piston nicely fitted, to be pushed down by means of a long lever, at whose extremity different weights were appended. Rain-water being introduced into the cavity, was subjected to an enormous pressure, equivalent to that of 313 atmospheres, and had its volume then diminished between one thirty-fifth and one thirty-sixth part. This quantity gives, for the effect of a single incumbent atmosphere, a condensation amounting to seventy-five millionth parts, instead of forty-six, as found by Mr Canton. The excess was no doubt owing to the distention of the brass cylinder, which, with all its strength and solidity, would yet partially yield to the action of such prodigious force. This circumstance renders the experiment somewhat unsatisfactory, and the influence of friction must likewise affect the accuracy of the calculation.

Zimmerman.

The effect of such distention is easily witnessed in the case of glass. If a large bulb of a thermometer be suddenly squeezed between the finger and the thumb, the mercury will start up in the stem perhaps several degrees, and will again sink as quickly after the pressure is removed. To prevent any derangement from communication of heat, the hand may be covered with a thick glove. But the fact can be shown in a less exceptionable way: Let a mercurial thermometer, with a large bulb and a long stem, be first held upright, and then immediately inverted; between these two positions the column of mercury will descend through a visible space. This apparent change of volume has been hastily supposed by some experimenters to mark the compressibility of mercury, which could not be sensible but under the action of a column of incomparably greater height.

Bramah's hydraulic press.

It would be most desirable to institute a new set of observations on the condensation of different substances, by means of Bramah's hydraulic press, which is a far more perfect machine, and scarcely subject at all to the disturbance of friction. Having once ascertained the distention of the metallic cavity from pressure, it would be hence easy to correct all the other results. This mode of experimenting promises also the important advantage of enabling us to determine, with ease, the compressibility of solids themselves. It would only be required to give those bodies a cylindrical form nearly adapted to the cavity, and to fill up the interstice with water, or rather with mercury. The contraction which the thin sheet of fluid would undergo, being deducted from the whole contraction, would exhibit the contraction suffered by the solid nucleus.

Celerity of sound through water.

From all these investigations we may gather, that an impulse, or a sonorous tremor, would shoot through a body of fresh water with the velocity of about 4,475 feet each second, being four times swifter than the ordinary flight of sound in the atmosphere. Through the waters of the ocean, the transmission of sound would be still more rapid, by a seventeenth part. It hence follows, that a violent commotion, excited under that vast mass, might reach from pole to pole in the space of three hours and twenty minutes.

The swell of the sea is accordingly always observed to precede the coming storm. The shocks of the famous earthquake at Lisbon, in 1755, were partially felt at very distant points of the ocean, as far even as the West Indies, but after a considerable interval of time.

and through ice.

Respecting the power of ice to conduct sound, we possess not sufficient data for the solution of the problem. The Danish philosophers are indeed said to have lately performed experiments of this kind on a very extensive scale, along the frozen surface of the Baltic. We are not acquainted with the precise results; but it seems probable, from various analogies, that ice has nearly the same faculty of transmission as water itself. If a heavy blow be struck against any part of the frozen surface of a large pool or lake, a person standing at a wide distance from the spot will feel, under foot, a very sensible tremor, some considerable time before the noise conveyed through the atmosphere has reached his ear. It is asserted, that the savage tribes who rove on the icy steppes of Tartary can readily distinguish, from afar, the approach of cavalry, by applying their head close to the frozen surface of the ground.

Propagation of sound through the atmosphere.

But the proper and ordinary vehicle of sound is our atmosphere. Aristotle, deriving his information probably from the tenets of the Pythagorean school, seems to have acquired tolerably just notions of the nature of sound and of the theory of harmonics. The language of that philosopher was so much corrupted, however, and disguised by ignorant transcribers, that Galileo, who not only studied music as a science, but practised it as a delightful art, may be fairly allowed to have rediscovered those general doctrines. Mersenne and Kircher afterwards made a variety of most ingenious experiments, which, though rather overlooked at the time, tended greatly to extend the science of harmony. But it was reserved for the genius of Newton to sketch out the true theory of sound.

Newton's theory of the propagation of sound.

In his *Principia* he explained the origin of aërial pulses, and, by a fine application of dynamics, conducted with his usual sagacity, he succeeded in calculating their celerity of transmission. The solution which he has given of this intricate problem is far, however, from being unexceptionable in the form and mode of reasoning. Instead of attempting to embrace all the conditions affecting the problem, in a differential equation, for which, indeed, his fluxionary calculus was not yet far enough advanced, he proceeds less boldly, and only arrives at the conclusion by an indirect process and a sort of compensation of errors. His investigation of the progress of sound through the air is chiefly drawn from the analogy of the motion of waves along the surface of water. This comparison greatly assists our conceptions, but it fails in a variety of essential points. Newton further assumed the rising and subsiding of waves to be a reciprocating motion, similar to that of the oscillations of a fluid contained in a wide and long tube, with its ends turned upwards. On this supposition, it was not difficult to prove, that those alternating movements would correspond to the vibrations of a pendulum of half the length of the tube. Transferring the inference, therefore, to the undulations of a fluid, it followed, that the space between two consecutive waves would be described during the sweep of a pendulum having a length equal to this interval. But the conclusion does not very well accord with the phenomena. That a wave travels with a velocity as the square root of its breadth, may be nearly true; and that its reciprocating motions, whatever be the height, are all performed in the same time, is a necessary consequence of the great principle in dynamics first pointed out by Huygens and Hooke,—that when the effort to restore equilibrium is proportioned to the quantity of displacement, the alternations of figure are constantly isochronous. But the velocity of the undulating progression, as calculated from those principles, will not be found to correspond with actual observation. Newton was apparently sensible of this disagreement, and would consider his proposition as only an approximation to the truth; assigning as the cause of discrepancy, *that the particles of water do not rise and fall perpendicularly, but rather describe arcs of a circle.* The great defect of the hypothesis, however, consisted in supposing all the parts of a wave to rise up and sink together in the same spot. The fact is, that the fore part of a wave is always in the act of ascending, while the hinder part of it is as constantly subsiding; which combined but contrary movements, without actually transferring any portion of the water, give an appearance of progressive advance to the swell.

In extending this theory to the propagation of sound, Newton was, on the whole, more successful. It resulted from his investigation, that the aërial pulses fly uniformly, spreading themselves equally on every side, and with a celerity equal to what would be acquired by a body in falling through half the height of the modulus of the air's elasticity. This modulus, or the altitude of a column of air, of uniform density, and whose pressure would be equivalent to the ordinary elasticity of that fluid, was computed in the first edition of the *Principia*, which came out in 1687, on the supposition that water is 850 times denser than air, mercury $13\frac{1}{2}$ times denser than water, and that the mean height of the barometer is thirty English inches. The modulus of elasticity, or the height of an equiponderant column of air, was therefore estimated at 29,042 feet, which gave 968 feet each second for the celerity of the transmission of sound through the atmosphere. In the next edition, which did not appear till twenty-six years thereafter, the computation of the modulus was somewhat altered, but certainly not rendered more correct. Assuming the same standard of barometric height as before, and supposing mercury to be $13\frac{2}{3}$ times heavier than water, and water 870 times heavier than air, the modulus would be 29,725 feet, to which the corresponding velocity of sound is 979 feet in the second.

His correction of the theory.

In these successive estimates, there is perhaps betrayed some desire to magnify the result, yet without nearly approaching to the amount of actual observation. Dr Derham had recently determined, from repeated trials made with care, that the ordinary flight of sound is at the rate of 1142 feet each second; and Newton endeavoured, by some very strained hypotheses, to accommodate his calculation to this correct measure. 1. He supposes the particles of air to be perfectly solid spherules, whose diameter is the ninth part of their mutual distance. Sound, being instantaneously communicated through these, would thus have its velocity increased by one-ninth, or 109 feet, or brought up to 1088 feet in the second. 2. He next assumes, that the particles of vapour concealed in the air, and augmenting the common elasticity without partaking of the impression of sound, amount to a tenth part of the whole. This would increase the celerity of the sonorous pulse in the subduplicate ratio of 10 to 11, or as 20 to 21 nearly, and consequently advance the last measure from 1088 to 1142 feet.

Remarks on these corrections.

But these random and fanciful conjectures hardly require any serious consideration. What may be the size of the ultimate particles of air, or whether they have any sensible magnitude at all, we are utterly without the means of determining. There appears no limit, indeed, to the degree of condensation of which the air is capable, but what proceeds from the imperfection of the engines employed for that purpose. Nay, supposing so large a proportion of absolute matter to exist in the composition of our atmosphere, it really would not affect the result, since the transit of sound, as we have shown, is necessarily progressive, even through the most solid substance. To this principle there could be no exception, unless the particles of air were held to be mere atoms, incapable of further subdivision,—in short, without actual magnitude, and therefore bearing no relation whatever to the space in which they float. The second hypothesis advanced is still more insufficient to rectify the general conclusion. That moisture, in its latent or gaseous form, is united with the air, will be granted; but it by no means constitutes so notable a share of the fluid as Newton has assumed, scarcely exceeding, at the ordinary temperature, perhaps the five-hundredth part of the whole weight. But this diffuse vapour could not in the least derange the original calculation; for, being always combined with the air, the measure of elasticity assigned by experiment was really that of the compound fluid which forms our atmosphere.

Rectified calculation of the velocity of sound.

We are now enabled, by the help of more perfect data, to rectify the modulus of atmospheric elasticity, or the height of a homogeneous and equiponderant column of the fluid. From the observations made with barometrical measurements, it appears that such a column, exerting a pressure equivalent to the elasticity of the air, has, at the limit of freezing water, an altitude of 26,060 feet, and consequently, that the modulus would, at an ordinary temperature of 62° by Fahrenheit, amount to 27,800 feet. This corrected estimate gives only 943 feet each second for the celerity of sound. And since the elasticity of the medium is exactly proportioned to its density, the result is the same, whatever be the rarefaction or condensation of the air, so long as its temperature continues unaltered. The flight of sound is hence as rapid near the surface as in the higher regions of the atmosphere. It is the conjunction of heat alone that will increase the celerity of transmission, by augmenting the elasticity of the medium without adding to its weight. The acceleration thus produced must amount to rather more than one foot in the second for each degree by Fahrenheit's scale. Such a difference ought to be perceptible under the torrid zone.

Rate of transmission through different gases.

But the rate of the transmission of sound must vary in different gases, after the inverse subduplicate ratio of their densities. Thus, through carbonic gas, the communication of the tremor would be about one-third slower than ordinary; but through hydrogen gas, which is twelve times more elastic than common air, the flight would very nearly exceed three and a half times the usual rapidity. An admixture of this gas with the atmosphere would, therefore, greatly accelerate the transmission of sound. The joint combination of heat and moisture, by heightening the elasticity of the air, must likewise produce a similar effect.

Experiment in France,

These inferences are confirmed by observation, as far as it extends. The velocity of sound was determined with considerable accuracy, and on a great scale, by Cassini and Maraldi, while employed in conducting the trigonometrical survey of France. During the winter of the years 1738 and 1739, these astronomers repeatedly discharged, at night, when the air was calm and the temperature uniform, a small piece of ordnance, from their station on Mont Martre, above Paris, and measured the time that elapsed between the flash and the report, as observed from their signal tower at Montlehery, at the distance of about eighteen miles. The mean of numerous trials gave 1130 feet for the velocity of the transmission of sound.

and in America.

About the same time, Condamine, who was sent with the other academicians to ascertain the length of a degree in Peru, took an opportunity of likewise measuring the celerity of sound, at two very different points. He found this was 1175 feet on the sultry plain of Cayenne, and only 1120 feet on the frozen heights of Quito. It was obvious, therefore, that the rarefaction of the air in those lofty regions had in no degree affected the result. Compared with what had been observed in France, the velocity of the aërial pulses was somewhat diminished at Quito by the prevailing cold, but was, on the other hand, considerably augmented by the excessive heat and moisture which oppress Cayenne.



But the difference, amounting indeed to one-fifth of the whole, between the velocity of sound as deduced from theory, and as determined by actual experiment, still appeared very perplexing. This want of congruity was the more felt, since the Newtonian system of gravitation, after maintaining a long struggle with the adherents of the Cartesian philosophy, had at last obtained the undisputed possession of the Continent. Its triumph was insured by the admirable dissertations on the subject of tides, transmitted to the Academy of Sciences at Paris in the year 1740, when our celebrated countryman Maclaurin had the honour of sharing the prize with Euler and Daniel Bernoulli. The law of attraction received, indeed, a temporary shock a few years afterwards, from the result of the investigation which Clairaut first gave of the lunar inequalities; but, on resuming his analysis of the problem, and computing the values of the smaller terms of the formula, that great geometer obtained, in 1752, a final product, exactly conformable to the best astronomical observations; and the solidity of the Newtonian system was henceforth placed on the firmest foundation.

It was therefore peculiarly desirable to examine likewise the justness of the hydrodynamical conclusions of Newton. The propositions concerning the propagation of sound were perhaps justly considered as the most obscure part of the whole *Principia*. Some of the first-rate mathematicians abroad, particularly D'Alembert and John Bernoulli, declared their utter inability to comprehend such intricate and disjointed demonstrations. At last the problem of sonorous pulses was attacked directly and in its full extent, by the late Count Lagrange, whose death, although at a ripe age, will be lamented as a most severe loss to mathematical science. That illustrious geometer shone forth at once like a meteor, and before he had completed his twenty-third year he gave a rigorous and profound analysis of the propagation of sound through the atmosphere, in the first volume of the Turin Memoirs, which appeared in 1759. "He pointed out some mistakes that even Newton had committed in the reasoning; but mistakes which, by a happy compensation of errors, did not affect essentially the results. Advancing from these discussions, he assigned the dynamical conditions of undulation, which, after the proper limitations, were reduced to an equation involving *partial differences* of the second order. But this refined branch of analysis, invented by D'Alembert and Euler, is still so imperfect, that, in order to integrate the final expression, it had become requisite to omit the higher powers of the differentials. Yet after all this display of accurate research and skilful adaptation of symbols, followed by a lax and incomplete calculus, the same conclusion was obtained as that which Newton had derived chiefly from the force of analogy and sagacity of observation; and philosophers were thus obliged to submit, and to content themselves with recording the variance between theory and experiment in regard to the celerity of sound, or with referring that discrepancy to some extraneous influence." (*Edinb. Review*, vol. xv. p. 431.)

Investigation of La-Grange.

M. Poisson, one of those interesting men whose native

Acoustics. genius has surmounted all the obstacles of fortune, very lately attempted a more complete analysis of the propagation of sound, in the Papers of the Polytechnic School. The final equation is more fully expressed, and its integration is pushed some few steps farther; but still the result is precisely the same as before. The skill and precaution displayed in framing the conditions of the problem are afterwards mostly abandoned in the various simplifications adopted to arrive at the conclusion.

Rectification of the theory by Laplace.

A very ingenious and apparently satisfactory method of reconciling theory with observation, in the estimate of the transmission of sound, was not long since suggested by the celebrated Count Laplace. If the heat contained in air had, at every state of the density, been united constantly after the same proportion, the elasticity resulting from the infusion of this subtile and highly distensible element would invariably accord with what observation assigns to the compound aërial fluid. But the capacity of air, or its aptitude to retain heat, varies with its internal condition; being increased by rarefaction, and proportionally diminished by condensation. When air is compressed, therefore, it liberates a portion of its heat; and when it undergoes dilatation, it becomes disposed to abstract more heat from the adjoining bodies. Till the equilibrium of heat is restored, the air will be sensibly warmer after each act of compression, and colder when suffered to dilate. If the shock given to a portion of air be very sudden and violent, the quantity of heat evolved from it is profuse and powerful. On this principle, M. Mollet, member of the academy of Lyons, led by some facts noticed by artists who manufactured wind-guns, first constructed, in 1804, the curious instrument for producing fire by the rapid condensation of air confined in a tube. But such evolution of heat must besides augment the elasticity of the air, as the contrary abstraction of it will, in a like degree, diminish that force. At every sudden alteration of density, therefore, a new power is infused, which had not entered into the ordinary and undisturbed estimate of the air's elasticity. Consequently, from this consideration alone, the aërial pulses must shoot with some greater celerity than calculation assigns, because the particles of air, which are suddenly condensed, have their elasticity further augmented by the portion of heat evolved, while the corresponding particles, which are simultaneously dilated, have their disposition to contract likewise increased, by the momentary prevalence of cold.

Examination of this correction.

The principle advanced by Laplace must therefore have a real operation, tending to reconcile the calculated velocity of sound with that which is deduced from experiment. The only question is, how far its influence could actually extend. But, according to the formula given in Leslie's *Elements of Geometry*, p. 495, a condensation equal to the 90th part of the volume of air would occasion the extrication of one degree of heat by Fahrenheit's scale. Now, since each degree of heat enlarges the bulk or augments the elasticity of the air by the 450th part, it follows, that the heat, extricated by sudden impulse, will communicate to the air a momentary additional spring, amounting to one-fifth of the whole elastic force. Wherefore the celerity of sound would, by that influence, be increased in the subduplicate ratio of five to six, or nearly as 21 to 23; which gives an addition of only 90 feet each second to the whole quantity, bringing it up to 1033 feet. The correction is thus insufficient, not amounting to half of the discrepancy which it was its object to reconcile.

It may be suspected, therefore, that some inaccuracy or omission infects the investigation itself. Till the integral calculus has arrived at much greater perfection, it will often be requisite for the analyst, in the solution of dynamical problems, to descend from his elevation, and seek to simplify the differential expressions by a sober and judicious application of the principles of physics. "Imagine a string of particles, or physical points, A, B, C, D, E, F, &c. in a state of rest, or mutual balance. If A were pushed nearer to B, and then suddenly abandoned, it would recoil with a motion exactly similar to the oscillation of a pendulum. The time of this relapse might easily be determined, from a comparison of the force of gravity with that of elasticity, or from the number of particles contained in a column of equipoise. The minute interval between the adjacent particles, being now divided by the duration of each fit of contraction, will give the velocity with which the vibratory influence shoots along the chain of communication. This simple investigation leads still to the same result as before. But it proceeds on assumptions which are evidently incorrect; for it supposes the pulses to follow each other in accurate succession, every contraction terminating as the next begins. Since the particles, however, do not exist in a state of insulation, while B repels A, it must likewise press against C; and C, in its turn, must gradually affect D. Before the contraction of A and B is completed, that of B and C is therefore partially performed; and this anticipated influence may even extend to the remoter particles. Nor is the system of mutual action at all materially disturbed by such anticipations. Each pulsation is performed in the same way as if it were quite detached; only the succeeding one is partly accomplished before the regular period of its commencement. The velocity of aërial undulation is in this way much accelerated." (*Edinb. Rev.* vol. xv. p. 433.) Each successive movement among the particles may be viewed as produced by a force not regularly decreasing, but partaking of the uniformity which obtains in projection. Hence the velocity of sound is intermediate between that derived from theory and that with which air would rush into a vacuum. But the arithmetical mean between 943 and 1334 feet is $1138\frac{1}{2}$, and the geometrical is $1121\frac{1}{2}$ feet; neither of which differs much from 1130 feet, the quantity determined by actual experiment.

Modifications required in the theory of sound.

After the last correction, however, proposed by M. Laplace, for adjusting theory with observation relative to the celerity of the transmission of sound, the difference will not perhaps be regarded such as longer to present any serious obstacle; especially when the coincidence appears closer than what generally attends the theoretical deductions concerning the motions of fluids. The remaining difficulties affecting the subject refer chiefly to the way in which the aërial pulses are propagated, and the modifications which they are afterwards capable of receiving.

Duration and strength of pulsation.

1. No sensation is ever excited, unless the impression made upon our organs be repeated or continued during a certain short space of time. On this principle depends the whole success of the juggler, who contrives to change the situation of the various objects before us with a rapidity exceeding the ordinary exercise of sight or touch. A brand whirled swiftly round the head gives all the appearance of a circle of fire; and if one presses very hard an ivory ball between his fingers, he will seem still to feel it for several instants after it has been withdrawn. To excite the sensation of sound, it is requisite that the aërial pulses should have a certain force and duration. According to some observations, the ear is not affected at all, unless the tremulous impulse communicated to the tympanum lasts during the tenth part of a second. Every pulsation of a more transient kind is lost absolutely and completely to our organ of hearing.

On the other hand, the impression of sound is not prolonged beyond the time of its actual production. If it were otherwise, indeed, all sounds would degenerate into indistinct noises; and articulate discourse, which distinguishes man from the lower animals, and constitutes the charm of social life, would have been utterly impossible. This fact, so obvious, and yet so important, shows indisputably that the propagation of sonorous pulses through the atmosphere is not, in all its circumstances, analogous to the succession of waves on the surface of water. These undulations continue long afterwards to rise and spread from the centre of their production. The pulsations of the air, no doubt, likewise survive their excitement; but such of them as succeed the first impulsion must not have the force and character of those which are directly shot through the fluid. What is the precise discrimination between these different pulses, we are not enabled from mere theory to determine. But such a distinction must undoubtedly exist, otherwise indeed all discourse would continue to fill the ear with a monotonous hum, or an indistinct muttering. It would be difficult to institute conclusive experiments on this subject, yet collateral researches might be devised which could not fail to guide our inquiry.

Concentration in a particular direction.

2. But another defect in the analogy between waves and sonorous pulses is, that the latter, without affecting to spread equally, are capable of acquiring a superior force or tendency in some given direction. Certain unconfined sounds, indeed, are diffused uniformly on every side. Thus, the noise of the explosion of a powder-mill is heard, and often dreadfully felt, at a great distance all round the scene of disaster. But the report of a cannon, though audible in every direction, appears invariably loudest in the quarter to which the engine is pointed. On this principle, a seaman, when he seeks to be heard more audibly, or at a greater distance, is accustomed, if no other help occurs, to apply his spread hands on each side of his mouth, and thus check or diminish the waste of sound by its lateral dispersion. For the same reason, the bent and projecting circular piece annexed to the farther end of a speaking-trumpet is of most decided use, in assisting to give direction to the flight of the aërial pulses.

Accumulation along barriers.

3. The theory of undulatory movements furnishes some elucidation, but no adequate explication, of the augmented effect of sound in the direction of a lateral barrier. The extension of such an obstacle might appear to check merely the spread and consequent attenuation of the sonorous pulses; but the great accumulation of impulse always occurs, on either side, at the extremity of the advancing wave. By what system of interior forces this effect is produced, it would be difficult satisfactorily to explain. Yet we perceive something analogous in the swell which runs along the margin of a pool, and in the billow which, flowing from the open sea, heaves against the sides of a projecting mole.

It is hence that sound is made to sweep with such intensity over the smooth surface of a long wall or of an extended gallery. An elliptical figure, though of manifest advantage, is not really essential to a whispering gallery; for the point of sonorous concentration is found beyond the true catoptrical focus, and much nearer to the wall. A fact of the same kind is well ascertained—that sounds are always heard the most audibly, and at the greatest distance, in a level open country, or still better on the smooth surface of a vast lake, or of the ocean itself. The roaring of the cannon in certain naval engagements has been noticed at points so very remote from the scene of action, as might seem, if not perfectly authenticated, to be altogether incredible. On the other hand, again, sound is enfeebled and dissipated sooner in alpine regions. Thus, the traveller, roving at some height above a valley, descries, with uncommon clearness, perhaps a huntsman on the brow of the opposite mountain, and while he watches every flash, yet can he scarcely hear the report of the fowling-piece.

On a similar principle, we would explain the operation of the ear-trumpet, which affords such relief to one of the most cheerless maladies that can afflict humanity. The wide mouth of that instrument, it is well known, is turned to catch the stream of sound; the extent of pulsation is gradually contracted as the tide advances; and the same quantity of impulse being probably maintained, the vibratory energy is intensely accumulated at the narrow extremity, where it strikes the cavity of the ear. A trumpet of this form might, in many cases, be found very advantageous, not only for remedying the defects of the organ of hearing, but for assisting the observer to collect feeble and distant sounds. Even an umbrella held close behind the head, with its concavity fronting the sonorous pulses, will, it has been alleged, sensibly heighten their impression.

Reflection modified.

4. To explain legitimately the reflection of sound, would require some modifications in the theory of atmospheric undulation. Each obstructing point is certainly not the centre of a new system of pulses; for, in many cases, this would occasion unutterable confusion. Nor can the excitement of sound be supposed to dart in straight lines, or to perform the same accurate reflection as the rays of light. In fact, neither smoothness nor exact regularity of surface is required for the production of an echo. A range of buildings, a row of tall trees, a ridge of rocks, or a chain of heights, will, in certain positions, reflect sound with clear and audible effect. It follows, therefore, that the reflection must be formed, not at the immediate surface of those obstacles, which could occasion only an irregular dispersion, but at some boundary at a small distance, and running parallel to the mean direction of the whole barrier. We may conceive the tide of sound accumulating where it stops, and investing the opposite surface like an atmosphere, till a repulsion is exerted, which again rolls it back. What seems to constitute the perfection of an echo, is, that the sum of the distances of every point of the reflecting surface from the person who speaks, and from him who listens, should be the same. When this disposition obtains, all the reflected sounds must reach the ear in due succession, without being intermingled or confused.

We may observe, that echoes are often confounded with the mere *resonance* occasioned by vibrations excited among the obstacles themselves. In a large empty room, with its naked floor, and walls, and benches, the voice quickly throws the whole into a tremulous commotion, and seems drowned in the ringing prolonged sound which is produced; nor does this unpleasant effect cease, until the spectators have occupied the benches, filled the hall, and obstructed by their weight the vibration of the floor. What is called the *deadening* of sound, consists in merely checking or preventing the disturbance of extraneous tremor. For this purpose, the floor is covered with carpets, and the walls lined with wainscot or hangings. Such barriers, we have seen, would not, by their yielding quality, blunt or obstruct the formation of echoes. Their only effect is, to muffle the elastic surfaces which they cover.

Speaking trumpet.

The performance of the speaking-trumpet has generally been referred to the concentrated reflection of sound. Some authors have carried the hypothesis even so far as to investigate, from mathematical principles, the best figure of that instrument. Much labour and great ingenuity have been utterly wasted in this fruitless attempt.

Kircher proposed the tube to be shaped like a truncated parabolic conoid, the mouth-piece occupying the focus; and he concludes that all the *rays of sound* would, by reflection from such a surface, be sent forward exactly in parallel lines. Other philosophers have imagined, from a fanciful analogy to the property of ivory balls, that the figure described by the revolution of the logarithmic curve about its absciss would be the most proper for the speaking-trumpet. M. Lambert, of the Berlin academy, whose genius and originality were both of the first order, has given a solution still different. But it would be idle to recite the various attempts which have ended in no practical result.

The true physical explication of the speaking-trumpet was first given, as far as we know, in the course of an incidental remark by Professor Leslie, in his *Experimental Inquiry into the Nature and Propagation of Heat.* "In the case of articulate sounds," says he, "the confining of the air does not affect the pitch of voice, but it augments the degree of intonation. The lateral flow being checked, that fugacious medium receives a more condensed and vigorous impulsion. As the breath then escapes more slowly from the mouth, it waits and bears a fuller stroke from the organs of speech. But the speaking-trumpet is only an extension of the same principle. Its performance does certainly not depend upon any supposed repercussion of sound; repeated echoes might divide, but could not augment the quantity of impulse. In reality, however, neither the shape of the instrument, nor the kind of material of which it is made, seems to be of much consequence. Nor can we admit that the speaking-trumpet possesses any peculiar power of collecting sound in one direction; for it is distinctly audible on all sides, and is perhaps not much louder in front, comparatively, than the simple unassisted voice. The tube, by its length and narrowness, detains the efflux of air, and has the same effect as if it diminished the volubility of that fluid, or increased its density. The organs of articulation strike with concentrated force; and the pulses, so vigorously thus excited, are, from the reflected form of the aperture, finally enabled to escape, and to spread themselves along the atmosphere. To speak through a trumpet costs a very sensible effort, and soon fatigues and exhausts a person. This observation singularly confirms the justness of the theory which I have now brought forward."

Hassenfratz.

Nearly about the same time, this theory was confirmed by some ingenious experiments made by M. Hassenfratz, at Paris. His method of estimating the power of a speaking-trumpet consisted in fixing a small watch in the mouth-piece, and observing at what distance the beats ceased to be distinctly audible. He found that the effects were precisely the same with a trumpet of tinned iron, whether used in its naked form, or after it was tightly bound with linen to prevent any vibration of the metal. Nor could there be the smallest reflection of sound from the internal surface of the tube, for the beating of the watch was heard exactly at the same distance after the whole of the inside had been lined with woollen cloth. These simple experiments prove decisively that the performance of the speaking-trumpet depends principally on the intenser pulsation which is excited in the column of confined air. In the same way, sound is prodigiously augmented in a long narrow passage. If a musket be fired within the gallery of a mine, the explosion heard in a remote corner will have the loudness and character of thunder.

Sound of musketry.

The progressive motion of sound furnishes the explication of various remarkable facts and striking phenomena. Thus, to a person standing at some distance, and directly in front of a long file of musketry, the general discharge will appear as a single collected sound, the numerous reports all reaching his ear nearly at the same instant. But one stationed at the end of the line will hear only a prolonged rolling noise, not unlike a running fire; because the distinct sounds, from the different distances which they have to travel, will arrive in a continued succession.

Noise of thunder.

Hence, likewise, the tremendous rumbling noise of distant thunder, which is not produced, as many have supposed, by the repetition of echoes. In certain situations, indeed, and particularly in hilly tracts, echoes may no doubt contribute to augment the general effect; but their ordinary influence seems to be really insignificant, since it should cause the same modification of sound in the explosion of a cannon, which is essentially different, however, from the muttering and crash of thunder. This lengthened and varied noise must yet be the production of a moment. The rapidity of lightning surpasses conception, and the prolongation of the sound which follows it is owing to the various distances of the chain of points which emit the sonorous impressions. The electrical influence darts with immeasurable swiftness from cloud to cloud, till perhaps it strikes at last into the ground. But from every point of this tortuous path distinct pulses of sound are transmitted, which consequently reach the ear at very different intervals. Sometimes they arrive intermingled, and give the sensation of a violent crash; at other times they seem suspended, and form a sort of pause. It would not be very difficult in any case to imagine the zig-zag track which the lightning must pursue in order to produce a given protracted rumbling noise. The duration of each peal of thunder will evidently be shortened if it chance to shoot athwart, but must continue the longest when it runs in the line of the spectator. As the distance of thunder is estimated by allowing somewhat more than a mile for every five seconds that elapse between the flash and the beginning of the report, so the space traversed by the lightning, if its general direction were known, might be computed by the same rule, from the endurance of the sound.

Musical note.

We will not enter at present on that branch of acoustics which treats of the doctrine of harmony; but a few scattered remarks may trace the general outline of the subject. A musical note, far from being only a repetition of the same simple sound, should be considered as the conjunction of subordinate sounds reiterated at proportional intervals. The sweetness of this compound effect or tone appears to depend on the frequent recurrence of interior unison. The secondary sounds which naturally and invariably accompany the fundamental note are repeated only two, three, or four times faster; nor does the science of music admit of any proportions but what arise from the limited combinations of those very simple numbers. Harmony, again, is created by an artificial union of different notes, analogous to the natural composition of tone.

Vibrating instruments.

All tones are produced by the regular vibrations either of solid substances or of confined air itself. Strings of gut or of metal are most generally used; but small plates or pillars of wood, of glass, or even of stone, will answer the same purpose, forming the singular instrument called *staccata* or *harmonica.* In these cases, the quality of the vibrations depends on the joint influence of a variety of circumstances; not only on the length of the fibres, but on their thickness, their elasticity, their density, and the degree of tension to which they are subjected. The motion of a musical stretched chord was first investigated by the very ingenious Dr Brook Taylor, though his solution has been since proved to be incomplete. At the same time, in fact, that the whole chord oscillates, its simpler portions, the half, the third, and the fourth of its length, actually perform a set of intermediate vibrations.

Wind-instruments.

Wind-instruments produce their effect by the vibrations of a column of air confined at one end, and either open or shut at the other. These vibrations are determined merely by the length of the sounding column. Yet interior and subordinate vibrations are found to co-exist with the fundamental one. The whole column spontaneously divides itself into portions equal to the half, the third, or the fourth of its longitudinal extent. We shall more easily conceive these longitudinal vibrations, by observing the contractions and expansions of a long and very elastic string, to the end of which a ball is attached. A spiral spring shows still better the repeated stretching and recoil. If struck suddenly at the one end, it will exhibit not only a total vibration, but likewise partial ones, winding vermicularly along the chain of elastic rings.

But when the air is struck with uncommon force, the subordinate vibrations become predominant, and yield the clearest and loudest tones. This we perceive in the dying sounds of a bell, which rise by one or two octaves, and expire in the shrillest note. On such a very narrow foundation—on the variable force with which it is blown—rests the whole performance of the bugle-horn, whose compass is extremely small, consisting only of the simplest notes. In other wind-instruments, the several notes are caused by the different lengths of the tube, or by the various positions of the holes made in its side.

Tones produced by the burning of hydrogen gas.

The longitudinal vibrations of a column of air, contained within a tube open at both ends, are powerfully excited, and very loud and clear tones produced, by the inflammation of a streamlet of hydrogen gas. This curious experiment was made first in Germany, and appears indeed to have been scarcely known, or at least noticed in other countries. Yet it is most easily performed, and will be considered as amusing, if not instructive. A phial, having a long narrow glass pipe fitted to its neck, being partly filled with dilute sulphuric acid, a few bits of zinc are dropt into the liquid. As the decomposition of the water embodied with the acid now proceeds, the hydrogen gas thus generated flows regularly from the aperture, and is capable of catching fire, and of burning for some considerable time, with a small yet steady round flame. This very simple arrangement, frequently styled the philosophic lamp, is in reality of the same nature with the combination, on a large scale, of the gas lights. A glass tube being passed over the exit-pipe, the burning speck at its point instantly shoots into an elongated flame, and creates a continued sharp and brilliant musical sound. This effect is not owing to any vibrations of the tube itself, for it is nowise altered by tying a handkerchief tightly about the glass, or even by substituting a cylinder of paper. The tremor excited in the column of air is therefore the sole cause of the incessant tone, which only varies by a change in the place of the flame, or a partial obstruction applied at the end of the tube. But still it is not easy to conceive how the mere burning of a jet of hydrogen gas within the cavity should produce such powerful vibrations. The exciting force must necessarily act by starts, and not uniformly. The length of the flame might seem to prove, that the hydrogen gas is not consumed or converted into aqueous vapour as fast as it issues from the aperture. A jet of it catches instantaneous fire, but is immediately followed by another, the succession of inflamed portions being so rapid as entirely to escape the keenness of sight. The column of air contained within the tube would thus be agitated by a series of incessant strokes or sudden expansions.



The singular fact now described had occurred incidentally to the writer of this article in the course of his earliest experiments; and he has often thought since, that, on the same principle, an organ might be constructed, which would have a very curious and pleasing effect. A vertical motion of the glass tubes, and the partial shutting or opening of their upper ends, would occasion a considerable variety of notes. By passing the hydrogen gas over different metals, the flame would be made to assume various colours. The apparatus might work by a spontaneous mechanism; and while the eye was gratified by the display of rich and vivid tints, the ear would be charmed with strains of new and melodious symphony. (J. L.)

## Part III.

Distinction between musical and other sounds.

We shall here add some further explanations in regard to the nature of different sounds, and particularly of musical sounds.

Nothing appears more surprising than that variety of sounds which different bodies emit when excited either by percussion or by any other method. If we strike, for example, upon a log of wood, or a table, or a book, we obtain nothing but a harsh sort of noise, which ceases almost the moment it is emitted. Whatever shape we form the wood into, it makes hardly any difference. The same thing takes place with other bodies, such as metal, or glass, or earthen ware, &c. when these are in large masses; but how different is the case if we form them into rods or slips, into thin plates, or, still better, into cylindrical or hemispherical vessels, as cups, tumblers, bells, cymbals, &c. These, when struck, invariably emit a sound much more prolonged, and in general highly musical or grateful to the ear. What, then, is the cause of this remarkable distinction? All that we can observe generally in regard to these sonorous bodies when sounding is, that the whole body is agitated by an internal tremor, which continues so long as the sound can be heard. But if we examine them in their simplest forms, some very remarkable circumstances are brought to light. Take, for example, a slip of metal or glass, fix it firmly at one extremity, and then strike the other; the body, as in other cases, emits a prolonged and musical note, and becomes agitated with the usual sonorous tremor. This is particularly well observed in a common tuning fork. But the nature of this agitation is of a very simple kind. The slip merely oscillates backwards and forwards with great rapidity on the extremity by which it is fixed. Each of these oscillations, as the slip strikes the surrounding air, must produce a distinct sound; but these impressions following each other in very rapid succession, the ear can distinguish nothing but a single continued and prolonged note. The same thing takes place if we fix the slip at both ends, provided it be long enough and thin enough to oscillate in the middle; and this is the case with all kinds of distended wires or strings. These are fixed at the two ends, and when they are struck, as with the hammer of the key of the piano-forte, or drawn aside by the hand and then abandoned, they continue to vibrate for a long time, and to emit tones varying in gravity or acuteness, but all highly musical. One remarkable circumstance regarding the vibrations of these slips or chords is, that they are all performed in the very same time, however minute or however extended. They vary in different slips or chords, according to their length, tension, and other circumstances; but in the same slip or chord they are all alike. When any chord or slip is drawn out of the straight line and then abandoned, the oscillations are wide at first, but

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continually diminish in extent till they cease altogether, as at Plate I. *Fig.* 1. Now the smallest of these vibrations takes just as long time in its performance as the largest; and the latter, again, however wide, is performed just as quickly as the former. The reason is, that the force of elasticity, which produces the vibrations, increases as the chord is drawn farther from the straight line, and thus accelerates the wide vibrations in proportion to their extent, as can easily be demonstrated. The consequence is, that the successive impressions of sound which constitute the continued and prolonged note, all follow each other at the same interval; and the regularity with which these impressions successively fall on the ear appears to be one essential ingredient in that melody or agreeable effect which the sound produces. This is proved by a very simple experiment. If we sound one of the strings of a violin or violoncello, it emits for a long time the musical note which belongs to it; but if, while it is sounding, we move the finger quickly along it from the bottom upwards, so as to shorten continually the length of the string, to accelerate thereby the vibrations, and thus alter the regularity of their succession, the sound continues, but all sort of melody is gone. Some philosophers, and in particular Dr Robison, have thought that this regular succession of sonorous impressions is the only source of melody; but this is far from being the case, else how could we account for those diversities in the sweetness of different tones, produced by different instruments or from different sources? What can be more regular in succession than the impressions of sound from a distant water-fall? And accordingly the effect is soft and agreeable in a high degree, yet how inferior in melody to the tone of a fine bell, or of an organ, or the notes of a distant bugle. Another remarkable circumstance regarding the vibrations of these slips or chords is, that the sound is not emitted from the string itself so much as from the mass with which it communicates. If, for example, we strike a tuning fork gently, so as to make it vibrate, it emits a sound so feeble that it cannot be heard until we bring it close up to the ear; but if, when it is vibrating, we press the extremity on a table, or a book, or any similar substance, the sound becomes perfectly audible. In the same manner a distended wire, if quite insulated, hardly emits an audible tone; but set it on a board, or, which is still better, on a hollow box, and then the tones are loud, deep, and highly musical. Many authors who have treated this subject ascribe the sound to the wire or chord striking the air at every vibration. This, however, is but an imperfect view of what really takes place. The tones arising from this source are in general perfectly inaudible, and the use of the wire is rather to excite the vibrations in the mass with which it is connected. This is the true sonorous body; and in this manner even wood, which appears when struck the most tuneless of all substances, is yet made to emit tones of the most exquisite sweetness; as appears in the violin and violoncello, harp, and indeed in all stringed instruments. The wood appears incapable of having a continued series of vibrations excited in it by percussion; but the strings produce this effect in a very remarkable manner, and which has hardly received that attention from writers on Acoustics which it deserves. They put the whole mass of the wood into a tremor, they excite its vibrations, and they determine and govern their frequency and the regularity of their succession. These vibrations over the whole surface of the wood communicate an infinite multitude of similar vibrations in the air, all which reaching the ear at the same instant, produce those powerful and audible tones which we observe.

Let us now consider the nature of those remarkable distinctions of musical sounds into grave and acute, on the combination of which depends the whole charm of music. Every one knows, that in stringed instruments this depends entirely on the length and tension of the string, as is well observed in the violin. By shortening the strings with the fingers, we obtain notes always more and more acute; and by tightening the strings with the pins at their extremities, we produce the same effect. In different strings, also, another circumstance has a sensible effect, namely, the thickness or mass of the string: the greater this is, the sound is the more grave, and the less the more acute. All these effects are very clearly observed, and proved with mathematical accuracy, by means of an instrument termed the monochord or sonometer; which is an apparatus contrived for stretching different strings and causing them to sound by vibration, with props or bridges to vary their lengths, and weights suspended to vary and measure the different tensions, the vibrations of the strings being communicated to a hollow box of thin elastic wood, to augment the sound. *Fig.* 2. represents the instrument in an upright form, which is best adapted for experiment with tension, because the weight can be applied directly under the string without friction. *Fig.* 3. is a horizontal form: the weight here is applied over a pulley, and therefore the tension cannot be so very accurately measured. It answers, however, better for some other kinds of experiments, in regard to the length of the strings and the subordinate vibrations. Whichever of these forms of the instrument be used, we obtain invariably the same results. The more weight we apply to stretch any of the chords, the more acute does the sound become. If we lengthen the strings again in any degree, the more grave does the sound become; and the same takes place if we substitute a heavy for a light string. It is very remarkable, however, that if we examine these effects carefully, and apply the aid of mathematical investigation, they all resolve into one general law. Adding to the weight and tension on the strings, shortening their length and diminishing their weight, have all the same common effect; namely, to quicken their vibrations. It is on the single circumstance, therefore, of the quickness or slowness of the vibrations of the strings, in whatever way it is produced, that the acuteness or gravity of the tones depends. This, then, is the great law on which all the gradations of musical notes depend: quicken the vibrations of the chord by any means, and we are sure to sharpen the tone in the very same proportion: make the vibrations slower in any way, and in the same proportion does the tone become more grave. The above circumstances, however, do not all alter the rate of vibration in the same degree. If we shorten or lengthen the string, the vibrations are quickened or slackened, and consequently the tones made more acute or grave in the very same proportion: that is, a string half the length of another just makes double the number of vibrations in the same time, and one one-third of the length three times; one double the length, again, makes half the number of vibrations, and one triple the length one-third of the number. The effect of the tension, again, and the weight of the strings, follows a different law. If we load one string with double the weight of another, it does not double the number of vibrations: it requires four times the weight to do this, and nine times the weight to triple the number; the quickness being in all cases in proportion to the square root of the weight. The effect of the weight of the string follows a similar law; one string requiring four times the mass of another to make its vibrations in half the time, and nine times this to make them in one-third of the time. So that if we denote the length of the string by L, the weight

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of a lineal inch by W, and the weight or force of tension by T, then the number of vibrations, N, in a given time will be in proportion to $\frac{\sqrt{T}}{L\sqrt{W}}$.

On this law depends the construction of all kinds of stringed instruments, and the adjustment of the length, magnitude, and tension of the strings, to produce the tones that we wish in the instrument, without overstraining the materials, or making them any way liable to go out of tune. Accurate experiments, however, are wanting to apply with success the above formula to actual practice. On the above principle, also, of the velocity of the vibrations regulating the tone of every sound, depends entirely the system of our musical scale, as well as all those combinations of sound which constitute concord or harmony in music. Every one knows, that if with any sound we strike its octave at the same time, the two coalesce so completely together as to form almost a single continued note, which in music forms the most perfect concord. Now the octave above is emitted from that string whose vibrations are exactly double in number to the original note. The vibrations of the latter, therefore, must coincide completely with the former at every other vibration. The impression of both these reaches the ear at the very same instant, and thus the two sounds are blended into one. The intermediate sound of the octave which intervenes between these is hardly perceived, owing to the rapidity of their succession; and as it also recurs at regular intervals, it does not interrupt the harmony, but rather contributes to give fulness and richness to the combined tone. The same thing takes place, though in a less degree, with the double, the triple, and other octaves, and with all the different sounds which form concords together; and the more frequently the two sounds unite, the more perfect in every case is the concord. When they do not unite but at sensible intervals, there is then produced at each of these a distinct rise in the sound, which becomes suddenly louder from the union of the two, and then diminishes as they begin to separate, producing a succession of swells, or *beats*, as they are termed in music. The intervals between these beats are filled up by the vibrations of the two sounds occurring, first one and then the other; and as they form on the whole a very irregular succession of impressions, they produce a jarring effect, which grates on the ear. These combined sounds are hence termed *discords*. All this will be readily understood by an example or two, and a figure. Take first the fundamental tone and its octave; let the vibrations of each which produce the continued sound be represented by dots, as at *Fig.* 4; and when the two sounds concur, let this be denoted by dots larger in size: then the succession of impressions will be as at *Fig.* 5, where we have a regular succession of beats, recurring in such rapid succession that the ear can only distinguish a single sound. The octave also intervenes, but quite regularly, and also in such rapid succession, that it seems rather to heighten than to mar the general harmony. In the same manner, *Fig.* 6. represents the union of the fundamental sound and its double octave; which is the same system, only the beats are at wider intervals, and the intermediate octaves double in number. Take now two sounds, the number of whose vibrations are to each other as 2 to 3; that is, suppose one of them performs its vibrations in two very small parts of a second, and the other in three. If we take the annexed scale to represent the parts of a second, we easily form the series of sounds and of beats at *Fig.* 7. We have still, it will be seen, a regular succession of beats, but the intermediate single sounds do not recur at regular intervals. We have first an interval of two parts of a second; then we have three sounds succeeding each other during the other three parts; and then an interval of two parts between that and the beat. There is obviously, therefore, a tendency to discord; but the whole series occurs in such rapid succession that the effect on the ear is quite harmonious. Take now the proportion of 5 to 7. Here, as at *Fig.* 8, we have a regular succession of beats, but we have no fewer than ten intermediate single sounds, and these succeeding each other in a very irregular manner. We have all the elements of discord, therefore; and accordingly the union of these two sounds would be sure to grate on the ear, unless they were of so high a pitch that the beats should become inaudible. These would then produce, as before, a continued sound; and the effect of the intermediate ones would be in some degree, but not altogether, lost: we might have a concord, but not a very perfect one. It hence appears obvious why the union of some notes, which on a grave key are discordant, become harmonious by raising sufficiently the pitch. In the same manner, in every other case the greater the intervals between the successive conjunctions of the sounds, and the more irregular the succession of the intermediate impression, the greater will be the discord.

Such are the effects of combined sounds; but it is extremely remarkable that every single sound, besides its fundamental note, yields also spontaneously various others of the most perfect concord with it, but all higher, and each rising successively in pitch, so that they have hence received the name of *Acute Harmonics*. This curious and important fact, first noticed by Galileo, to whom also we are indebted for the theory of musical strings, has since excited much attention among succeeding philosophers, as well as among those skilled in the practice of music. In stringed instruments, it is best observed in the low notes of the piano-forte or violoncello. These were formerly thought to emit one simple uniform tone. An attentive ear, however, as is now universally allowed by musicians, can actually discover three others besides the original, viz. the octave above, the twelfth, and the double octave. This was first distinctly proved by Rameau; and the experiment is easily tried by striking one of the low keys, and withdrawing the finger briskly: then, after the fundamental note has ceased, the three shriller ones will be heard. The octave being in some measure blended with the original note, is not so easily perceived, except by an ear habituated to the minutest discrimination of sound. But with ordinary attention the twelfth and the double octave are heard distinctly.

Nothing in the whole science of Acoustics has given rise to so much speculation and varied discussion as this singular property of musical strings. It would appear at first sight to overturn the whole doctrine we have been laying down regarding the effect of the rapidity of the vibrations in regulating the tone; for here we have the same string yielding at once a diversity of notes, varying in a wide gradation from grave to acute. Can it be possible that the string, besides one principal series of vibrations from end to end, may at the same time execute vibrations among its parts, throwing itself, as in *Fig.* 9, into two, three, or four subdivisions; and the whole string, as it oscillates between its extremities, serving as a movable axis on which such partial vibrations may be at the same time performed? This appeared at first so extraordinary and wild a conjecture, that it was long ere it could meet with any serious attention among philosophers, far less be admitted as an accurate view of what really takes place. It was rather ascribed to something unconnected with the string; some referring the production of these harmonic notes to the structure of the ear, and the mode in which it receives the impression of the fundamental note; others, as the celebrated Lagrange, (to whom, along with our countryman Taylor, and Bernoulli, Euler, and D'Alembert, we owe the whole theory of the curves assumed by the vibration of musical strings,) supposed that they arose from sympathetic vibrations excited in the different bodies adjacent to the string, but without attempting to give any reason why these affections should always excite notes more acute than the fundamental. The possibility of these partial vibrations, however, was clearly proved by Daniel Bernoulli; and, however curious it may seem, the fact has now been established by many conclusive experiments and observations. That strings are capable of vibrating in this way, we may be convinced, from the following considerations. If we take any string, and withdraw it from the straight line by applying the finger, not to the centre, but nearer to one of the ends, so as to bring it into the position A B C, *Fig.* 10, then it will on the other side assume the position A D C, in every way the reverse of the first, as is easily proved by experiment. In general, the vibrations are so quick that they cannot be perceived by the eye; but if the finger be held opposite to B, or in any other part between A and C, it will be found that the vibration is nowhere so great as at D. In the same manner, if we apply both fingers in opposite directions, and at equal distances from the extremities, so as to draw the string into the position A B D C, the centre E remaining unchanged, then, on the other side, it will assume the position A *b* E *d* C; and as the central point E continues all the time immovable, it is evident that the whole string will continue vibrating partially, in the very same manner as if it had been composed of two strings, each half the length, and fixed at E. This point E is hence generally termed a node, or *nodal point.* In the same way, by applying the moving forces at other different points, the string may be made to perform three, four, or any greater number of partial vibrations, in relation to so many intermediate nodal points, *Fig.* 12; and it is not difficult to conceive, therefore, how, by the application of certain forces, the whole string may be performing its oscillations from end to end, while at the same time it may be agitated internally by two, three, or more partial vibrations; and this is proved by actual experiment. If we take a piece of common twine about fifteen or twenty feet long, and stretch it between two fixed points rather loosely;—if we then cause it to vibrate by the middle, it merely makes the ordinary vibrations; but if we apply our force to withdraw it from the straight line near one of the extremities, we can then see distinctly, besides its principal vibrations, a series of subordinate ones going on throughout its whole length. It is remarkable also that strings of this kind are extremely susceptible of these subordinate vibrations. When the string is vibrating regularly between its extremities, the slightest deranging circumstance is sufficient to excite and to superinduce the partial actions; as appears very distinctly in an experiment contrived by Mr Hawkins of London, by stretching between two bridges a long and spirally coiled brass wire, the spirals being about the diameter of a quill, and extended considerably more than those of a cork-screw. The tension was such as hardly to emit any sound, but to leave the vibrations when touched quite visible to the eye. If, when the whole string is vibrating, we oppose a slight obstacle, say at the middle, the string then instantly divides itself into two, and along with its principal vibration performs two others between the centre and each extremity. If the obstacle—and even a puff of wind from the mouth is sufficient—be placed at the distance of one-fourth the length of the string from either extremity, then it divides itself into four, and along with its principal vibration performs four others; and so on, according to whatever aliquot part of the string the obstacle be presented; the latter always subdividing itself into the same number of parts, and performing a series of subordinate vibrations between each, which can often be observed and heard for several minutes accompanying the principal one. The same effects are beautifully observed, as was first shown by Professor Robison, by means of a monochord sounded by an ivory wheel. When the string was vibrating simply, if its middle point was then touched slightly with a quill, this point instantly stopped, but the string continued to vibrate in two parts, sounding the octave; and the same thing happened if it was touched at one-third,—it then divided itself into three parts, with two nodal points, and sounded the twelfth; and any thing soft, such as a lock of cotton, put in the way of the wide vibrations of the string, was sufficient to produce the effect.

From these facts and observations, therefore, no doubt can remain that the acute harmonics accompanying the fundamental note arise entirely from these partial vibrations, of which every string appears to be so susceptible. But one important question still remains, and has never yet received any satisfactory solution; namely, what are the circumstances which determine these partial vibrations so generally in every string? Very slight obstacles are no doubt sufficient, but still there must be some particular causes to determine every string to divide itself so regularly into two, three, four, or more parts; executing in such regular succession the vibration peculiar to each. Inequalities in the densities or thicknesses of the different parts of the strings have been suggested as a probable reason; but this appears quite inadequate to produce effects so very constant in their operation, and which besides occur, let the string or wire be ever so uniform in its texture. This subject requires further examination, and the trial of several experiments. The only probable circumstance to which we can ascribe these effects consists in the re-action of the supports to which the extremities of the strings are attached. It is well known, that when two strings in the same instrument are tuned to the same note, if one of them be struck, the other begins to vibrate, and to sound at the same time. Strings differing by an octave have the same effect; and even those differing more in tone, yet appear to act and to re-act on each other. These effects have usually been ascribed to the action of the air, communicating the vibrations from one string to another. This, however, is not the case, as is proved by a simple experiment. If we stretch two similar strings on two different boards, and tune them to the same note; then if we detach the one wholly from the other, the vibrations of the one do not in the least affect those of the other, let them be even brought quite close together. But the moment we place the boards in contact with each other, though the strings themselves be thereby farther separated than before, yet the one vibrates uniformly in sympathy with the other; and the moment the boards are again detached, the effect ceases. It is clear, therefore, that the vibrations of the one string are communicated to those of the other, not through the medium of the air, but through that of the wood; and this can only take place by means of the vibrations of the one string communicating through the supports to the wood. This agitates the supports of the other string, and these giving at first a very slight vibrating motion to the extremities, this gradually increases as it is continued, until the whole string is made to vibrate with the other. Instead of the effect, therefore, proceeding from the middle of the string to either extremity, as would be the case with aërial pulses, it is just the reverse. When once the motion is begun, the aërial undulations may certainly aid and augment the effect; but this, without doubt, originates at the extremities of the strings, and from these is communicated to the centre. That strings in unison with each other should vibrate in this manner more readily than any other, is quite easily accounted for; because in that case the vibrations of the one, however they may be produced, are quite isochronous with those of the other: they are more readily excited, therefore, because when they are once begun, however minute they may be at first, they yet harmonize exactly with the other, and every succeeding impulse from it just arrives in the proper time to augment the effect of the preceding, until the two motions become exactly alike. Were the string not isochronous, the succeeding impulses might tend sometimes to augment and sometimes to diminish the effect of the preceding ones; so that no sensible vibration would take place, as really happens with all discordant strings. With octaves, however, and other concords, the vibrations are still produced, because the vibrations of the fundamental note always concur with those at certain intervals, and at others do not oppose them. All these effects are very similar to what occurs in the motion of pendulums; a very slight impulse is sufficient to put a large pendulum into very wide vibrations, if it be often repeated, and always at the proper time to augment and not oppose the motion already communicated. Here it is that pendulums swinging in the same frame affect wonderfully the vibrations of each other, exactly like musical strings in the same instrument. If when two isochronous pendulums are at rest one of them be set in motion, in a short time the other commences to vibrate, in a very slight degree at first, but always increasing and increasing, until at last its oscillations become quite as wide as the other. This effect arises entirely from the vibrations of the one pendulum communicating through the wood very slight impulses to the axis or centre on which the other moves. This sets it in motion, and the impulses being constantly repeated and properly timed, excite at last vibrations as wide as the original. In a similar manner it is that one string causes another in the same instrument to vibrate, by means of the supports on which it is stretched; and if this be the case so remarkably in different strings, may not the vibrations of any single string re-act on itself through its own supports, and thus excite all those secondary vibrations which produce the acute harmonics? The string being first struck in the centre, the fundamental note must first of all be emitted. But the vibration of this agitating the supports at each extremity, these must necessarily re-act upon the string itself, must modify the original central impulse, and excite all those subordinate vibrations which are observed. That this is the true cause of these partial actions, and consequently of all those varied tones which they excite, appears extremely probable. But experiments, as we observed, are wanting to demonstrate these effects satisfactorily.

Such, then, are the singular phenomena of the acute harmonics, and of the subordinate vibrations of strings from whence they arise. Whatever be the cause of these, no doubt whatever can remain of the fact itself; and it is to this circumstance that we must perhaps ascribe much of that agreeable effect, so pleasing to the ear, which we experience in the tones of our musical instruments. Regularity of succession may determine a certain pitch in the sound; but it is from the harmonic tones mingling together, and blending with the gravity of the original note, that appears to arise all that sweetness and rich melody which so peculiarly belongs to them. Hence also we can now understand the reason of the musical effect arising from the sound of thin plates, cups, or bells: in all these, when they are examined minutely, we observe numerous vibrations among the parts; the substance of the plate dividing itself into various subdivisions, separated by nodal lines, between which all the parts are thrown into vibration. Hence arise a variety of harmonious notes; and these mingling together, produce that highly musical effect which we observe. It is to Professor Chladni that we owe a variety of curious facts regarding these vibrations of plates; which he observed by strewing them with fine sand: the nodal points and lines were then shown by the sand throwing itself from all the vibrating parts, and accumulating in little heaps along the lines which divide the vibrating surface, and where, therefore, there was no agitation at all. Squares of plate glass are well adapted for showing these effects. If we hold these by the centre in a sort of small wooden vice, as at *Fig.* 13, and then cause them to sound by drawing a bow along any of the edges, which are smoothed for the purpose with emery, the gravest tone is produced by applying the bow to one of the angles; and then the sand assumes the figure represented in *Fig.* 14. The tone next to this in graveness is produced by applying the bow to the middle of one of the sides; and then the sand assumes the figure represented in *Fig.* 15. By varying the points of application in this manner, and the figure of the plates, we obtain many other figures and curves for the nodal lines; such as *Fig.* 16, 17, 18, 19, &c. These effects are extremely curious and interesting: they are also very beautifully exhibited by plates of paper or other flexible membranes, stretched on frames like those of a drum or tambourine. But we must refer for further details on this subject to the *Traité d'Acoustique* of Chladni.

Besides the lateral vibrations above described, of strings, membranes, and plates, all these bodies are capable of vibrating longitudinally, and of emitting sounds which are in general much more acute than the others, and are regulated in their pitch by the length of the rods or strings. In this manner even the air itself, confined in a tube or pipe, is made to vibrate regularly, and to emit musical tones; and from this source arises another extensive and very important class of sounds, namely, those which are produced by the various kinds of wind-instruments, and of which also the tones of the human voice and of that of different animals present interesting examples. One is apt to imagine that the sound of a pipe or flute is emitted from the wood or other material of which it is composed; it really, however, arises from the cylinder of inclosed air, which is thrown into vibration by the current of air striking against the reed of the pipe, or against the sides of the hole in the plate. For a particular account of this class of sounds, see ORGAN, TRUMPET, &c.; and for a more particular account of the scale, and of musical harmony, see HARMONICS, MUSIC, TEMPERAMENT.

(G. B.)



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ACQS, or AX, a town at the foot of the Pyrenean mountains, in the department of Ariege, and 20 miles south-east of Foix, in France. It takes its name from the hot waters in these parts. Pop. 1991.

ACQUAPENDENTE, a pretty large town of Italy, in the territory of the Church and patrimony of St Peter, with a bishop's see. It is seated on a mountain near the river Paglia, 10 miles west of Orvieto, and 57 north by west of Rome. It takes its name from a fall of water near it, and is now almost desolate. Lat. 42. 46. N. Long. 11. 52. E.

ACQUARA, a Neapolitan town, in the province of Calabria Citra. Pop. 2263.

ACQUARIA, a small town of Italy, in Frigana, a district of Modena, which is remarkable for its medicinal waters. It is 18 miles south-west of the city of Modena.

ACQUAVIVA, a walled Neapolitan town, in the province of Terra di Bari, about 18 miles S.S.W. from Bari. Pop. 5400; has two hospitals, and a *Monte di Pietà.*

ACQUI, one of the provinces into which the continental dominions of the king of Sardinia are divided. It is bounded on the north-east by Alessandria, on the south-east and south by Genoa, on the south-west by Mondovi, on the west by Alba, and on the north-west by Asti. The extent is 444 square miles, or 284,160 acres. In the north the mountains decline to a fine undulating plain, watered by the rivers Bormida, Orba, Erro, and Belba, which in the adjoining province fall into the Tanaro, and then join the Po. The land is productive, and yields wheat, garden vegetables, wine, fruit, chestnuts, and much silk. Some cattle are bred and fattened; but the chief call for labour is in winding and throwing the silk. There are a few mines of iron and of some other minerals, but all inconsiderable. This province, which formerly was Upper Montferrat, contains two cities, 81 towns and villages, and nine hamlets, with a population amounting, in 1848, to 101,202 persons.

Acqui, a town of Italy, in the province of that name, with a bishop's see and commodious baths. It was taken by the Spaniards in 1745, and retaken by the Piedmontese in 1746; but after this it was taken again and dismantled by the French, who afterwards forsook it. It is seated on the river Bormida, 25 miles north-west of Genoa, and 30 south of Casal. Long. 8. 32. E. Lat. 44. 41. N.

ACRA, a considerable country near the eastern extremity of the Gold Coast of Africa. It is fertile and healthy, and the inhabitants are of a more polished and civilized character than the majority of those found upon that coast. While the slave-trade was carried on with activity, there was a great resort of the European nations to Acra, and the factories established by them, Fort James by the English, Crevecœur by the Dutch, and Christiansborg by the Danes, were the centre of an extensive trade. Acra has now greatly declined; and it may be considered, along with the rest of the coast, as dependent upon Dahomey. Adams considers this country as the boundary of the gold trade on the one side, and the ivory trade on the other; and sharing to a certain degree in both, though not to the same extent with some other districts.

Acra, in *Ancient Geography*, one of the hills of Jerusalem, on which stood the lower town, which was the old Jerusalem; to which was afterwards added Zion, or the City of David. It was probably called *Acra*, from the fortress which Antiochus built there in order to annoy the temple, and which Simon Maccabeus took and razed to the ground.

*Acra Japygia*, in *Ancient Geography*, called *Salentia* by Ptolemy; now *Capo di Leuca:* a promontory in the kingdom of Naples, the southernmost point of Otranto.

ACRAGAS, or Agragas, in *Ancient Geography*, so called by the Greeks, and somtimes by the Romans, but more generally *Agrigentum* by the latter; a town on the south coast of Sicily. See Agrigentum.

ACRASIA, among *Physicians*, implies the predominancy of one quality above another, either with regard to artificial mixtures, or the humours of the human body. The word is Greek, and compounded of α, privative, and κεραννυμι, to *mix; q. d.* not mixed in a just proportion.

ACRE, or Akka, or Accho, a town and seaport of Palestine, in the pachalic of Acre, and in ancient times a celebrated city, called *Ptolemais*, from Ptolemy, king of Egypt. It was named Acra from its fortifications; and by the knights of St John of Jerusalem it was called St John d'Acre. No town has experienced greater changes from political revolutions and the calamities of war. It has been successively possessed by Alexander's successors, who ruled in Egypt, by the Romans, the Saracens, the Christian crusaders, and finally by the Turks. According to some travellers, this city was the Accho of the Scriptures, one of the strongholds of which the Israelites could not dispossess the Canaanites; and in confirmation of this supposition, Mr Buckingham, who visited Acre in 1816, found in the ditches which they were then digging around the wall, fragments of houses which bore marks of the highest antiquity; consisting of that highly sun-burnt brick, with a mixture of cement and sand, which was only used in buildings constructed in the remotest ages. It is only, however, during its possession by Ptolemy, and when it was called Ptolemais, that history gives any certain account of it. It was known during those ancient times to be a great city; and although no perfect monument of its grandeur now remains, yet throughout the modern town are seen fine marble and granite pillars, used at the thresholds of door-ways, or in other parts of ordinary buildings, or lying neglected on the ground. When the empire of the Romans began to extend over Asia, Ptolemais came into their possession; and it yielded in like manner to the growing power of the Saracens. They were expelled from it in 1110 by the crusaders, who retained it until 1187, when it was recovered by Saladin, sultan of Egypt. In 1191 it was retaken by Richard I. of England and Philip of France, who purchased this conquest by the sacrifice of 100,000 troops. They gave the town to the knights of St John of Jerusalem, and it afterwards became the principal scene of contest between the crusaders and the Saracens. It was at this time a large and extensive city, on the direct route to Jerusalem, and a place of great resort. It was accordingly populous and wealthy, and contained numerous churches, convents, and hospitals, of which no traces now remain. The city was under a peculiar system of government, being ruled by all the Christian powers both of Europe and Asia, 19 of whom exercised independent authority within its bounds. It was taken by the Saracens after a bloody siege in 1291, during which it suffered severely, and afterwards fell into decay. Under their dominion it remained till 1517, when it fell into the hands of the Turkish sultan, Selim I. So late as the year 1696, Maundrell, who visited it, states that it had never recovered from its last overthrow; and that, with the exception of the residences of the French factors, a mosque, and a few poor cottages, it presented a vast and spacious scene of ruin. After this period Acre again became a considerable city, and was much strengthened and improved. It is memorable in modern history for the gallantry with which it was defended in 1799 by the Turks, animated by the example and advice of Sir Sydney Smith, against Bonaparte, who, after spending sixty-one days before it, was obliged to retreat. It was afterwards strongly fortified by Jezzar Pacha, and continued to enjoy an increasing degree of prosperity till 1832. Though fettered by imposts and monopolies, it carried on a considerable foreign trade, and had resident consuls from most of the great states of Europe. During its siege by Ibrahim Pacha in the winter of 1831–32, which lasted five months and twenty-one days, its public and private buildings were mostly destroyed. The only one that escaped uninjured was the fountain of Djezzar. Its fortifications were subsequently repaired and improved; but on the 3d November 1840, the town was reduced to ruins by a three hours' bombardment from the British fleet, acting as the allies of the sultan.

The town is situate at the extremity of a plain on the edge of the sea-shore, and at the point of a bay formed by the promontory of Mount Carmel on the south-west, and the termination of the plain itself on the north-east. This bay faces the north-west, and from Cape Carmel to the city it may be about ten miles across. The bay affords no shelter in bad weather, being open to the north-west winds, which blow violently on the coast; and the port of Acre is a small hollow basin behind a ruined mole, scarcely capable of containing a dozen boats. Vessels coming to this coast, therefore, either to load or discharge their cargoes, generally frequent the road of Caipha, a place of anchorage on the south side of the bay, near which the river Kishon flows into the sea. Acre is now the chief mart for the cotton of Syria, and the principal commercial nations of Europe have consuls here. It is 80 miles N.N.W. of Jerusalem, and 27 S. of Tyre. Long. 36. 6. E. Lat. 32. 56. N.

Acre, a measure of superficies, and the principal denomination of land-measure in use throughout the whole of Great Britain. The word (formed from the Saxon *acher*, or the German *aker*, a field) did not originally signify a determinate quantity of land, but any open ground, especially a wide campaign; and in this antique sense it seems to be preserved in the names of places, as Castle-acre, West-acre, &c. The English standard acre, now the imperial acre of Britain, is formed by raising a square of which the basis is the chain of 66 feet, or 22 yards, or 1-80th of a mile; and ten of these squares form the acre, which thus contains 4840 square yards. This is divided into *roods*, of which there are four in the acre; and into *poles* or *perches*, of which there are 40 in each rood, or 160 in the acre. The rood will thus measure 1210 square yards, and the pole $30\frac{1}{4}$ square yards, according to the following table, which contains also other denominations useful to be compared with the acre.

| Inches. | Links. | Feet. | Yards. | Poles or Perch. | Chains | Roods. | Acre. |
|---|---|---|---|---|---|---|---|
| 62·726 | 1 | | | | | | |
| 144 | 2·295 | 1 | | | | | |
| 1296 | 20·661 | 9 | 1 | | | | |
| 39204 | 625 | $272\frac{1}{4}$ | $30\frac{1}{4}$ | 1 | | | |
| 627264 | 10000 | 4356 | 484 | 16 | 1 | | |
| 1568160 | 25000 | 10890 | 1210 | 40 | $2\frac{1}{2}$ | 1 | |
| 6272640 | 100000 | 43560 | 4840 | 160 | 10 | 4 | 1 |

The above is the standard acre of England; but various customary acres are in use throughout the different counties, deviating considerably from this standard both in excess and defect, though all of them are now illegal since the act 5 George IV., which establishes the same standard throughout the whole kingdom. In *Bedfordshire*, it is sometimes only two roods; *Cheshire*, formerly, and still in some places, 10,240 square yards; *Cornwall*, sometimes 5760 yards; *Dorsetshire*, generally 134 perches; *Hampshire*, from 107 to 120 perches, but sometimes 180; *Herefordshire*, two-thirds of a statute acre. The acre for *hops* contains 1000 plants, and is only equal to half a statute acre; for *wood*, again, it is 256 perches. *Leicestershire*, $2308\frac{3}{4}$ square yards; *Lincolnshire*, five roods, particularly for copyhold land; *Staffordshire*, nearly $2\frac{1}{4}$ acres; *Sussex*, 107, 110, 120, 130, or 212 perches; the *short* acre 100 or 120 perches, the *forest* acre 180 perches. *Westmoreland*, 6760 square yards, or 160 perches of $6\frac{1}{2}$ yards square; in some parts the Irish acre is used: *Worcester*, the *hop* acre, of 1000 stocks, 90 perches, sometimes 132 or 141 perches.



In North Wales, the *Erw* or true acre is 4320 square yards, the *Stang* or customary acre 3240 square yards, as in Anglesea and Caernarvonshire, making $5\frac{1}{3}$ Llathen, = 160 perches of $4\frac{1}{2}$ yards square, called *paladr:* 8 acres make an *ox-land*, and 8 of these a *plough-land*, in *Pembrokeshire.* In South Wales the Erw varies greatly with the perch; sometimes this is nine feet square, 160 perches making one stangell, and four stangells one erw of 5760 yards; sometimes $10\frac{1}{2}$ feet square, making a quart or quarter of a llath, 40 of which make a stangell, and four stangells an erw, which is thus 7840 yards, equal to the Irish acre; sometimes 11 feet, called bat or eglwys haw, making the erw 9384 yards, as in *Glamorganshire*, one-fifth more = 11,261 yards; sometimes $11\frac{1}{2}$ feet, called a llath, 48 making a quarter cyvar, and four cyvars an erw of 11,776 yards; lastly, 12 feet, giving an erw of 10,240 yards, equal to the Staffordshire acre.

Nothing can show more clearly than the existence of such numerous and useless diversities, the necessity of the late act for establishing a uniform standard throughout Great Britain, and which only requires to be enforced with strictness to abolish for ever every other measure. In Scotland the acre is much more uniform, scarcely deviating in any part more than one per cent. from the standard. It is raised from the chain of 24 ells; and by the verdict of the jury assembled at Edinburgh on the 4th February 1826, to determine the proportion between the existing measures and the imperial, the ell was found, according to an accurate measurement made by Mr Jardine, civil engineer, 37·0598 inches, making the chain 74·1196 feet, and the acre 6104 square yards and ·12789, &c. decimals of a yard. It is considerably larger, therefore, than the imperial acre; and as the act of uniformity establishes this latter in its stead, it makes an important change throughout Scotland, and it becomes necessary to know exactly the proportions between them. The imperial, we have seen, contains 4840 square yards, while the Scottish contains 6104·12789, &c. They are to each other, therefore, as 1 is to 1·26118345; so that 1000 acres Scottish are equal to 1261·18345 imperial; and in every case, to convert Scottish into imperial, multiply by the fraction 1·26118345: such minuteness, however, is seldom required in practice. A ready and very accurate approximation will be obtained by reckoning one acre Scottish equal to five quarters imperial, and $\frac{1}{80}$th part more. This will give the value of the acre almost to one-fourth of a square yard in defect. Hence we have this general rule: *To convert Scottish acres into imperial, add one-fourth; and if that is not sufficiently minute, add $\frac{1}{80}$th more.* Take, for example, 1000 acres, add one-fourth or 250, and we have 1250; add still $\frac{1}{80}$th, or 11, and we have 1261. This rule is obtained by expressing the above fraction in a series of which we take only the first three terms. It is one acre Scottish $= 1 + \frac{1}{4} + \frac{1}{80} + \frac{1}{14000}$, &c. acres imperial. By a similar rule, it is easy to convert the Scottish *money rates or prices* of land into imperial: we have only to multiply the Scottish prices by the fraction 0·792906, the reciprocal of the other; or *deduct one-fifth from the price, and for greater accuracy $\frac{1}{140}$th more; or what is still simpler, deduct $20\frac{3}{4}$ per cent. or 4s. $1\frac{3}{4}$d. in the pound from the Scottish prices.* An estate of 1000 acres, for example, is to be let at 30s. per acre: What is the rent per imperial acre? Deduct 4s. $1\frac{3}{4}$d. and the half of it for the additional 10s., and we have 6s. $2\frac{1}{2}$d. less, or on the whole 23s. $9\frac{1}{2}$d. These rules will apply in every practical case; and for very particular and extremely accurate purposes, recourse must be had to the original fraction 0·792906 and 1·26118345.

Such are the relations of the Scottish standard acre to the imperial; but until of late years, it was the practice of land-surveyors to measure with a chain of 74 feet and 4-10ths of a foot in length, the length of the ell having been erroneously estimated at 37 inches and 2-10ths of an inch. This practice increased the acre from 6104·13448 to 6150·4 square yards; it made the ratio of this acre to the imperial as 1 to 1·27074, &c.; or we may reckon one acre equal to five quarters imperial, and $\frac{1}{60}$th more.

When this error in the length of the chain came to be discovered, surveyors took to the chain of exactly 74 feet; this length being recommended by the round number, and the nearer approach to the standard. By it the acre contains only 6084·4444, &c. yards; it is to the imperial acre as 1 to 1·25711662, &c. or we make one of these acres equal to five quarters imperial, and $\frac{1}{180}$th more.

In Ireland the perch, of which the acre contains as usual 160, is a square of seven yards. The acre, therefore, contains 7840 square yards. See Weights and Measures; *Parliamentary Reports of the Commissioners of Weights and Measures; Act 5 Geo. IV.;* and Buchanan's *Tables of Weights and Measures,* where the conversions are all given by inspection. (G. B.)

*The following table contains the principal foreign land measures, with their equivalents in Imperial measurement.*

| | | Acres. | Roods. | Perches. |
|---|---|---|---|---|
| France, | Are . . . . | 0 | 0 | 3·9538 |
| „ | Hectare, . . . | 2 | 1 | 35·38 |
| „ | Arpent, great, . . | 1 | 1 | 1·92 |
| „ | Arpent, small, . . | 0 | 3 | 15·18 |
| Amsterdam, | Morgen, . . . | 2 | 0 | 1·38 |
| Berlin, | Morgen, large, . . | 1 | 1 | 24·32 |
| „ | Morgen, small, . . | 0 | 2 | 20·95 |
| Dantzic, | Morgen, . . . | 1 | 1 | 19·99 |
| Hamburg, | Morgen, . . . | 2 | 1 | 21·64 |
| „ | Scheffel of corn land, . | 1 | 0 | 6· |
| Nuremberg, | Morgen, corn land, . | 1 | 0 | 26·90 |
| „ | Morgen, meadow, . . | 0 | 2 | 4·09 |
| Hanover, | Morgen, . . . | 0 | 2 | 22·47 |
| Prussia, | Morgen, . . . | 0 | 2 | 20·92 |
| Rhineland, | Morgen, . . . | 2 | 0 | 16·69 |
| Zurich, | Acre, common, . . | 0 | 3 | 8·11 |
| „ | Acre, wood, . . . | 0 | 3 | 22·35 |
| „ | Acre, meadow, . . | 0 | 2 | 33·88 |
| Saxony, | Acre, . . . . . | 1 | 1 | 17·85 |
| Spain, | Fanegada, for corn land, | 1 | 0 | 21·81 |
| „ | Arranzada, for vineyards, | 0 | 3 | 32·82 |
| Russia, | Dessetina, . . . . | 2 | 2 | 31·95 |
| Sweden, | Tuneland, . . . | 1 | 0 | 35·04 |
| Switzerland, | Faux, . . . . | 1 | 2 | 19·66 |
| Tuscany, | Quadrato, . . . | 0 | 3 | 14·67 |
| Vienna, | Joch, . . . . | 1 | 1 | 27·73 |
| Naples, | Moggia, . . . . | 0 | 3 | 12·16 |
| Rome, | Pezza, . . . . | 0 | 2 | 24·40 |
| Portugal, | Geira, . . . . . | 1 | 1 | 30·41 |

In the United States of America the imperial acre is used. The Roman jugerum was somewhat larger than half an imperial acre, containing 2 roods, 19 perches, 189 square feet. Two jugera formed a heredium, so called from its being the quantity of land originally assigned to each Roman citizen; a hundred heredia formed a centuria, and four centuriæ a saltus. The Greek plethron consisted of 4 aruræ, and was equal to 37 perches, 153 square feet.

*Acre-Fight,* an old sort of duel fought by English and Scottish combatants, between the frontiers of their kingdoms, with sword and lance: it was also called *camp-fight,* and the combatants *champions,* from the open field being the stage of trial.

ACRIBEIA, a term purely Greek, literally denoting an exquisite or delicate accuracy; sometimes used in our language, for want of a word of equal signification.

ACRIDOPHAGI, in *Ancient Geography,* an Ethiopian people, represented as inhabiting near the deserts, and to have fed on locusts. This latter circumstance their name imports, the word being compounded of the Greek ακρις, *locust,* and φαγω, *to eat.* Dr Sparrman informs us,[1] that "Locusts sometimes afford a high treat to the more unpolished and remote hordes of the Hottentots; when, as sometimes happens, after an interval of 8, 10, 15, or 20 years, they make their appearance in incredible numbers." The Abbé Poiret, also, in his *Memoir on the Insects of Barbary and Numidia,* informs us that the Moors make locusts a part of their food, that they go to hunt them, fry them in oil and butter, and sell them publicly at Tunis, at Bonne, &c. From these accounts, we may see the folly of that dispute among the divines about the nature of St John's food in the wilderness; some maintaining the original word to signify the fruit of the carobe tree; others, a kind of birds, &c.: but those who adhered to the literal meaning of the text were at least the most orthodox, although their arguments were perhaps not so strong as they might have been had they had an opportunity of quoting such authors as the above.

[1] *Voyage to the Cape,* vol. i. p. 366.

ACRISIUS, in *Fabulous History,* king of Argos, being told by the oracle that he should be killed by his grandchild, shut up his only daughter Danäe in a brazen tower; but Jupiter coming down in a golden shower, begot Perseus by her. Acrisius was accidentally killed by the quoit of Perseus in the games at Larissa, whither he had gone to avoid the consummation of the prophecy.

ACRITAS, in *Ancient Geography,* a promontory of Messenia, running into the sea, and forming the beginning of the bay of Messene; now *Capo de Gallo.*

ACROAMA, in *Antiquity,* signified any thing heard, especially if it gave pleasure, such as music, plays, or reading, for the entertainment of guests. The term was also applied to the performers, and to interludes at the public games.

ACROAMATIC, or Acroatic, in general denotes a thing sublime, profound, or abstruse.

ACROAMATICI, a denomination given to the disciples or followers of Aristotle, &c. who were admitted into the secrets of the inner or acroamatic philosophy.

ACROATIC is a name given to Aristotle's lectures to his disciples, which were of two kinds, *exoteric* and *acroatic.* The acroatic were those to which only his own disciples and intimate friends were admitted; whereas the exoteric were public and open to all. But there are other differences. The acroatic were set apart for the higher and more abstruse subjects; the exoteric were employed in rhetorical and civil speculations. Again, the acroatics were more subtile and exact, evidence and demonstration being here aimed at; the exoterics chiefly aimed at the probable and plausible. The former were the subject of the morning exercises in the Lyceum, the latter of the evening. Besides, the exoterics were published, whereas the acroatics were kept secret, being either entirely concealed, or, if they were published, it was in such obscure terms that few but his own disciples could be the wiser for them. Hence, when Alexander complained of his preceptor for publishing his acroatics, and thus revealing what should have been reserved to his disciples, Aristotle answered, that they were made public and not public; for that none who had not heard them explained by the author *viva voce* could understand them.

ACROBATES, in *Antiquity,* were rope-dancers, who performed various feats by vaulting or tumbling on a rope; sliding down on a rope from a lofty station with arms and legs extended, in imitation of flying; and running, dancing, and leaping, on a rope stretched horizontally.

ACROBATICA, or Acrobaticum, from ακρος, *high,* and βατεω or βαινω, *I go;* an ancient engine whereby people were raised aloft, that they might see more conveniently about them. The *acrobatica* among the Greeks amounted to the same with what they call *scansorium* among the Latins. Authors are divided as to the use of this engine. Turnebus and Barbarus take it to have been of the military kind, raised by besiegers, high enough to overlook the walls and discover the state of things on the other side. Baldus rather supposes it a kind of moveable scaffold, or cradle, contrived for raising painters, plasterers, and other workmen, to the tops of houses, trees, &c. Some suspect that it might have been used for both purposes; which is the opinion of Vitruvius and Aquinas.

ACROCERAUNIA, or MONTES CERAUNII, in *Ancient Geography*, mountains so called from their being often struck by thunder. They are on the western coast of Greece, and terminate at a cape in Lat. 40. 25. N.

ACROCHERISMUS, among the Greeks, a sort of gymnastic exercise, in which the two combatants contended with their hands and fingers only, without closing or engaging the other parts of the body.

ACROCORINTHUS, in *Ancient Geography*, a high and steep hill overhanging the city of Corinth, on which was built the acropolis, or citadel. Height 1885 feet.

ACRODUS, a genus of Placoïd fossil Fish, established by *Agassiz*.

ACROGASTER, a fossil genus of Placoïd Fishes.—*Agassiz*.

ACROGENS (i. e. *point growers*), a botanical term applied to arborescent ferns, &c. that increase only at the top.

ACROGNATHUS, a fossil genus of Cycloïd Fishes.—*Agassiz*.

ACROLEPIS, a fossil genus of Ganoïd Fishes.—*Agassiz*.

ACROLITH, a statue, with the head and extremities of stone, the trunk being usually made of wood, either gilt or draped. Pausanias describes several such, particularly the Minerva Areia of the Platæans.

ACROMION, in *Anatomy*, the upper part of the scapula or shoulder-blade.

ACROMONOGRAMMATICUM, in *Poetry*, a kind of poem, wherein every subsequent verse begins with the letter wherewith the immediately preceding one terminated.

ACRON, a celebrated physician of Agrigentum, in Sicily, who lived about the middle of the fifth century before Christ. The successful measure of lighting large fires, and purifying the air with perfumes, to put a stop to the pestilence that ravaged Athens, originated with him. He wrote two treatises, according to Suidas, in the Doric dialect; the one on physic, and the other on abstinence or diet.

ACRONICAL, ACHRONYCAL, or ACHRONICAL, in *Astronomy*, is a term applied to the rising of a star when the sun is set in the evening; but has been promiscuously used to express a star's rising at sunset, or setting at sunrise.

ACROPOLIS, Ακροπολις, a word signifying the upper town, or chief place of a city, a citadel, which was usually on the summit of a rock or hill. The most celebrated was that in Athens, the remains of which still delight and astonish travellers. It was enclosed by walls, part of which was extremely ancient. It had nine gates; but the principal was a splendid structure of Pentelican marble, in noble Doric architecture, which bore the name of *Propylaion*. Besides other beautiful edifices, it contains the Παρθενων, or temple of the virgin goddess Pallas, the most glorious monument of ancient Grecian architecture. See ARCHITECTURE and ATHENS.

ACROPOLITA, GEORGE, one of the writers in the Byzantine history, was born at Constantinople in the year 1220, and educated at the court of the Emperor John Ducas at Nice. He was employed in the most important affairs of the empire, being sent as ambassador to Larissa to establish a peace with Michael of Epirus; and was constituted judge to try Michael Comnenus, who was suspected of engaging in a conspiracy. Theodorus Lascaris, the son of John, whom he had taught logic, appointed him governor of all the western provinces in his empire. In 1255, he was taken prisoner, in a war with Michael Angelus; but gaining his liberty in 1260, by means of the Emperor Palæologus, he was sent by him as ambassador to Constantine, prince of Bulgaria; and was employed in several other negotiations. He wrote a Continuation of the Greek History, from the taking of Constantinople by the Latins till its recovery by Michael Palæologus in 1261, which makes part of the Byzantine history. He died A.D. 1282.



ACROSPIRE, a vulgar term for what botanists call the *plumes*.

ACROSPIRED, in *Malt-Making*, is the grain's shooting both at the root and blade end.

ACROSTIC, in *Poetry*, a kind of poetical composition, disposed in such a manner that the initial letters of the verses form the name of some person, kingdom, place, motto, &c. The word is compounded of the Greek ακρος, *extremity*, and στιχος, *verse*. The acrostic is considered by the critics as a species of false wit, and is therefore very little regarded by the moderns.

ACROSTICHUM, RUSTYBACK, WALL-RUE, or FORK-FERN.

ACROSTOLIUM, in *Ancient Naval Architecture*, the extreme part of the ornament used on the prows of ships, which was sometimes in the shape of a buckler, helmet, animal, &c. but more frequently circular, or spiral. It was usual to tear them from the prows of vanquished vessels, and fix them to those of the conquerors, as a signal of victory. They were frequently represented on the reverse of ancient medals.

ACROTELEUTIC, among ecclesiastic writers, an appellation given to anything added to the end of a psalm; as the Gloria Patri, or Doxology.

ACROTEMNUS, a fossil genus of Ganoïd Fishes.—*Agassiz*.

ACT, in general, denotes the exertion of power; and differs from power, as the effect from the cause.

ACT, in *Logic*, is particularly understood of an operation of the human mind. Thus, to discern and examine are acts of the understanding; to judge and affirm are acts of the will.

ACT, in the *Universities*, signifies a thesis maintained in public by a candidate for a degree; or to show the capacity and proficiency of a student.

*ACT of Faith*, in Italian *Atto di Fede*, in Portuguese *Auto da Fe*, in the Romish church, is a solemn day held by the inquisition, for the punishment of heretics and the absolution of the innocent accused. They usually contrive the *Auto* to fall on some great festival, that the execution may pass with the more awe and regard; at least it is always on a Sunday.

The Auto da Fe may be called the last act of the inquisitorial tragedy: it is a kind of jail delivery, appointed as often as a competent number of prisoners in the inquisition are convicted of heresy, either by their own voluntary or extorted confession, or on the evidence of certain witnesses. The process as performed last in Lisbon is thus: In the morning they are brought into a great hall, where they have certain habits put on, which they are to wear in the procession. The procession is led up by Dominican friars; after which come the penitents, some with san-benitos and some without, according to the nature of their crimes; being all in black coats without sleeves, and barefooted, with wax candles in their hands. These are followed by the penitents who have narrowly escaped being burnt: over their black coats they have flames painted, with their points turned downwards, *fuego revolto*. Next come the negative and relapsed, who are to be burnt, having flames on their habits pointing upwards. After these come such as profess doctrines contrary to the faith of Rome, who, besides flames pointed upwards, have their picture painted on their breasts, with dogs, serpents, and devils, all open-mouthed, around it.

Each prisoner is attended by a familiar of the inquisition; and those to be burnt have also a Jesuit on each hand, who continually exhorts them to abjure. After the prisoners comes a troop of familiars on horseback; and after them the inquisitors, and other officers of the court, on mules; last of all, the inquisitor-general on a white horse, led by two men with black hats and green hat-bands. A scaffold is erected in the *Terreiro de Paço*, large enough for two or three thousand people; at one end of which are the prisoners, at the other, the inquisitors. After a sermon made up of encomiums on the inquisition, and invectives against heretics, a priest ascends a desk near the middle of the scaffold, and having taken the abjuration of the penitents, recites the final sentence of those who are to be put to death; and delivers them to the secular arm, earnestly beseeching at the same time the secular power not to touch their blood, or put their lives in danger. The prisoners being thus in the hands of the civil magistrate, are presently loaded with chains, and carried first to the jail, and from thence in an hour or two brought before the civil judge; who, after asking in what religion they intend to die, pronounces sentence on such as declare they die in the communion of the church of Rome, that they shall be first strangled, and then burnt to ashes; on such as die in any other faith, that they be burnt alive. Both are immediately carried to the Ribera, the place of execution, where there are as many stakes set up as there are prisoners to be burnt, each surrounded by a pile of dry furze. The stakes of the professed, that is, such as persist in their heresy, are about four yards high, having a small board towards the top for the prisoner to be seated on. The negative and relapsed being first strangled and burnt, the professed mount their stakes by a ladder; and the Jesuits, after several repeated exhortations to be reconciled to the church, part with them, telling them they leave them to the devil, who is standing at their elbow to receive their souls, and carry them with him into the flames of hell. On this a great shout is raised; and the cry is, Let the dogs' *beards be made;* which is done by thrusting flaming furzes fastened to long poles against their faces, till their faces are burnt to a coal, which is accompanied with the loudest acclamations of joy. At last, fire is set to the furze at the bottom of the stake, over which the professed are chained so high that the top of the flame seldom reaches higher than the seat they sit on, so that they rather seem roasted than burnt. There cannot be a more atrocious spectacle, yet it is beheld by all sexes and ages with transports of joy and satisfaction.

Act, in *Dramatic Poetry*, signifies a certain division or part of a play, designed to give some respite both to the actors and spectators. The Romans were the first who divided their theatrical pieces into acts; for no such divisions appear in the works of the first dramatic poets. Their pieces indeed consisted of several parts or divisions, which they called *protasis, epitasis, catastasis*, and *catastrophe;* but these divisions were not marked by any real interruptions in the theatre. Nor does Aristotle mention anything of acts in his *Art of Poetry*. But, in the time of Horace, all regular and finished pieces were divided into five acts.

> *Neve minor, neu sit quinto productior actu*
> *Fabula, quæ posci vult, et spectata reponi.*
> If you would have your play deserve success,
> Give it five acts complete, nor more nor less.
>
> Francis.

The first act, according to some critics, besides introducing upon the stage the principal characters of the play, ought to propose the argument or subject of the piece; the second, to exhibit this to the audience, by carrying the fable into execution; the third, to raise obstacles and difficulties; the fourth to remove these, or raise new ones in the attempt; and the fifth to conclude the piece, by introducing some accident that may unravel the whole affair. This division, however, is not essentially necessary, but may be varied according to the humour of the author or the nature of the subject.



Act, among *Lawyers*, is an instrument in writing for declaring or justifying the truth of any thing; in which sense records, decrees, sentences, reports, certificates, &c. are called *acts*.

*Act of Parliament* is a positive law, passed by the two houses of parliament, and assented to by the Crown, consisting of two parts, the words of the act, and its true sense and meaning; which being joined, make the law. The words of acts of parliament should be taken in a lawful sense. Cases of the same nature are within the intention, though without the letter of the act; and some acts extend by equity to things not mentioned therein. See Legislation and Statute.

*Acta Consistorii*, the edicts or declarations of the council of state of the Roman emperors. These edicts were generally expressed in such terms as these: "The august emperors, *Dioclesian* and *Maximin*, in council declare, That the children of decurions shall not be exposed to wild beasts in the amphitheatre."—The senate and soldiers often swore, either through abject flattery or by compulsion, upon the edicts of the emperor, as we do upon the Bible. The name of Apidius Merula was erased by Nero out of the register of senators, because he refused to swear upon the edicts of the Emperor Augustus.

*Acta Diurna*, was a sort of Roman gazette, containing an authorized narrative of the transactions worthy of notice which happened at Rome. Petronius has given us a specimen of the *acta diurna* in his account of Trimalchi; and as it may not perhaps be unentertaining to see how exactly a Roman newspaper runs in the style of an English one, the following articles are extracted from it:

"On the 26th of July, 30 boys and 40 girls were born at Trimalchi's estate at Cuma.

"At the same time a slave was put to death for uttering disrespectful words against his lord.

"The same day a fire broke out in Pompey's gardens, which began in the night, in the steward's apartment." See *Le Clerc, des Journeaux chez les Romains*, Par. 1838; and *Lieberkühn de Diurnis Romanorum Actis*, Weimar, 1840.

*Acta Eruditorum*, a celebrated literary journal, which was established at Leipzic in 1682 by Professor Otto Mencke. It contains the papers of Leibnitz, and many other learned men. The first series is in 50 volumes. The new series, with supplements, &c. reaches to 77 volumes more, making in all 127 volumes.

*Acta Populi*, among the Romans, were journals or registers of the daily occurrences; as assemblies, trials, executions, buildings, births, marriages, deaths, &c. of illustrious persons, and the like. These were otherwise called *Acta Publica* and *Acta Diurna*, or simply *Acta*. The Acta differed from Annals, in that only the greater and more important matters were in the latter, and those of less note were in the former. Their origin is attributed to Julius Cæsar, who first ordered the keeping and making public the acts of the people. Some trace them higher, to Servius Tullius; who, to discover the number of persons born, dead, and alive, ordered that the next of kin, upon a birth, should put a certain piece of money into the treasury of Juno Lucina; upon a death, into that of Venus Libitina: the like was also to be done upon assuming the toga virilis, &c. Under Marcus Antoninus, this was carried further: persons were obliged to notify the births of their children, with their names and surnames, the day, consul, and whether legitimate or spurious, to the prefects of the *Ærarium Saturni*, to be entered in the public acts; though before this time the births of persons of quality appear to have been thus registered.

Acta Senatus, among the Romans, were minutes of what passed and was debated in the senate-house. These were also called *Commentarii*, and by a Greek name ὑπομνηματα. They had their origin in the consulship of Julius Cæsar, who ordered them to be kept and also published. The keeping of them was continued under Augustus, but the publication was abrogated. Afterwards all writings relating to the decrees or sentences of the judges, or what passed and was done before them, or by their authority, in any cause, were also called by the name *Acta:* in which sense we read of civil acts, criminal acts, intervenient acts; *acta civilia, criminalia, interveniientia*, &c.

*Acts of the Apostles*, one of the sacred books of the New Testament, containing the history of the infant church during the space of 29 or 30 years, from the ascension of our Lord to the year of Christ 63. It was written by St Luke, and addressed to Theophilus, the person to whom the evangelist had before dedicated his gospel. We here find the accomplishment of several of the promises made by our Saviour; his ascension, the descent of the Holy Ghost, the first preaching of the apostles, and the miracles whereby their doctrines were confirmed; an admirable picture of the manners of the primitive Christians; and, in short, every thing that passed in the church till the dispersion of the apostles, who separated themselves in order to propagate the gospel throughout the world. From the period of that separation, St Luke quits the history of the other apostles, who were then at too great a distance from him, and confines himself more particularly to that of St Paul, who had chosen him for the companion of his labours. He follows that apostle in all his missions, and even to Rome itself; for it appears that the Acts were published in the second year of St Paul's residence in that city, or the 63d year of the Christian era, and in the ninth or tenth year of Nero's reign. The style of this work, which was originally composed in Greek, is much purer than that of the other canonical writers; and it is observable that St Luke, who was much better acquainted with the Greek than with the Hebrew language, always, in his quotations from the Old Testament, makes use of the Septuagint version. The council of Laodicea places the Acts of the Apostles among the canonical books, and all the churches have acknowledged it as such without any controversy.

There were several *spurious* Acts of the Apostles; particularly, 1. *Acts*, supposed to be written by Abdias, the pretended bishop of Babylon, who gave out that he was ordained bishop by the apostles themselves when they were upon their journey into Persia. 2. *The Acts of St Peter:* this book came originally from the school of the Ebionites. 3. *The Acts of St Paul;* which is entirely lost. Eusebius, who had seen it, pronounces it of no authority. 4. *The Acts of St John the Evangelist;* a book made use of by the Encratites, Manichæans, and Priscillianists. 5. *The Acts of St Andrew;* received by the Manichæans, Encratites, and Apotactics. 6. *The Acts of St Thomas the Apostle;* received particularly by the Manichæans. 7. *The Acts of St Philip.* This book the Gnostics made use of. 8. *The Acts of St Matthias.* Some have imagined that the Jews for a long time had concealed the original Acts of the life and death of St Matthias, written in Hebrew; and that a monk of the abbey of St Matthias at Treves, having got them out of their hands, procured them to be translated into Latin, and published them; but the critics will not allow them to be genuine.

*Acts of Pilate*, a relation sent by Pilate to the Emperor Tiberius, concerning Jesus Christ, his death, resurrection, ascension, and the crimes of which he was convicted before him.[1] It was a custom among the Romans, that the proconsuls and governors of provinces should draw up acts, or memoirs, of what happened in the course of their government, and send them to the emperor and senate. The genuine *acts* of Pilate were sent by him to Tiberius, who reported them to the senate; but they were rejected by that assembly, because not immediately addressed to them; as is testified by Tertullian in his *Apol.* cap. 5, and 20, 21. The heretics forged acts in imitation of them: in the reign of the Emperor Maximin, the Gentiles, to throw an odium on the Christian name, spread about spurious acts of Pilate; which the emperor, by a solemn edict, ordered to be sent into all the provinces of the empire, and enjoined the schoolmasters to teach and explain them to their scholars, and make them learn them by heart. These acts, both the genuine and the spurious, are lost. There is indeed extant, in the Pseudo-Hegesippus, a letter from Pilate to the Emperor Claudius, concerning Jesus Christ;[2] but it discovers itself at first sight to be spurious.

[1] Eusebii *Hist. Eccl.* lib. ii. cap. 2, and ix. 5.

[2] Cave *Hist. Literar.*



ACTÆ were meadows of remarkable verdure and luxuriancy near the sea-shore, where the Romans used to indulge themselves to a great degree in softness and delicacy of living. The word is used in this sense by Cicero and Virgil; but Vossius thinks it can only be used in speaking of Sicily, as these two authors did.

ACTÆA, Herb-Christopher, or Bane-Berries.

ACTÆON, in *Fabulous History*, son of Aristæus and Autonöe, was a famous hunter. For the crime of looking at Diana while bathing, he was transformed into a stag, and devoured by his own dogs. The effect of impertinent curiosity and expensive pleasures seems to be the moral of the fable. *Ovid. Met.* iii.; *Hygin. Fab.* 181.

ACTIAN Games, in *Roman Antiquity*, were solemn games instituted by Augustus, in memory of his victory over Mark Antony at Actium, held every fifth year, and celebrated in honour of Apollo, surnamed *Actius.* Hence also *Actian* Years, an era commencing from the battle of Actium, called the *Era of Augustus.* Virgil insinuates them to have been instituted by Æneas, from that passage, Æn. iii. v. 280:

Actiaque Iliacis celebramus littora ludis.

But this he only does by way of compliment to Augustus; attributing that to the hero from whom he descended, which was done by the emperor himself; as is observed by Servius.

ACTINIA, in *Zoology*, a genus belonging to the class of *Acalephæ* of Zoophytes, called *Animal Flowers* and *Sea Anemones.*

ACTINOBATIS, a genus of fossil Fishes of the order Placoid of *Agassiz.*

ACTINOCAMAX, a division of Belemnites, according to *Miller.*

ACTINOCERAS, a division of fossil Cephalopodæ.

ACTINOCRINITES, a genus of fossil Crinodea, or lily-shaped animals.—*Miller.*

ACTINOMETER, a *measurer of solar rays.* It is a thermometer with a large bulb, filled with a dark blue fluid, and is enclosed in a box, the sides of which are blackened, and the whole covered with a thick plate of glass. It is the invention of Sir John Herschel; and is described in the *Edinburgh Journal of Science* for 1825. The zero is adjusted by a screw attached to the bulb.

ACTIO, in *Roman Antiquity*, is an action at law in a court of justice. The formalities used by the Romans, in judicial actions, were these: If the difference failed to be made up by friends, the injured person proceeded *in jus reum vocare*, to summon to court the offending party, who was obliged to go, or give bond for his appearance.

The offending party might be summoned into court *viva voce*, by the plaintiff himself meeting the defendant, declaring his intention to him, and commanding him to go before the magistrate and make his defence. If he would not go willingly, the plaintiff might drag and force him, unless he gave security for his appearance on some appointed day. If he failed to appear on the day agreed on, then the plaintiff, whensoever he met him, might take him along with him by force, calling any bystanders to bear witness, by asking them *visne antestari?* The bystanders upon this turned their ear toward him in token of their consent. To this Horace alludes in his satire against the impertinent, lib. i. sat. 9.

Both parties being met before the prætor, or other supreme magistrate presiding in the court, the plaintiff proposed to the defendant the action in which he designed to prosecute him. This was termed *edere actionem;* and was commonly performed by writing it in a tablet, and offering it to the defendant, that he might see whether it were better for him to stand the suit or to compound.

In the next place came the *postulatio actionis,* or the plaintiff's petition to the prætor for leave to prosecute the defendant in such an action. The petition was granted by writing at the bottom of it *actionem do;* or refused, by writing in the same manner *actionem non do.*

The petition being granted, the plaintiff *vadabatur reum, i. e.* obliged him to give sureties for his appearance on such a day in the court; and this was all that was done in public before the day fixed upon for the trial.

In the meantime, the difference was often made up either *transactione,* by letting the cause fall as dubious; or *pactione,* by composition for damages amongst friends.

On the day appointed for hearing, the prætor ordered the several bills to be read, and the parties summoned by an *accensus,* or beadle.

Upon the non-appearance of either party, the defaulter lost his cause: if they both appeared, they were said *se stetisse;* and then the plaintiff proceeded *litem sive actionem intendere, i. e.* to prefer his suit; which was done in a set form of words, varying according to the difference of the actions. After this the plaintiff desired judgment of the prætor, that is, to be allowed a *judex* or *arbiter,* else the *recuperatores* or *centumviri.* These he requested for the hearing and deciding the business: but none of them could be selected without the consent of both parties.

The prætor, having assigned them their judges, defined and determined the number of witnesses to be admitted, to hinder the protracting of the suit; and then the parties proceeded to give their caution, that the judgment, whatever it were, should be admitted and performed on both sides. The judges took a solemn oath to be impartial; and the parties took the *juramentum calumniæ.* Then the trial began with the assistance of witnesses, writings, &c. which was called *disceptatio causæ.*

ACTION, in a general sense, implies nearly the same thing with Act. Grammarians, however, observe some distinction between *action* and *act;* the former being generally restricted to the common or ordinary transactions, whereas the latter is used to express those which are remarkable. Thus, we say it is a good *action* to comfort the unhappy; it is a generous *act* to deprive ourselves of what is necessary for their sake.

Action, in *Commerce,* is a term used abroad for a certain part or share of a public company's capital stock. Thus, if a company has 400,000 livres capital stock, this may be divided into 400 actions, each consisting of 1000 livres.

Action, in *Mechanics,* implies either the effort which a body or power makes against another body or power, or the effect itself of that effort.

All power is nothing more than a body actually in motion, or which tends to move itself; that is, a body which would move itself if nothing opposed it. The action therefore of a body is rendered evident to us by its motion only; and consequently we must not fix any other idea to the word action than that of actual motion, or a simple tendency to motion. The famous question relating to *vis viva* and *vis mortua* owes its existence, in all probability, to an inadequate idea of the word action; for had Leibnitz and his followers observed that the only precise and distinct idea we can give to the word force or action reduces it to its effect, that is, to the motion it actually produces or tends to produce, they would never have made that curious distinction.



*Quantity of Action,* a name given by M. de Maupertuis, in the Memoirs of the Parisian Academy of Sciences for 1744, and those of Berlin for 1746, to the product of the mass of a body by the space which it runs through, and by its celerity. He lays it down as a general law, that "in the changes made in the state of a body, the quantity of action necessary to produce such change is the least possible." This principle he applies to the investigation of the laws of refraction, of equilibrium, &c. and even to the ways of acting employed by the Supreme Being. In this manner M. de Maupertuis attempts to connect the metaphysics of final causes with the fundamental truths of mechanics.

Action, in *Law,* is a demand made before a judge for obtaining what we are legally entitled to demand, and is more commonly known by the name of *law-suit* or *process.*

Action, in *Oratory,* is the outward deportment of the orator, or the accommodation of his countenance, voice, and gesture, to the subject of which he is treating.

Action, in *Painting* and *Sculpture,* is the attitude or position of the several parts of the face, body, and limbs, of such figures as are represented, and whereby they seem to be really actuated by passions. Thus, we say, the action of such a figure finely expresses the passions with which it is agitated; we also use the same expression with regard to animals.

Action, in *Physiology,* is applied to the functions of the body, whether vital, animal, or natural.—The *vital* functions, or actions, are those which are absolutely necessary to life, and without which there is no life; as the action of the heart, lungs, and arteries.—The *natural* functions are those which are instrumental in repairing the several losses which the body sustains; for life is destructive of itself, its very offices occasioning a perpetual waste. The manducation of food, the deglutition and digestion thereof, also the separation and distribution of the chyle and excrementitious parts, &c. are under the head of natural functions, as by these our aliment is converted into our nature. They are necessary to the continuance of our bodies.—The *animal* functions are those which, though not absolutely essential to life, are distinctive of animal existence, such as sensation, and voluntary motion.

Action, in *Poetry,* the same with subject or fable. Critics generally distinguish two kinds, the principal and the incidental. The principal action is what is generally called the *fable,* and the incidental an *episode.*

ACTIONARY, or Actionist, a proprietor of stock in a trading company.

ACTIVE denotes something that communicates action or motion to another; in which acceptation it stands opposed to passive.

Active, in *Grammar,* is applied to such words as express action, and is therefore opposed to passive. The active performs the action, as the passive receives it. Thus we say, a verb *active,* a conjugation *active,* &c. or an *active* participle.

*Active Verbs* are such as do not only signify doing, or acting, but have also nouns following them, to be the subject of the action or impression. Thus, *to love, to teach,* are verbs *active;* because we can say, *to love a thing, to teach a man.* See Grammar.

ACTIUM, in *Ancient Geography,* a town situate on the coast of Acarnania, in itself inconsiderable, but famous for a temple of Apollo, a safe harbour, and an adjoining promontory of the same name, in the mouth of the Sinus Ambracius, opposite to Nicopolis, on the other side of the bay. It became famous on account of Augustus's victory over Antony and Cleopatra, and for quinquennial games instituted there, called *Actia*, or *Ludi Actiaci*. Hence the epithet *Actius*, given to Apollo. (Virgil.) *Actiaca æra*, a computation of time from the battle of Actium. See ROMAN HISTORY.

ACTIUS, in *Mythology*, a surname of Apollo, from Actium, where he was worshipped.

ACTON, a large village in the county of Middlesex and hundred of Ossulton, about five miles from London. It was formerly frequented on account of some saline springs, which have now fallen into disuse. The grand junction canal, in its way from Uxbridge to London, passes through the parish. It is a rectory in the patronage of the bishop of London. The number of inhabitants in 1831, was 2453; in 1841, 2665; and in 1851, 2582.

ACTOR, in the *Drama*, is a person who represents some part or character. See DRAMA. Actors were highly honoured at Athens: at Rome they were despised, and not only denied all rank among the citizens, but even when any citizen appeared upon the stage, he was expelled his tribe, and deprived of the right of suffrage by the censors. The French have in this respect adopted the ideas of the Romans; the English those of the Greeks. Female actors were unknown to the ancients, among whom men always performed the female character; and hence one reason for the use of masks among them. Actresses are by some said not to have been introduced on the English stage till after the restoration of King Charles II. who has been charged with contributing to the corrupting of our manners by importing this usage from abroad. But this can be but partly true, for Prynne, in his *Histriomastix*, speaks of women actors as prostitutes; which, as the Queen of Charles I. sometimes acted in the court dramas, was one occasion of the severe prosecution brought against him for that book. See BIBLIOGRAPHY, sect. 6.

ACTOR, the name of several persons in *Fabulous History*. One *Actor* among the Aurunci is described by Virgil as a hero of the first rank.—*Æn*. ix. xii.

ACTORUM TABULÆ, in *Antiquity*, were tables instituted by Servius Tullius, in which the births of children were registered. They were kept in the treasury of Saturn.

ACTUARIÆ NAVES, a kind of long and light ships among the Romans, thus denominated because they were chiefly designed for swiftness and expedition. They correspond to what the French call *brigantines*.

ACTUARIUS, a celebrated Greek physician of the thirteenth century, and the first Greek author who has treated of mild purgatives, such as cassia, manna, senna, &c. He is the first also who mentions distilled waters. His works were printed in one volume folio, by Henry Stephens, in 1567.

ACTUARIUS, or ACTARIUS, a notary, or officer, appointed to write the acts or proceedings of a court, or the like. In the eastern empire, the actuarii were, properly, officers who kept the military accounts, received the corn from the *susceptores*, or storekeepers, and delivered it to the soldiers.

ACTUARY, an officer of a society or company, usually combining the functions of secretary and adviser. It is most usually applied to the manager of an insurance company, or joint stock association, under a board of directors.

ACTUS, in *Ancient Architecture*, a measure in length equal to 120 Roman feet. In *Ancient Agriculture* the word signified the length of one furrow, or the distance a plough goes before it turns.

*ACTUS Intervicinalis*, a space of ground four feet in breadth, left between the lands as a path or way.



*ACTUS Major*, or *Actus Quadratus*, a piece of ground in a square form, whose side was equal to 120 feet, equal to half the jugerum.

*ACTUS Minimus* was a quantity of land 120 feet in length and four in breadth.

ACUANITES, in *Ecclesiastical History*, the same with those called more frequently MANICHEES. They took the name from Acua, a disciple of Thomas, one of the twelve apostles.

ACULEATE, or ACULEATI, a term applied to any plant or animal armed with prickles.

ACULEI, the prickles of animals or of plants.

ACULER, in the *Manege*, is used for the motion of a horse, when, in working upon volts, he does not go far enough forward at every time or motion, so that his shoulders embrace or take in too little ground, and his croupe comes too near the centre of the volt. Horses are naturally inclined to this fault in making demi-volts.

ACUMINA, in *Antiquity*, a kind of military omen most generally supposed to have been taken from the points or edges of darts, swords, or other weapons.

ACUNA, CHRISTOPHER D', a Spanish Jesuit, born at Burgos. He was admitted into the society in 1612, being then but 15 years of age. After having devoted some years to study, he went to America, where he assisted in making converts in Chili and Peru. In 1640 he returned to Spain, and gave the king an account how far he had succeeded in the commission he had received to make discoveries on the river of the Amazons; and the year following he published, at Madrid, in a quarto volume, a description of this river, entitled *Nuevo Descubrimiento del Gran Rio de las Amazonas*. He was ten months together upon this river, having had instructions to inquire into every thing with the greatest exactness, that his Majesty might thereby be enabled to render the navigation more easy and commodious. He embarked in a boat at Jaen in Quito with Peter Texiera, who had already been so far up the river, and was therefore thought a proper person to accompany him in this expedition. They embarked in February 1639, but did not arrive at Para till the December following. It is thought that the revolution of Portugal, by which the Spaniards lost Brazil, and the colony of Para, at the mouth of the river of the Amazons, led to the suppression of Acuna's narrative; for, as it could not be of any advantage to the Spaniards, they were afraid it might prove of service to the Portuguese, by instructing them in the navigation of that great river. M. de Gomberville, the possessor of one of the few copies that escaped, published a French translation at Paris in 1682, in 2 vols. 12mo. Acuna appears to have returned to Peru, and to have died there; but the year of his death is uncertain.

ACUPUNCTURE, the name of a surgical operation among the Chinese and Japanese, which is performed by pricking the part affected with a silver needle. They employ this operation in headaches, lethargies, convulsions, colics, &c.; and it has more lately been introduced into British practice.

ACUTE, an epithet applied to such things as terminate in a sharp point or edge; and in this sense it stands opposed to obtuse.

*ACUTE-angled*, in *Geometry*, is that which is less than a right angle, or which does not subtend 90 degrees.

ACUTIATOR, in writers of the barbarous ages, denotes a person that whets or grinds cutting instruments; called also in ancient glossaries *acutor*, ακονητης, *samiarius*, *cotiarius*, &c. In the ancient armies there were *acutiatores*, a kind of smiths, retained for whetting or keeping the arms sharp.

AD, a Latin preposition, originally signifying *to*, and frequently used in composition, both with and without the *d*, to express the relation of one thing to another.

*Ad Bestias*, in *Antiquity*, is the punishment of criminals condemned to be thrown to wild beasts.

*Ad Hominem*, in *Logic*, a kind of argument drawn from the principles or prejudices of those with whom we argue.

*Ad Ludos*, in *Antiquity*, a sentence upon criminals among the Romans, whereby they were condemned to entertain the people by fighting either with wild beasts or with one another, and thus executing justice upon themselves.

*Ad Metalla*, in *Antiquity*, the punishment of such criminals as were condemned to the mines, among the Romans; and therefore called *Metallici*.

*Ad Valorem*, a term chiefly used in speaking of the duties or customs paid for certain goods. The duties on some articles are paid by the number, weight, measure, tale, &c.; and others are paid *ad valorem*, that is, according to their value.

ADAGE, a proverb, or short sentence, containing some wise observation or popular saying. Erasmus has made a very large and valuable collection of the Greek and Roman adages; and Mr Ray has done the same with regard to the English. We have also Kelly's Collection of Scots Proverbs.

ADAGIO, in *Music*. See MUSIC.

ADAIR, or ADARE, an ancient town in Ireland, now reduced to a village. It is eight miles S.W. of Limerick, and has a fine old bridge over the river Maig.

ADAIR is also the name of two counties in the United States of America; the first in Kentucky, with a population of 9917; the second in Missouri, with a population of 2351.

ADAL, or ADEL, or ADAIEL, a region between Abyssinia and the Red Sea, to the south of Bab-el-Mandeb. It was little known to Europeans until described in the travels of Isenberg and Krapf in 1839, and later by Beke. It forms the S.W. coasts of the Red Sea for 300 miles, which are composed of coral rock. The country is generally barren, intensely hot, and rather flat. A lofty mountain of 5000 feet high, Mount Gedem, stands isolated in the plain, and is succeeded in the ascent to the table-land of Tigré by a series of conical hills. Some parts of it are fit for pasturage, and those portions are inhabited by tribes possessing many domestic animals; and beasts of prey, and elephants are said not to be uncommon. The route to Abyssinia from Massowah lies through this country; but that from Tajarrah to Ankobar, to the south, is preferable, as less steep. On this route is seen a remarkable salt lake, Bahr Assal, which is 570 feet below the surface of the Red Sea; and volcanic rocks occur in various parts of the route. Two mountains of 4000 feet in height are mentioned, Abida and Aiyala, which occupy the centre of a volcanic district, and have sent down streams of lava on all sides to the distance of 30 miles. The river Hawash runs through this district, and is said to be navigable for boats 300 miles from its embouchure. This country has also been visited by the English missionaries, Messrs Keith and Coffin.

Adal is inhabited by many tribes who call themselves Danâkil and Dankali. Rüppel, who visited this country, mentions only the name of Shohos, whom he describes as strong and muscular, with black, crisp hair, short straight noses, thick lips, but less so than the negro feature, their colour dark brown. They are nomadic, and are Mahomedans. The only traffic in the country is in the salt of the Bahr Assal. (T. S. T.)

ADALBERT, *Saint*, one of the first founders of Christianity in Germany, was sprung of a noble family in pagan Sclavonia, and raised to the see of Prague, A.D. 983. Having laboured incessantly to reclaim the clergy and laity from their licentious ways, he retired in despair to the monastery of St Alexis at Rome; but from this retreat he was speedily recalled by his flock, who received him with public honours.





Finding little amendment, however, in their course of living, and having learnt that all his kinsmen had been massacred in a church, he resolved to end his days in missionary labours. But while engaged in worship with some converts in Pomerania, a pagan priest thrust a spear through his heart, A.D. 997.

ADALIDES, in the Spanish policy, are officers of justice for matters touching the military forces. In the laws of King Alphonsus, the adalides are spoken of as officers appointed to guide and direct the marching of the forces in time of war.

ADAM (אדם), the word by which the Bible designates the first human being.

The meaning of the primary word is, most probably, any kind of *reddish tint*, as a beautiful human complexion; but its various derivatives are applied to different objects of a red or brown hue, or approaching to such. The word *Adam*, therefore, is an appellative noun converted into a proper one.

That men and other animals have existed from eternity, has been asserted by some: whether they really believed their own assertion may well be doubted. Others have maintained that the first man and his female mate, or a number of such, came into existence by some spontaneous action of the earth or the elements, a chance combination of matter and properties, without an intellectual designing cause. We hold these notions to be unworthy of a serious refutation. An upright mind, upon a little serious reflection, must perceive their absurdity, self-contradiction, and impossibility.

It is among the clearest deductions of reason, that men and all dependent beings have been *created*, that is, produced or brought into their first existence by an intelligent and adequately powerful being. A question, however, arises, of great interest and importance. Did the Almighty Creator produce only one man and one woman, from whom all other human beings have descended?—or did he create several parental pairs, from whom distinct stocks of men have been derived? The affirmative of the latter position has been maintained by some, and, it must be confessed, not without apparent reason.

But the admission of the possibility is not a concession of the reality. So great is the evidence in favour of the derivation of the entire mass of human beings from one pair of ancestors, that it has obtained the suffrage of the men most competent to judge upon a question of comparative anatomy and physiology. The late illustrious Cuvier and Blumenbach, and our countryman Lawrence, are examples of the highest order. But no writer has a claim to deference upon this subject superior to that of Dr J. C. Prichard.

It is evident upon a little reflection, and the closest investigation confirms the conclusion, that the first human pair must have been created in a state equivalent to that which all subsequent human beings have had to reach by slow degrees, in growth, experience, observation, imitation, and the instruction of others: that is, a state of prime maturity, and with an infusion, concreation, or whatever we may call it, of knowledge and habits, both physical and intellectual, suitable to the place which man had to occupy in the system of creation, and adequate to his necessities in that place. Had it been otherwise, the new beings could not have preserved their animal existence, nor have held rational converse with each other, nor have paid to their Creator the homage of knowledge and love, adoration and obedience; and reason clearly tells us that the last was the noblest end of existence. Those whom unhappy prejudices lead to reject revelation must either admit this, or must resort to suppositions of palpable absurdity and impossibility. If they will not admit a direct action of divine power in creation and adaptation to the designed mode of existence, they must admit something far beyond the miraculous, an infinite succession of finite beings, or a spontaneous production of order, organization, and systematic action, from some unintelligent origin. The Bible coincides with this dictate of honest reason, expressing these facts in simple and artless language, suited to the circumstances of the men to whom revelation was first granted. That this production in a mature state was the fact with regard to the vegetable part of the creation, is declared in Gen. ii. 4, 5: "In the day of Jehovah God's making the earth and the heavens, and every shrub of the field before it should be in the earth, and every herb of the field before it should bud." The reader sees that we have translated the verbs (which stand in the Hebrew future form) by our potential mood, as the nearest in correspondence with the idiom called by Dr Nordheimer the "Dependent Use of the Future." (*Critical Grammar of the Heb. Lang.*, vol. ii. p. 186; New York, 1841.) The two terms, shrubs and herbage, are put, by the common synecdoche, to designate the whole vegetable kingdom. The reason of the case comprehends the other division of organized nature; and this is applied to man and all other animals, in the words, "Out of the ground—dust out of the ground—Jehovah God formed them."

It is to be observed that there are two narratives at the beginning of the Mosaic records, different in style and manner, distinct and independent; at first sight somewhat discrepant, but when strictly examined, perfectly compatible, and each one illustrating and completing the other. The first is contained in Gen. i. 1. to ii. 3.; and the other, ii. 4. to iv. 26. As is the case with the Scripture history generally, they consist of a few principal facts, detached anecdotes, leaving much of necessary implication which the good sense of the reader is called upon to supply; and passing over large spaces of the history of life, upon which all conjecture would be fruitless.

In the second of these narratives we read, "And Jehovah God formed the man [*Heb.* the Adam], dust from the ground [האדמה, *haadamah*], and blew into his nostrils the breath of life; and the man became a living animal" (Gen. ii. 7). Here are two objects of attention, the organic mechanism of the human body, and the vitality with which it was endowed.

The mechanical material, formed (moulded, or arranged, as an artificer models clay or wax) into the human and all other animal bodies, is called "dust from the ground." This would be a natural and easy expression to men in the early ages, before chemistry was known or minute philosophical distinctions were thought of, to convey, in a general form, the idea of *earthy matter*, the constituent substance of the ground on which we tread. To say, that of this the human and every other animal body was formed, is a position which would be at once the most easily apprehensible to an uncultivated mind, and which yet is the most exactly true upon the highest philosophical grounds. We now know, from chemical analysis, that the animal body is composed, in the inscrutable manner called *organization*, of carbon, hydrogen, oxygen, nitrogen, lime, iron, sulphur, and phosphorus. Now all these are mineral substances, which in their various combinations form a very large part of the solid ground.

In the Scripture narrative, we are told, "God created man in his own image: in the image of God created he him; male and female created he them." (Gen. i. 27.) *The image* (צלם *tselem*, resemblance, such as a shadow bears to the object which casts it) *of God* is an expression which breathes at once archaic simplicity and the most recondite wisdom: for what term could the most cultivated and copious language bring forth more suitable to the purpose? It presents to us man as made in a resemblance to the author of his being, a true resemblance, but faint and shadowy; an outline, faithful according to its capacity, yet infinitely remote from the reality: a distant form of the *intelligence*, *wisdom*, *power*, *rectitude*, *goodness*, and *dominion* of the Adorable Supreme.



On man was also conferred the shadow of the divine *dominion* and *authority* over the inferior creation. The attribute of *power* was given to him, in his being made able to convert the inanimate objects and those possessing only the vegetable life, into the instruments and the materials for supplying his wants, and continually enlarging his sphere of command.

In such a state of things *knowledge* and *wisdom* are implied: above all, *moral excellence* must have been comprised in this "image of God;" and not only forming a part of it, but being its crown of beauty and glory.

In this perfection of the faculties, and with these high prerogatives of moral existence, did human nature, in its first subject, rise up from the creating hand. The whole Scripture-narrative implies that this STATE of existence was one of correspondent *activity* and *enjoyment*. It plainly represents the DEITY himself as condescending *to assume a human form and to employ human speech*, in order to instruct and exercise the happy beings whom God created for immortality in the image of his own nature.

The noble and sublime idea that man thus had his Maker for his teacher and guide, precludes a thousand difficulties. It shows us the simple, direct, and effectual method by which the newly-formed creature would have communicated to him all the intellectual knowledge, and all the practical arts and manipulations, which were needful and beneficial for him. The universal management of the "garden in Eden eastward" (Gen. ii. 8), the treatment of the soil, the use of water, the various training of the plants and trees, the operations for insuring future produce, the necessary implements and the way of using them;—all these must have been included in the words "to dress it and to keep it" (ver. 15.)

Religious knowledge and its appropriate habits also required an immediate infusion: and these are pre-eminently comprehended "in the image of God." It is not to be supposed that the newly-created man and his female companion were inspired with a very ample share of the doctrinal knowledge which was communicated to their posterity by the successive and accumulating revolutions of more than four thousand years: and it is impossible that they could be left in gross ignorance of the existence and excellencies of the Being who had made them, their obligations to him, and the way in which they might continue to receive the greatest blessings from him.

The next important article in this primeval history is the creation of the human female. The narrative is given in the more summary manner in the former of the two documents:—'Male and female created he them." (Gen. i. 27.) It stands a little more at length in a *third* document, which begins the fifth chapter, and has the characteristic heading or title by which the Hebrews designated a separate work. "This, the book of the generations of Adam. In the day God created Adam, he made him in the likeness [דמית, *demuth*, a different word from that already treated upon, and which merely signifies *resemblance*] of God, male and female he created them; and he blessed them, and he called their name Adam, in the day of their being created" (ver. 1, 2.) The reader will observe that, in this passage, we have translated the word for *man* as the proper name, because it is so taken up in the next following sentence.

The second of the narratives is more circumstantial: "And Jehovah God said, it is not good the man's being alone: I will make for him a help suitable for him." Then follows the passage concerning the review and the naming of the inferior animals; and it continues—"but for Adam he found not a help suitable for him. And Jehovah God caused a deep sleep to fall upon the man [the Adam], and he slept: and he took one out of his ribs, and closed up the flesh in its place: and Jehovah God built up the rib which he had taken from the man into a woman, and he brought her to the man: and the man said, this is the hit; bone out of my bones, and flesh out of my flesh;

Adam. this shall be called woman [*ishah*], for this was taken from out of man [*ish*]" (Gen. ii. 18–23).

This *peculiar manner* of the creation of the woman has, by some, been treated as merely a childish fable; by others, as an allegorical fiction intended to represent the close relation of the female sex to the male, and the tender claims which women have to sympathy and love. That such was the intention we do not doubt; but why should that intention be founded upon a mythic allegory? Is it not taught much better, and impressed much more forcibly, by its standing not on a fiction, but on a fact?

Another inquiry presents itself. How long did the state of paradisiac innocence and happiness continue? Some have regarded the period as very brief, not more even than a single day; but this manifestly falls very short of the time which a reasonable probability requires. The first man was brought into existence in the region called Eden; then he was introduced into a particular part of it, the garden, replenished with the richest productions of the Creator's bounty for the delight of the eye and the other senses; the most agreeable labour was required "to dress and to keep it," implying some arts of culture, preservation from injury, training flowers and fruits, and knowing the various uses and enjoyments of the produce; making observation upon the works of God, of which an investigation and designating of animals is expressly specified; nor can we suppose that there was no contemplation of the magnificent sky and the heavenly bodies: above all, the wondrous communion with the condescending Deity, and probably with created spirits of superior orders, by which the mind would be excited, its capacity enlarged, and its holy felicity continually increased. It is also to be remarked, that the narrative (Gen. ii. 19, 20) conveys the implication that some time was allowed to elapse, that Adam might discover and feel his want of a companion of his own species, "a help correspondent to him."

These considerations impress us with a sense of probability, amounting to a conviction, that a period not very short was requisite for the exercise of man's faculties, the disclosures of his happiness, and the service of adoration which he could pay to his Creator. But all these considerations are strengthened by the recollection that they attach to man's solitary state; and that they all require new and enlarged application when the addition of conjugal life is brought into the account. The conclusion appears irresistible that a duration of many days, or rather weeks or months, would be requisite for so many and important purposes.

Thus divinely honoured and happy were the progenitors of mankind in the state of their creation.

The next scene which the sacred history brings before us is a dark reverse. Another agent comes into the field and successfully employs his arts for seducing Eve, and by her means Adam, from their original state of rectitude, dignity, and happiness.

Among the provisions of Divine wisdom and goodness were two vegetable productions of wondrous qualities and mysterious significancy; "the tree of life in the midst of the garden, and the tree of knowledge of good and evil." (Gen. ii. 9.)

We see no sufficient reason to understand, as some do, "the tree of life" collectively, as implying a species, and that there were many trees of that species.

The "tree of the knowledge of good and evil" might be any tree whatever; it might be of any species even yet remaining, though, if it were so, we could not determine its species, for the plain reason that no name, description, or information whatever is given that could possibly lead to the ascertainment. One cannot but lament the vulgar practice of painters representing it as an apple-tree, and thus giving occasion to profane and silly witticisms.

Yet we cannot but think the more reasonable probability to be, that it was a tree having poisonous properties, stimulating and intoxicating, such as are found in some existing species, especially in hot climates. On this ground the prohibition to eat or even touch the tree was a beneficent provision against the danger of pain and death.

But the revealed object of this "tree of the knowledge of good and evil" was that which would require no particular properties beyond some degree of external beauty, and fruit of an immediately pleasant taste. That object was to be a *test of obedience.* For such a purpose, it is evident, that to select an indifferent act to be the object prohibited, was necessary; as the obligation to refrain should be only that which arises simply, so far as the subject of the law can know, from the sacred will of the lawgiver. There was no difficulty in the observance of their Creator's precept. They were surrounded with a paradise of delights, and they had no reason to imagine that any good whatever would accrue to them from their seizing upon any thing prohibited. If perplexity or doubt arose, they had ready access to their Divine benefactor for obtaining information and direction. But they allowed the thought of disobedience to form itself into a disposition, and then a purpose.

Thus was the seal broken,—the integrity of the heart was gone,—the sin was generated,—and the outward act was the consummation of the entire process. Eve, less informed, less cautious, less endowed with strength of mind, became the more ready victim. "The woman, being deceived, was in the transgression;" but "Adam was not deceived" (1 Tim. ii. 14.) He rushed knowingly and deliberately to ruin. The offence had grievous aggravations. It was the preference of a trifling gratification to the approbation of the Supreme Lord of the universe; it implied a denial of the wisdom, holiness, goodness, veracity, and power of God; it was marked with extreme ingratitude; and it involved a contemptuous disregard of consequences, awfully impious as it referred to their immediate connection with the moral government of God, and cruelly selfish as it respected their posterity.

The instrument of the temptation was a serpent; whether any one of the existing kinds, it is evidently impossible for us to know. Of that numerous order many species are of brilliant colours, and playful in their attitudes and manners; so that one may well conceive of such an object attracting and fascinating the first woman. Whether it spoke in an articulate voice, like the human, or expressed the sentiments attributed to it by a succession of remarkable and significant actions, may be a subject of reasonable question.

This part of the narrative begins with the words, "And the serpent was crafty above every animal of the field" (Gen. iii. 1.) It is to be observed that this is not said of the order of serpents, as if it were a general property of them, but of *that* particular serpent. Had the noun been intended generically, as is often the case, it would have required to be without the substantive verb; for such is the usual Hebrew method of expressing universal propositions: of this the Hebrew scholar may see constant examples in the Book of Proverbs.

Indeed, this "cunning craftiness, lying in wait to deceive" (Eph. iv. 14.), is the very character of that malignant creature of whose wily stratagems the serpent was a mere instrument. The existence of spirits, superior to man, and of whom some have become depraved, and are labouring to spread wickedness and misery to the utmost of their power, has been found to be the belief of all nations, ancient and modern, of whom we possess information. It has also been the general doctrine of both Jews and Christians, that one of those fallen spirits was the real agent in this first and successful temptation. Of this doctrine, the declarations of our Lord and his apostles contain abundant confirmation.

After their fearful transgression, the condescending Deity, who had held gracious and instructive communion with the parents of mankind, assuming a human form, visibly stood before them; by a searching interrogatory he drew from them the confession of their guilt, which they aggravated by evasions and insinuations against God himself: he then pronounced sentence on them and their seducer. On the woman he inflicted the pains of child-bearing, and a deeper and more humiliating dependence upon her husband. He doomed the man to hard and often fruitless toil, instead of easy and pleasant labour. On both, or rather on human nature universally, he pronounced the awful sentence of death. The denunciation of the serpent partakes more of a symbolical character, and so seems to carry a strong implication of the nature and the wickedness of the concealed agent. The human sufferings threatened are all, excepting the last, of a remedial and corrective kind.

Of a quite different character are the penal denunciations upon the serpent. If they be understood literally, and of course applied to the whole order of Ophidia (as, we believe, is the common interpretation), they will be found to be flagrantly at variance with demonstrated facts in their physiology and economy.

But all difficulty is swept away when we consider the fact, that the Hebrew is הנחש היה *hannachash haiah*, THE *serpent was*, &c. and that it refers specifically and personally to a rational and accountable being, *the spirit of lying and cruelty, the devil, the Satan, the old serpent*. That God, the infinitely holy, good, and wise, should have permitted any one or more celestial spirits to apostatise from purity, and to be the successful seducers of mankind, is indeed an awful and overwhelming mystery. But it is not more so than the permitted existence of many among mankind, whose rare talents and extraordinary command of power and opportunity, combined with extreme depravity, have rendered them the plague and curse of the earth; and the whole merges into the awful and insolvable problem, Why has the All-perfect Deity permitted evil at all? We are firmly assured, that He will bring forth, at last, the most triumphant evidence that "He is righteous in all his ways, and holy in all his works." In the meantime, our happiness lies in the implicit confidence which we cannot but feel to be due to the Being of infinite perfection.

The remaining part of the denunciation upon the false and cruel seducer sent a beam of light into the agonized hearts of our guilty first parents: "And enmity will I put between thee and the woman, and between thy seed and her seed: he will attack thee [on] the head, and thou wilt attack him [at] the heel." Christian interpreters generally regard this as the *Protevangelium*, the first gospel-promise, and we think with good reason. It was a manifestation of mercy; it revealed a Deliverer, "who should be a human being, in a peculiar sense the offspring of the female, who should also, in some way not yet made known, counteract and remedy the injury inflicted, and who, though partially suffering from the malignant power, should, in the end, completely conquer it, and convert its very success into its own punishment." (J. Pye Smith, *Scripture Testimony to the Messiah*, vol. i. p. 226.)

The awful threatening to man was, "In the day that thou eatest of it, thou wilt die the death." The infliction is *Death*, in the most comprehensive sense,—that which stands opposed to *Life*,—the life of not only animal enjoyment, but holy happiness, the life which comported with the image of God. This was lost by the fall; and the sentence of physical death was pronounced, to be executed in due time. Divine mercy gave a long respite.

The same mercy was displayed in still more tempering the terrors of justice. The garden of delights was not to be the abode of rebellious creatures. But before they were turned out into a bleak and dreary wilderness, God was pleased to direct them to make clothing, suitable to their new and degraded condition, of the skins of animals. That those animals had been offered in sacrifice, is a conjecture supported by so much probable evidence, that we may regard it as a well-established truth.

From this time we have little recorded of the lives of Adam and Eve. Their three sons are mentioned with important circumstances connected with each of them. Cain was probably born in the year after the fall; Abel possibly some years later; Seth, certainly one hundred and thirty years from the creation of his parents. After that Adam lived eight hundred years, and had sons and daughters, doubtless by Eve, and then he died, nine hundred and thirty years old. In that prodigious period, many events, and those of great importance, must have occurred; but the wise providence of God has not seen fit to preserve to us any memorial of them, and scarcely any vestiges or hints are afforded of the occupations and mode of life of men through the antediluvian period.

ADAM *of Bremen* was a canon of the cathedral of Bremen, and lived in the latter part of the eleventh century. He wrote a church history, in four books, treating of the propagation of the Christian faith in the north, entitled *Historia ecclesiastica ecclesiarum Hamburgensis et Bremensis, ab anno* 788 *ad an.* 1072; and also another work particularly interesting to geographers, called *Chronographia Scandinaviæ*, or, *De Situ Daniæ et reliquarum trans Daniam regionum natura.* The time of his death is not known.



ADAM, *Alexander*, Rector of the High School, Edinburgh, and author of several valuable works connected with Roman literature, was born on the 24th of June 1741, on a small farm which his father rented, not far from Forres, in Morayshire. He does not appear to have received any powerful direction to literary pursuits, either from the attainments of his parents or the ability of the parochial schoolmaster; but is referable to a class of men, of which Scotland can produce a very honourable list, whom the secret workings of a naturally active mind have raised above the level of their associates, and urged on to distinction and usefulness under the severest pressure of difficulties. The gentle treatment of an old schoolmistress first taught him to like his book; and this propensity induced his parents to consent that he should learn Latin. To the imperfect instruction which he received at the parish school, he joined indefatigable study at home, notwithstanding the scanty means and poor accommodation of his father's house. Before he was sixteen he had read the whole of Livy, in a copy of the small Elzevir edition, which he had borrowed from a neighbouring clergyman, omitting for the present all such passages as his own sagacity and Cole's *Dictionary* did not enable him to construe. It was before day-break, during the mornings of winter, and by the light of splinters of bog-wood dug out of an adjoining moss, that he prosecuted the perusal of this difficult classic; for, as the whole family were collected round the only fire in the evening, he was prevented by the noise from reading with any advantage; and the day-light was spent at school.

In the autumn of 1757 he was a competitor for one of those bursaries, or small exhibitions, which are given by the university of Aberdeen to young men who distinguish themselves for their classical attainments; but as the prize was awarded to the best written exercises, and as Adam, with all his reading, had not yet been accustomed to write, he was foiled by some youth who had been more fortunate in his means of instruction. About the same time Mr Watson, a relation of his mother's, and one of the ministers of the Canongate, sent him a tardy invitation to come to Edinburgh, "provided he was prepared to endure every hardship for a season,"—a condition not likely to appal one who knew nothing of life but its hardships. The interest of Mr Watson procured him free admission to the lectures of the different professors; and as he had now also access to books in the College Library, his literary ardour made him submit with cheerfulness to the greatest personal privations. Eighteen months of assiduous application enabled him to repair the defects of his early tuition, and to obtain, after a comparative trial of candidates, the head mastership of the foundation known by the name of Watson's Hospital. At this period he was only nineteen, on which account the governors of the institution limited the appointment to half a year; but his steadiness and ability speedily removed their scruples. After holding the situation for three years, he was induced, by the prospect of having more leisure for the prosecution of his studies, to resign it, and become private tutor to the son of Mr Kincaid, a wealthy citizen, and afterwards Lord Provost of Edinburgh; and it was in consequence of this connection that he was afterwards raised to the office for which he was so eminently qualified. He taught in the High School, for the first time, in April 1765, as substitute for Mr Matheson, the rector; in consequence of whose growing infirmities, an arrangement was made, by which he retired on a small annuity, to be paid from the profits of the class; and Mr Adam was confirmed in the rectorship on the 8th of June 1768.

From this period the history of his life is little more than the history of his professional labours and of his literary productions. No sooner was he invested with the office, than he gave himself up with entire devotion to the business of his class, and the pursuits connected with it. For forty years his day was divided with singular regularity between the public duties of teaching and that unwearied research and industry in private which enabled him, amidst the incessant occupation of a High School master's life, to give to the world such a number of accurate and laborious compilations. So entirely did these objects of public utility engross his mind, that he mixed but little with society, and considered every moment as lost that was not dedicated in some way or other to the improvement of youth. Few men certainly could adopt, with more truth and propriety, the language of Horace, both with regard to his own feelings and the objects on which he was occupied.

......mihi tarda fluunt ingrataque tempora, quæ spem
Consiliumque morantur agendi gnaviter id, quod
Æque pauperibus prodest, locupletibus æque,
Æque, neglectum, pueris senibusque nocebit.
*Epist.* i. 1. 23.

The rector's class, which in the High School is the most advanced of five, consisted of no more than between thirty and forty boys when Dr Adam was appointed. His celebrity as a classical teacher, joined to the progress of the country in wealth and population, continued to increase this number up to the year of his death. His class-list for that year contained 167 names,—the largest number that had ever been collected in one class, and, what is remarkable, equal to the amount of the whole five classes during the year when he first taught in the school.

He performed an essential service to the literature of his country by introducing, in his own class, an additional hour of teaching for Greek and Geography; neither of which branches seems to have been contemplated in the original formation of the school. The introduction of Greek, which he effected a year or two after his election, was regarded by some professors of the university as a dangerous innovation, and an unwarrantable encroachment on the province of the Greek chair; and the measure was accordingly resisted (though, it is satisfactory to think, unsuccessfully) by the united efforts of the Senatus Academicus, in a petition and representation to the town-council, drawn up and proposed by the celebrated Principal of the university, Dr Robertson. This happened in 1772.

It is not possible for a man of principle and ordinary affections to be occupied in training a large portion of the youth of his country to knowledge and virtue, without feeling a deep responsibility, and a paramount interest in their progress and welldoing. That such were Dr Adam's feelings is proved, not less by the whole tenor of his life, than by his mode of conducting the business of his class; by the free scope and decided support he gave to talent, particularly when the possessor of it was poor and friendless; by the tender concern with which he followed his pupils into life; and by a test not the least unequivocal, the enthusiastic attachment and veneration which they entertain for his memory. In his class-room, his manner, while it imposed respect, was kindly and conciliating. He was fond of relieving the irksomeness of continued attention by narrating curious facts and amusing anecdotes. In the latter part of his life, he was perhaps too often the hero of his own tale; but there was something amiable even in this weakness, which arose from the vanity of having done much good, and was totally unmixed with any alloy of selfishness.

Dr Adam's first publication was his *Grammar*, which appeared in 1772. Although it met with the approbation of some eminently good judges, particularly of Bishop Lowth, the author had no sooner adopted it in his own class, and recommended it to others, than a host of enemies rose up against him, and he was involved in much altercation and vexatious hostility with the town-council and the four under masters.



His work on *Roman Antiquities* was published in 1791, and has contributed, more than any of his other productions, to give him a name as a classical scholar.

In 1794, he published his *Summary of Geography and History*, in one thick octavo volume of 900 pages, which had grown in his hands to this size from a small treatise on the same subject, printed for the use of his pupils in 1784.

His last work was his *Latin Dictionary*, which appeared in 1805, printed, like every other production of his pen, in the most unassuming form, and with the utmost anxiety to condense the greatest quantity of useful knowledge into the smallest bulk, and afford it to the student at the cheapest rate. It was intended chiefly for the use of schools, and to be followed by a larger work, containing copious illustrations of every word in the language. The MS. of this important work, which he did not survive to complete, is deposited in the library of the school over which he so long and so ably presided. He died on the 18th of December 1809, after an illness of five days. Amidst the wanderings of mind that accompanied it, he was constantly reverting to the business of the class, and addressing his boys; and in the last hour of his life, as he fancied himself examining on the lesson of the day, he stopped short, and said, "But it grows dark, you may go;" and almost immediately expired.

The magistrates of Edinburgh, whose predecessors had not always been alive to his merits, showed their respect for his memory by a public funeral. A short time before his death, he was solicited by some of his old pupils to sit to Mr Raeburn for his portrait, which was executed in the best style of that eminent artist, and placed, as a memorial of their gratitude and respect, in the library of the High School.

He was twice married; first in 1775, to Miss Munro, eldest daughter of the minister of Kinloss, by whom he had several children, the last of whom died within a few days of his father; and in 1789, to Miss Cosser, daughter of Mr Cosser, Comptroller of Excise, by whom he had two daughters and a son. (J. P—S.)

Adam, *Melchior*, lived in the seventeenth century. He was born in the territory of Grotkaw in Silesia, and educated in the college of Brieg, where he became a firm Protestant, and was enabled to pursue his studies by the liberality of a person of quality, who had left several exhibitions for young students. He was appointed rector of a college at Heidelberg, where he published, in the year 1615, the first volume of his *Vitæ Germanorum Philosophorum*, &c. This volume was followed by three others: that which treated of divines was printed in 1619; that of the lawyers came next; and, finally, that of the physicians: the last two were published in 1620. All the learned men whose lives are contained in these four volumes lived in the sixteenth or beginning of the seventeenth century, and are either Germans or Flemings; but he published in 1618 the lives of twenty divines of other countries in a separate volume, entitled *Decades duæ, continentes Vitas Theologorum exterorum principum.* All his divines are Protestants. His industry as a biographer is commended by Bayle, who acknowledges his obligations to his labours. He died in 1622.

Adam, *Robert*, an eminent architect, was born at Edinburgh in the year 1728. He was the second son of William Adam, Esq. of Maryburgh, in the county of Fife, who also has left some respectable specimens of his genius and abilities as an architect in Hopetoun House and the Royal Infirmary of Edinburgh, which were erected from designs executed by him. And it was perhaps owing to the fortunate circumstance of his father's example that young Adam first directed his attention to those studies, in the prosecution of which he afterwards rose to such distinguished celebrity. He received his education at the university of Edinburgh, where he had an opportunity of improving and enlarging his mind, by the conversation and acquaintance of some of the first literary characters of the age, who were then rising into reputation, or have since established their fame as historians and philosophers. Among these were Mr Hume, Dr Robertson, Dr Smith, and Dr Ferguson, who were the friends and companions of the father, and who continued through life their friendship and attachment to the son.

In the year 1754, Mr Adam travelled on the Continent, with a view to extend his knowledge and improve his taste in architecture, and resided in Italy for three years. Here he surveyed and studied those noble specimens of ancient grandeur which the magnificent public edifices of the Romans, even in ruins, still exhibit. In tracing the progress of architecture and the other fine arts among the Romans, Mr Adam observed that they had visibly declined previously to the time of Diocletian; but he was also convinced that the liberal patronage and munificence of that emperor had revived, during his reign, a better taste for architecture, and had formed artists who were capable of imitating the more elegant style of a purer age. He had seen this remarkably exemplified in the public baths at Rome, which were erected by him, the most entire and the noblest of the ancient buildings. Admiring the extent and fertility of genius of the artists from whose designs such magnificent structures had been executed, he was anxious to see and study any remains that yet existed of those masters whose works were striking monuments of an elegant and improved taste, but whose names, amid the wrecks of time, have sunk into oblivion. It was with this view that he undertook a voyage to Spalatro, in Dalmatia, to visit and examine the private palace of Diocletian. Mr Adam sailed from Venice in July 1754, accompanied by M. Clerisseau, a French artist and antiquary, and two experienced draughtsmen. On their arrival at Spalatro, they found, that though the palace had suffered much from the injuries of time, yet it had sustained no less from the dilapidations of the inhabitants to procure materials for building; and even the foundations of the ancient structure were covered with modern houses. Suspecting that their object was to view and make plans of the fortifications, an immediate and peremptory order was issued by the governor, commanding them to desist. This order, however, was soon counteracted through the mediation of General Græme, the commander-in-chief of the Venetian forces. They resumed their labours with double ardour, and in five weeks finished plans and views of the fragments which remain, from which they were enabled to execute perfect designs of the entire building.

Mr Adam now returned to England, and soon rose to very considerable professional eminence. In 1762 he was appointed architect to the king; and the year following he presented to the public the fruit of his voyage to Spalatro, in a splendid work, containing engravings and descriptions of the ruins of the palace.

In the year 1768, Mr Adam obtained a seat in parliament. He was chosen to represent the county of Kinross; and about the same time he resigned his office of architect to the king. But he continued his professional career with increasing reputation; and about the year 1773, in conjunction with his brother James, who also rose to considerable eminence as an architect, he published another splendid work, consisting of plans and elevations of public and private buildings which were erected from their designs. Among these are, Lord Mansfield's house at Caenwood; Luton House in Bedfordshire, belonging to Lord Bute; the new Gateway of the Admiralty Office; the Register Office at Edinburgh, &c.; which are universally admired as striking monuments of elegant design and correct taste. The Adelphi buildings at London, which also are a very fine example of the inventive genius of the Messrs Adam, proved an unsuccessful speculation.

The buildings more lately erected from the designs of Mr Adam afford additional proofs of his invention and skill. We may mention, in particular, the Infirmary of Glasgow, as exhibiting the most perfect symmetry and useful disposition of parts, combined with great beauty and lightness.

To the last period of his life Mr Adam displayed an increasing vigour of genius and refinement of taste; for, in the space of one year preceding his death, he designed eight great public works, besides twenty-five private buildings, so various in their style and beautiful in their composition, that they have been allowed, by the best judges, as sufficient of themselves to establish his fame. The improved taste which now pretty generally prevails in our public and private edifices, undoubtedly owes much to the elegant and correct style introduced by this distinguished artist.

He died on the 3d of March 1792, by the bursting of a blood-vessel, in the 64th year of his age, and was buried in Westminster Abbey. The natural suavity of his manners, joined to the excellence of his moral character, secured to him the affectionate regard of his friends, and the esteem of all who enjoyed his acquaintance. James Adam, already mentioned as associated with his brother in many of his labours, died on the 20th October 1794.

Adam, *William*, nephew of the preceding, was the eldest son of John Adam, Esq. of Blair-Adam (for a short time called Maryburgh), in the county of Kinross, in Scotland. He was born in Kinross-shire on the 2d of August 1751; and, after the usual courses at the colleges of Edinburgh and Glasgow, passed advocate at the Scotch bar in 1773. But he made no serious attempt to practise there, having very soon removed to England, where he obtained a seat in the House of Commons in 1774, and in 1782 was called to the English common-law bar. He continued in parliament till 1795, when he withdrew from it till 1806. Being then chosen to represent the united shires of Kinross and Kincardine, he resumed his seat, and continued in the House, but with some interruptions, till 1811.

His parliamentary life thus lasted about 30 years; during all which period he took a conspicuous part in most of the proceedings of the House. But it would be idle to detail his particular share in them here. It is only in the cases of the few men who leave permanent impressions on their age, that the details of parliamentary exertion, however honourable to him who makes them, and however interesting to his friends, are cared for by general readers. It is enough, therefore, to state that Mr Adam, though a popular speaker, was not an orator, and had far too much sense to try to be thought one. But he was one of the many members who do, by judgment and attention, what eloquence would in vain attempt to accomplish. He made himself of importance by good sense, industry, popularity of manner, and a firm adherence, though not without the incidental differences that will occasionally separate the steadiest partisans, to the Whig principles and the Whig party, which he had adopted, and from which he never swerved. Some inconsiderate words which occurred in a debate in 1779, produced a hostile meeting between him and Mr Fox, when the latter was slightly wounded; but neither before nor after could there be two better friends. They were both of the small but noble band who stood out for the practical exercise of the British constitution, against the encroachments which they thought that, under a real or pretended horror of the first French Revolution, were making upon it by Government. None of his parliamentary exertions were more valuable, or more ably conducted, than those which he made in March 1794, against the shocking proceedings of the Scotch Criminal Court in certain trials for sedition; when that court, while sedition, how often soever committed, could, in England, be only punished by fine and imprisonment, punished a first offence by 14 years' transportation; and this without a statute, and solely in the exercise of judicial discretion, and at a time when New South Wales, where these unfortunate men were sent, as the court understood that they would be, was in a state of desolate and unapproachable barbarism.

After being called to the English bar, he prosecuted its business with the steady assiduity of one who knew that success was necessary for his independence. If he had given himself to this field exclusively, he would have risen still higher in it than he actually did; for this is a profession in which no one can give himself fair play who attempts to combine it with any other occupation. He was known to be deeply engaged with parliament, and with the management of the pecuniary affairs of several members of the royal family, particularly of the Prince of Wales and the Duke of York, to whom his practical sagacity was of the greatest use. But still he rose to very considerable practice, and became a king's counsel in 1796,—counsel to the East India Company in 1802,—and was successively Attorney and Solicitor General to the Prince, afterwards George IV.,—one of the managers of the impeachment of Warren Hastings, and one of the counsel who conducted the defence of the first Lord Melville, when he (as Mr Dundas) was impeached also. During the short period when his party was in power, in 1806, he was Chancellor of the Duchy of Cornwall, and was afterwards a Privy Councillor, and Lord-Lieutenant of Kinross-shire.

In 1814 he withdrew from England, on being made a Baron of Exchequer in Scotland. This was preparatory to his last elevation as Chief Commissioner of the Jury-Court, to which he was appointed in 1815, and in connection with which institution he will be chiefly known historically.

The application of juries to the trial of civil causes was till then unknown in Scotland. The want of them had been long complained of, both by enlightened lawyers and by the public; and, though there were some haters of change to whom their introduction was offensive, it was recommended by all liberal legislators, legal and political, in both quarters of the island; and Baron Adam was selected to preside over the new tribunal. He continued to do so till 1830, by which time he had matured our jury practice sufficiently to enable it to be engrafted into the business of the permanent supreme tribunal, and to admit of his own separate jury-court being abolished.

The general problem of the fitness of juries for the decision of facts involving civil interests, and the success of the effort to introduce them into Scotland, are not questions for discussion here. There has recently been an apparent abatement of the idolatry of jury-trial in England, and there are some who hold the Scotch experiment to have totally failed. The truth probably is, that the English use civil juries too indiscriminately, and that the expectations of what they were to effect in Scotland were extravagant. But their total failure in Scotland is, unquestionably, not a fact. On the contrary, they continue to perform most valuable service in the administration of justice, and could not be given up without an instant revival of the unavoidable and intolerable evils, which, though now forgotten by many, produced the absolute necessity for their establishment.

But whatever may be now thought of the jury principle, there can be but one just opinion of the exact merit of the judge to whom its introduction into Scotland was entrusted. His devotion to his task was ardent and constant. No man ever gave himself more earnestly to the achievement of a great judicial end. He did not bring profound law to the work; one good effect of which was, that it liberated his mind from exclusive addiction to the system in which he had been trained. Unstiffened by previous habits, he was able to relieve Scotch awkwardness by English experience, and to enlarge English narrowness by Scotch reason. His skill in directing juries was not so great as his judgment in the formation of rules for ripening the system. His candour,—the cheerful endurance of his patience,—his simple but dignified urbanity, and his uniform accessibility, were all perfect. He and his court were, at first, so much obstructed by prejudice, that without his protection the measure would have been defeated without ever having had a fair trial.

Personally, he was, in all practical matters an able manager;—and always kind and pleasant,—beloved by his family and a large circle of friends,—of excellent conversation, and delightful in society. His long residence in London, and his acquaintance with almost all the celebrated men of all classes of his time, supplied him with a never-failing store of well-told anecdote. His connection with his native country previously to his final return to it in 1815, had been kept up by regular visits;—as might have been expected of one who never ceased to consider the country of his birth and education as his home, and to whom Blair-Adam was Arabia Felix. It is now, through his tasteful management, adorned by judiciously placed and thriving wood. When his grandfather acquired it, the whole foliage it could boast of was supplied by a single tree. He was one of the very best depositaries of all the old and fast-fading peculiarities of Scotland; the dialect of which, and when he chose, its accent, he retained thoroughly; and remembered and enjoyed all the sayings and customs of the country, its local literature, and all its curious old characters and occurrences. His combination of the social knowledge of both kingdoms, added to his natural shrewdness of observation on all passing subjects, gave him great conversational advantages, and made him a most agreeable companion.

After maintaining a gallant battle against some personal infirmities, and preserving his mental powers unimpaired, he died at Edinburgh on the 17th of February 1839, in his 89th year. He had long survived his wife, a daughter of Lord Elphinstone, and was succeeded by his eldest surviving son, Admiral Sir Charles Adam, governor of Greenwich Hospital; his only other remaining child now surviving being General Sir Frederick Adam. (H. C.)

Adam's *Apple*, a name given to a species of Citrus.

Adam's *Bridge*, or *Rama's Bridge*, in *Geography*, a ridge of sands and rocks, extending across the north end of Manaar gulf, from the island of that name on the north-west coast of Ceylon, to Ramencote or Ramisseram island, off Raman point. The extent of this chain of shoals and islands is about one degree; but some of the sand-banks are dry, while much of it has not more than three or four feet below water; and it is divided by three or four deeper cuts, that in calm weather permit the passage of native boats and small vessels through tortuous and intricate channels.

Adam's *Peak*, the highest mountain in Ceylon, is stated by Dr Davy, who ascended it, to rise to the height of 6680 feet in a very steep acclivity, and to terminate in a point not more than 74 feet by 24 feet. On this small plain is the supposed impression of the foot of *Boodhu*, an object of high veneration to the Cingalese, who make frequent pilgrimages to this sacred spot, where a priest resides to receive the offerings of the devotees, and to bless them on their departure. The *foot-mark* is partly natural, partly artificial, and measures 5 feet 4 inches by 2 feet 6 inches. It has a margin of brass ornamented with some gems of small value, and is covered by a roof. The mountain is wooded almost to the top, and is seen at the distance of twenty leagues from sea. The view from it is very sublime. Long. 80. 39. E. Lat. 6. 55. N.

ADAMANT, a name sometimes given to the diamond. (See Diamond.) It is likewise applied to the scoriæ of gold, the magnet, &c.

ADAMIC Earth, a name given to common red clay, alluding to that species of earth of which the first man is supposed to have been made.

ADAMI Pomum, in *Anatomy*, a protuberance in the fore part of the throat, formed by the os hyoides. It is thought to be so called from a strange conceit that a piece of the forbidden apple which Adam ate stuck by the way and occasioned it.

ADAMITES, or Adamians, in *Ecclesiastical History*, the name of a sect of ancient heretics, supposed to have been a branch of the Basilidians and Carpocratians.

Epiphanius tell us that they were called Adamites from their pretending to be re-established in the state of innocence, and to be such as Adam was at the moment of his creation, whence they ought to imitate him in his nakedness. They rejected marriage, maintaining that the conjugal union would never have taken place upon earth had sin been unknown.

This obscure and ridiculous sect did not at first last long; but it was revived, with additional absurdities, in the twelfth century, by one Tandamus, since known by the name of *Tanchelin*, who propagated his errors at Antwerp in the reign of the emperor Henry V. He maintained that there ought to be no distinction between priests and laymen, and that fornication and adultery were meritorious actions. Tanchelin had a great number of followers, and was constantly attended by 3000 of these profligates in arms. His sect did not, however, continue long after his death; but another appeared under the name of *Turlupins*, in Savoy and Dauphiny, where they committed the most brutal actions in open day.

About the beginning of the fifteenth century, one Picard, a native of Flanders, spread these errors in Germany and Bohemia, particularly in the army of the famous Zisca, notwithstanding the severe discipline he maintained. Picard pretended that he was sent into the world as a new Adam, to re-establish the law of nature; which, according to him, consisted in exposing every part of the body, and having all the women in common. This sect found also some partisans in Poland, Holland, and England: they assembled in the night; and it is asserted, that one of the fundamental maxims of their society was contained in the following verse:—

Jura, perjura, secretum prodere noli.

ADAMS, a township of Berkshire county, in the state of Massachusetts, in North America. It is 140 miles north-west of Boston, and contains 3703 inhabitants. In the northern part of this district, a stream called Hudson's brook has worn a channel through a stratum of white marble, and over the channel the rocks form a fine natural bridge, which is 12 or 15 feet long, 10 feet broad, and more than 60 feet above the water.

Adams, the name of six different counties in the United States of America. 1st, in Pennsylvania, population, in 1850, 25,988; 2d, in the southern district of Mississippi, population, 18,621; 3d, in Ohio, population, 18,943; 4th, in Indiana, population, 5774; 5th, in Illinois, population, 26,537; 6th, in Wisconsin, population, 187.

Adams, *John*, a distinguished statesman of the United States of North America. He was born on the 19th or (new style) 30th of October 1736, in that part of the township of Braintree, in Massachusetts, which on a subsequent division was called Quincy. His parents were of that class, then abounding in New England, who united the profession of agriculture with that of some one of the mechanic arts. His ancestor Henry had emigrated from Devonshire in the year 1632, and had established himself at Braintree with six sons, all of whom married: from one descended the subject of this memoir, and from another that Samuel Adams who, with John Hancock, was by name proscribed by an act of the British parliament, for the conspicuous part he acted in the early stages of the opposition to the measures of the mother country. When about fifteen years of age, his father proposed to his son John either to follow the family pursuits, and to receive in due time, as his portion, a part of the estate which they had cultivated, or to have the expense of a learned education bestowed upon him, with which, instead of any fortune, he was to make his way in future life. The son chose the latter alternative; and having received some preparatory instruction, was admitted a student at Harvard College in the year 1751. After passing about three years in that seminary, he removed to the town of Worcester, where, according to the economical practice of that day in New England, he became a tutor in a grammar school, and at the same time was initiated into the practice of the law in the office of Mr Putnam, then an attorney and a colonel of militia, and subsequently a general of some celebrity in the revolutionary war. A letter of Mr Adams, which has lately come before the public, written at the early age of nineteen, shows a degree of foresight which, like many other predictions, may have led to its own accomplishment. It is dated 12th October 1755, and says, "Soon after the Reformation, a few people came over to this new world for conscience' sake. Perhaps this apparently trivial incident may transfer the great seat of empire to America. It looks likely to me; for if we can remove the turbulent Gallic (the French in Canada), our people, according to the exactest computation, will in another century become more numerous than England itself. Should this be the case, since we have, I may say, all the naval stores of the nation in our hands, it will be easy to obtain the mastery of the seas; and then the united force of all Europe will not be able to subdue us. The only way to keep us from setting up for ourselves is to disunite us."

He was admitted to practice in the year 1758, and gradually rose to the degree of eminence which a local court can confer; and obtained distinction by some essays on the subject of the canon and feudal law, which were directed to point to the rising difference which commenced between the mother country and the colonies, soon after the peace of 1763 had delivered the latter from all disquietude respecting the establishments of France in the adjoining province of Canada. His character rose, both as a lawyer and a patriot, so as to induce Governor Barnard, who wished to gain him over to the royal party, to offer him the office of advocate-general in the Admiralty Court, which was deemed a sure step to the highest honours of the bench. Two years after, he was chosen one of the representatives of his native town to the congress of the province.

His professional integrity was soon after exhibited in the defence of Captain Preston and some soldiers, who were tried before a Boston jury on a charge of murder. In this case Adams was counsel for the defence; and being considered by the people, then in an inflamed state against the troops, as a determined friend of liberty, his eloquence obtained a verdict of acquittal, without lessening his popularity.

When it was determined, in 1774, to assemble a general congress from the several colonies, Mr Adams was one of those solicited for the purpose by the people of Massachusetts. Before departing for Philadelphia to join the congress, he parted with the friend of his youth, his fellow-student and associate at the bar, Jonathan Sewall, who had attained the rank of attorney-general, and was necessarily opposed to his political views. Sewall made a powerful effort to change his determination, and to deter him from going to the congress. He urged, that Britain was determined on her system, and was irresistible; and would be destructive to him and all those who should persevere in opposition to her designs. To this Adams replied: "I know that Great Britain has determined on her system, and that very fact determines me on mine. You know I have been constant and uniform in opposition to her measures; the die is now cast; I have passed the Rubicon; to swim or sink, live or die, survive or perish with my country, is my unalterable determination." The conversation was then terminated by Adams saying to his friend, "I see we must part; and with a bleeding heart, I say, I fear for ever. But you may depend upon it, this adieu is the sharpest thorn on which I ever set my foot."

When the continental congress was assembled, Mr Adams became one of its most active and energetic leaders. He was a member of that committee which framed the declaration of independence, and one of the most powerful advocates for its adoption by the general body; and by his eloquence obtained the unanimous suffrages of that assembly. Though he was appointed chief-justice in 1776, he declined the office, in order to dedicate his talents to the general purpose of the defence of the country.

In 1777, he, with three other members, was appointed a commissioner to France. He remained in Paris about a year and a half, when, in consequence of disagreements among themselves, in which Adams was not implicated, all but Franklin were recalled. In the latter end of 1779, he was charged with two commissions, one as a plenipotentiary to treat for peace, the other empowering him to form a commercial treaty with Great Britain. When arrived in Paris, the French government viewed with jealousy the purpose of the second commission; and Count de Vergennes advised him to keep it secret, with a view to prevail on the congress to revoke it. Mr Adams refused to communicate to the Count his instructions on that subject; and an altercation arose, from a claim made by France for a discrimination in favour of French holders of American paper money in the liquidation of it. The Count complained to congress, transmitted copies of Mr Adams' letters, and instructed the French minister at Philadelphia to demand his recal. The demand was rejected, but afterwards four others were joined with him in the commission. Whilst these negotiations were in progress, he went to Holland, and there, in opposition to the influence and talents of the British minister, Sir Joseph Yorke, succeeded both in negotiating a loan, and in procuring the assistance of that country in the defence against Great Britain. He formed a commercial treaty with that republic, and joined in the ephemeral association called "the armed neutrality."

In 1785 Mr Adams was appointed ambassador to the court of his former sovereign, where his conduct was such as to secure the approbation of his own country, and the respect of that to which he was commissioned. Whilst in London, he published his work entitled *Defence of the American Constitution*, in which he combated ably the opinions of Turgot, Mably, and Price, in favour of a single legislative assembly; and thus perhaps contributed to the division of power and the checks on its exercise, which became established in the United States. At the close of 1787 he returned, after ten years devoted to the public service, to America. He received the thanks of congress, and was elected soon after, under the presidency of Washington, to the office of vice-president. In 1790 Mr Adams gave to the public his *Discourses* on Davila, in which he exposed the revolutionary doctrines propagated by France and her emissaries in other countries. On the retirement of Washington, the choice of president fell on Mr Adams, who entered on that office in May 1797. At that time the government was entangled by the insolent pretensions of the French demagogues, and by their partisans in many of the states. Great differences of opinion arose between the individuals at the head of affairs: one party, with Mr Hamilton at their head, was disposed to resist the pretensions of France by open hostilities; whilst Mr Adams was disinclined to war, so long as there was a possibility of avoiding it with honour. Owing to this division of his own friends, rather than to a want of public confidence, at the conclusion of the four years for which the president is chosen, Mr Adams was not re-elected. Perhaps this was in some measure owing to the preponderance of the slave states, in which Mr Jefferson, his rival, and a proprietor of slaves, had a fellow-feeling among the chief of the people.



He retired with dignity, at sixty-eight years of age, to his native place, formed no political factions against those in power, but publicly expressed his approbation of the measures which were pursued by him who had been his rival, who had become his successor in power, but had never ceased to be his firmly attached friend.

The last public occasion on which Mr Adams appeared, was as a member of the convention for the revision of the constitution of Massachusetts, in which some slight alterations were requisite, in consequence of the province of Maine being separated from it.

He seems to have enjoyed his mental faculties to the close of his protracted life; and even on the last day of it, two hours only before its final close, on the 4th July 1825, the fiftieth anniversary of the act of independence, he dictated to a friend, as a sentiment to be given at the public dinner of the day, "Independence for ever."

Mr Adams was considered a sound scholar, well versed in the ancient languages, and in many branches of general literature. His style in writing was forcible and perspicuous, and, in the latter years of his life, remarkably elegant. In person he was of middling stature; his manners spoke the courtesy of the old school; and his address, at least when he was in England, was dignified and manly. (W. J.)

Adams, *John Quincy*, son of the preceding, was born at Boston in 1767. After spending some years in Europe, he settled as a lawyer in his native city. From 1794 to 1801 he filled the office of American minister at the Hague, and at Berlin. After some years spent in the practice of his profession, and the discharge of various public duties, he was sent, in 1809, as ambassador to St Petersburg, where his influence secured the treaty of peace with Great Britain. He was next ambassador at the court of St James's, from which he was recalled, to act as secretary of state. His distinguished abilities and services finally received their highest acknowledgment, by his election, in 1825, to the president's chair, which high office he discharged with a purity and fidelity that signalised his administration as a pattern of patriotic government. On the expiry of his term of office he retired into private life, acting, however, for many years as a representative in congress. He died at Washington on the 23d of February 1848, in the eighty-second year of his age.

ADAMSON, Patrick, a Scottish prelate, archbishop of St Andrews, was born in the year 1543, in the town of Perth, where he received the rudiments of his education. He afterwards studied philosophy, and took his degree of master of arts at the university of St Andrews. In 1566 he set out for Paris as tutor to a young gentleman. In the month of June of the same year, Mary Queen of Scots being

Adana.

delivered of a son, afterwards James VI. of Scotland and I. of England, Mr Adamson wrote a Latin poem on the occasion. In this poem he gave the prince the title of king of France and England. This proof of his loyalty involved him in difficulties. The French court was offended, and ordered him to be arrested; and he was confined for six months. He was released only through the intercession of Queen Mary and some of the principal nobility, who interested themselves in his behalf. As soon as he recovered his liberty, he retired with his pupil to Bourges. He was in this city during the massacre at Paris; and the same persecuting spirit prevailing among the Catholics at Bourges as at the metropolis, he lived concealed for seven months in a public-house, the aged master of which, in reward for his charity to heretics, was thrown from the roof, and had his brains dashed out. Whilst Mr Adamson lay thus in his sepulchre, as he called it, he wrote his Latin poetical version of the book of Job, and his tragedy of Herod in the same language. In the year 1573, he returned to Scotland, and, having entered into holy orders, became minister of Paisley. In the year 1575, he was appointed one of the commissioners, by the general assembly, to settle the jurisdiction and policy of the church; and the following year he was named, with Mr David Lindsay, to report their proceedings to the Earl of Morton, then regent. About this time the earl appointed him one of his chaplains; and, on the death of Archbishop Douglas, promoted him to the archiepiscopal see of St Andrews. His new dignity brought upon him great trouble and uneasiness. The clamour of the Presbyterian party rose high against him, and many inconsistent and absurd stories were propagated concerning him. Soon after his promotion, he published his catechism in Latin verse, a work highly approved even by his enemies, who nevertheless still continued to persecute him with great violence. In 1578 he submitted himself to the general assembly, which procured him peace but for a very little time; for, the year following, fresh accusations were brought against him. A provincial synod was held at St Andrews in April 1586: the archbishop was here accused and excommunicated. He appealed to the king and the states, but this availed him little. At the next general assembly, a paper being produced containing the archbishop's submission, he was absolved from the excommunication. In 1588 fresh accusations were brought against him. The year following he published the Lamentations of the prophet Jeremiah in Latin verse, which he dedicated to the king, complaining of his hard usage. In the latter end of the same year he published a translation of the Apocalypse in Latin verse, and a copy of Latin verses. The king was unmoved by his application, and granted the revenue of his see to the duke of Lennox; so that the prelate and his family were literally reduced to the want of bread. During the remaining part of his unfortunate life he was supported by charitable contribution, and died in 1591. The character of this prelate has been variously represented, according to the sentiments of religion and politics which prevailed. But there is little doubt that he encouraged and supported, under the authority of the king, oppressive and injurious measures. The panegyric of the editor of his works, Mr Wilson, is extravagant and absurd. He says, that "he was a miracle of nature, and rather seemed to be the immediate production of God Almighty, than born of a woman."

ADANA, a town of Asia Minor. It is a place of considerable trade; and, as commanding the passage of the mountains to the north of Syria, was an important military station in the contest between the Egyptians and Turks in 1832. After the defeat of the Turkish army at Konieh, it was taken possession of by Ibrahim Pacha, and continued to be held by the Egyptians until the treaty of July 1840 compelled them to evacuate it. It is the capital of the province of the same name. It is situate on the river Sihoon, on the banks of which stands a small but strong castle, built on a rock. It has a great number of beautiful fountains brought from the river by means of water-works. Over the river there is a stately bridge of fifteen arches, which leads to the water-works. The climate is pleasant and healthy, and the winter mild and serene; but the summer is so hot as to oblige the principal inhabitants to retire to the neighbouring mountains, where they spend six months among shady trees and grottos, in a most delicious manner. The adjacent country is rich and fertile, and produces melons, cucumbers, pomegranates, pulse, and herbs of all sorts, all the year round; besides corn, wine, and fruits, in their proper season. It is 30 miles north-east of Tarsus, on the road to Aleppo. Long. 35. 12. E. Lat. 37. 10. N.

Adanson.

ADANSON, Michael, a celebrated naturalist, was descended from a Scottish family which had at the Revolution attached itself to the fortunes of the house of Stuart; and was born the 7th of April 1727, at Aix in Provence, where his father was in the service of M. de Vintimille, then archbishop of that province. On the translation of this prelate to the archbishopric of Paris, about the year 1730, the elder Adanson also repaired thither, accompanied by his infant family of five children, all of whom were provided for by their father's patron. A small canonry fell to the lot of our future naturalist, the revenue of which defrayed the expenses of his education at the college of Plessis. While there, he was distinguished for great quickness of apprehension, strength of memory, and mental ardour; but his genius took no particular bent, until he received a microscope from the celebrated Tuberville Needham, who happened to be present at one of the public examinations, and was struck with admiration of his talents and acquirements. From the moment that young Adanson received this donation, to the last hour of his life, he persevered with a zeal almost unexampled, in the observation and study of nature.

On leaving college, his youthful ardour was well employed in the cabinets of Reaumur and Bernard de Jussieu, as well as in the *Jardin des Plantes*. Such was his zeal, that he repeated the instructions of the professors to such of his fellow-students as could not advance with a rapidity equal to his own; and before he had completed his nineteenth year, he had actually described (for his own improvement) four thousand species of the three kingdoms of nature. In this way he soon exhausted the rich stores of accumulated knowledge in Europe; and having obtained a small appointment in the colony of Senegal, he resigned his canonry, and embarked on the 20th of December 1748 for Africa.

The motives which decided the choice of Senegal as the scene of his observations are recorded by himself, and are too remarkably indicative of his ardent thirst of knowledge not to be noticed. "It was," says he, in a memorandum found after his death, "of all European establishments the most difficult to penetrate, the most hot, the most unhealthy, the most dangerous in every respect, and consequently the least known to naturalists."

His ardour remained unabated during the five years that he remained in Africa, in which period he collected and described an immense number of animals and plants; delineated maps of the country, and made astronomical observations; prepared grammars and dictionaries of the languages spoken on the banks of the Senegal; kept meteorological registers; composed a detailed account of all the plants of the country; and collected specimens of every object of commerce. M. Cuvier mentions that he had seen the produce and results of all these multifarious and laborious exertions.

He founded his classification of all known organized beings on the consideration of each individual organ. As each organ gave birth to new relations, so he established a corresponding number of arbitrary arrangements. Those beings possessing the greatest number of similar organs were referred to one great division, and the relationship was considered more remote in proportion to the dissimilarity of organs.

The chief defect of this method consists in presupposing a knowledge of species and their organization, altogether beyond the existing stage of attainment. It gives, however, distinct ideas of the degree of affinity subsisting between organized beings, independent of all physiological science. Of this *universal method*, as he called it, Adanson gave some account in an essay contained in his Treatise on Shells, published at the end of his *Voyage au Sénégal.*

Until the appearance of this work, the animals inhabiting shells had been much neglected. On this branch of his subject our author exercised his wonted zeal, while his methodical distribution, founded on not less than twenty of the partial classifications already alluded to, is decidedly superior to that of any of his predecessors. Like every first attempt, however, it had its imperfections, and these arose from not having examined the anatomical structure of the animals; from which cause he omitted, in his arrangement of the class of *Mollusca*, all *molluscous* animals without shells.

His original plan was to have published the whole of the observations made during his residence at Senegal, in eight volumes; but being deterred by the difficulties attending so extensive a publication, he abandoned the scheme, and applied himself entirely to his *Families of Plants*, which he published in 1763. In this he found the application of his general principle not less advantageous than in his preceding works.

In 1774 (eleven years after the appearance of his *Families of Plants*), he submitted to the consideration of the Academy of Sciences an immense work, containing what may be called the *universal application of his universal method;* for it extended to all known beings and substances, whether in the heavens or on the earth. Twenty-seven large volumes of manuscripts were employed in displaying the general relations of all these matters, and their distribution. One hundred and fifty volumes more were occupied with the alphabetical arrangement of 40,000 species. There was also a vocabulary, which contained 200,000 words, with their explanations; and the whole was closed by a number of detached memoirs, 40,000 figures, and 30,000 specimens of the three kingdoms of nature. The committee of the academy to which the inspection of this enormous mass had been intrusted, warmly recommended to Adanson to separate and publish all that was peculiarly his own, leaving out what was merely compilation: but he obstinately rejected this reasonable advice; by which means science has been deprived of many essays, which, if we may judge from others which he at different times gave to the world, would have possessed great merit. But his life was now drawing near to its close. He died, after many months of severe suffering, on the 3d of August 1806.

Adanson was never married. In his will he requested, as the only decoration of his grave, a garland of flowers gathered from the fifty-eight families which he had established;—"a touching though transitory image," says Cuvier, "of the more durable monument which he has erected to himself in his works." His zeal for science, his unwearied industry, and his talents as a philosophical observer, are conspicuous in all his writings. The serenity of his temper, and the unaffected goodness of his heart, endeared him to the few who knew him intimately.

His most important works are, his *Voyage to Senegal*, and his *Families of Plants.* To the former some essays, already noticed, were subjoined; and various others were published, at different times, in the *Transactions of the Academy of Sciences.* The volumes for the years 1759 and 1761 contain his observations upon the *Taret*, (a species of shell-fish exceedingly destructive to vessels,) and his account of the *Baobab*, an enormous African tree, now known under the name of *Adansonia.* The volume for 1769 contains an interesting discussion by Adanson, upon the origin of the varieties of cultivated plants; and in those for 1773 and 1779 will be found his valuable observations on gum-bearing trees. In the Transactions of 1767 he gave an account of the *Oscillatoria Adansonii*, which he considered a self-moving vegetable; but which ought, according to some observations of M. Vaucher, to be ranked as a zoophyte. Besides these essays, Adanson contributed several valuable articles in natural history to the earlier part of the Supplement to the first *Encyclopédie;* and he is also supposed to have been the author of an essay on the *Electricity of the Tourmaline* (Paris 1757), which bears the name of the Duke of Noya Caraffa. See *Eloge Historique de M. Adanson*, par Cuvier; *Mém. Mathem. et Physiques de l'Inst. National*, tom. vii. (C. M'K.)



ADANSONIA, Ethiopian Sour Gourd, Monkeys' Bread, or African Calabash Tree. (See Botany.)

ADAPIS, an extinct quadruped, described by Cuvier in his *Ossemens Fossiles.* It seems to have been about the size of a hare, but belonged to the *Pachydermata.*

ADAR, the name of a Hebrew month, answering to the end of February and beginning of March, the 12th of their sacred and 6th of their civil year. On the 7th day of it the Jews keep a fast for the death of Moses; on the 13th they have the feast of Esther; and on the 14th they celebrate the feast of Purim, for their deliverance from Haman's conspiracy. As the lunar year, which the Jews followed in their calculations, is shorter than the solar by about eleven days, which at the end of three years make a month, they then intercalate a thirteenth month, which they call *Veadar*, or the *second Adar.*

ADARCON, or Daric, δραχμή, the most ancient gold coin of which any specimens have been preserved to the present day. It was the earliest coined money known among the Jews; the impression on the coin is a crowned archer, in a garb such as is seen in the sculptures of Persepolis. The specimens weighed by Dr Bernard were fifteen grains heavier than our English guinea; their intrinsic value may therefore be reckoned at twenty-five shillings.—Eckhel, *Doctrina Nummorum Veterum;* Bernard, *De Mensuris et Ponderibus.*

ADARME, in *Commerce*, a small weight in Spain, which is also used at Buenos Ayres, and in all Spanish America. It is the 16th part of an ounce, which at Paris is called the *demi-gros.* But the Spanish ounce is seven per cent. lighter than that of Paris. Stephens renders it in English by a *drachm.*

ADATAIS, Adatis, or Adatys, in *Commerce*, a muslin or cotton cloth, very fine and clear, of which the piece is ten French ells long, and three quarters broad. It comes from the East Indies, and the finest is made in Bengal.

ADCORDABILES Denarii, in old law-books, signify money paid by the vassal to his lord, upon the selling or exchanging of a feud.

ADCRESCENTES, among the Romans, denoted a kind of soldiery, entered in the army, but not yet put on duty: from these the standing forces were recruited.

ADDA, the ancient *Addua*, a river of Switzerland and Italy, which rises in Mount Braulio, in the country of the Grisons, and passing through the Valteline, traverses the lake Como and the Milanese, and falls into he Po near Cremona.

ADDECIMATE, to ascertain or levy tithes.

ADDEPHAGIA, in *Medicine*, a term used by some physicians for gluttony, or a voracious appetite.

ADDER, in *Zoology*, a name for the VIPER.

ADDER'S GRASS, ADDER'S TONGUE, and ADDER'S WORT, are English names for the cryptogamian plant, *Ophioglossum vulgatum.*

ADDEXTRATORES, in the court of Rome, the pope's mitre-bearers; so called, according to Ducange, because they walk at the pope's right hand when he rides to visit the churches.

ADDICE, or ADZE, a kind of crooked axe used by shipwrights, carpenters, coopers, &c.

ADDICTI, in *Antiquity*, a kind of slaves, among the Romans, adjudged to serve some creditor whom they could not otherwise satisfy, and whose slaves they became till they could pay or work out the debt.

ADDICTIO IN DIEM, among the Romans, the adjudging a thing to a person for a certain price, unless by such a day the owner, or some other, give more for it.

ADDICTION, among the Romans, was the making over goods to another, either by sale or by legal sentence: the goods so delivered were called *bona addicta.* Debtors were sometimes delivered over in the same manner, and thence called *servi addicti.*

ADDISCOMBE COLLEGE is situate about a mile east of Croydon in the county of Surrey. It was established by the East India Company in 1809, for the purpose of providing a suitable education for officers intended for the scientific branches of the Indian army. The present system of education at Addiscombe is considered to be very efficient, and includes the following branches:—mathematics and classics; fortification and artillery; military drawing; military surveying; landscape drawing; French and Hindustani languages; geology and mineralogy; chemistry; and the sword exercise. There is also a chaplain in connection with the college. The appointment of the professors is vested in the court of directors, which has also the sole power of removing them. Pupils are admitted only on obtaining a nomination either from a director of the company or from the president of the board; and must be between 14 and 18 years of age. On entering they have to undergo a preliminary examination on the following subjects, viz.:—English, Latin, writing, the ordinary rules of arithmetic, with fractions, and the extraction of the square root; besides these, it is of great advantage to the cadet in his future studies to have some knowledge of mathematics and drawing. The academical course extends over four terms, comprised in two years study. The number of students at Addiscombe is 150; and, on an average, it annually furnishes the army with 75 cadets. All the officers of the engineers and artillery are required to study at Addiscombe; but those designed for the cavalry and the infantry generally do not study here. Appointments in the corps of engineers and artillery are given as prizes to those students who pass the highest examinations; the most distinguished being selected for the engineers according to the vacancies in that branch; those immediately following in succession are promoted to the artillery; and the others receive commissions in the infantry. The company receive annually L.100 from each pupil for his board and education. The average expenses of a pupil for the year may be estimated at a total of L.120, which includes uniform, books, instruments, and every contingent expense.

ADDISON, JOSEPH, was the eldest son of Dean Addison, the subject of the following article. He was born at his father's rectory of Milston in Wiltshire, on the 1st day of May 1672. After having passed through several schools, the last of which was the Charter-house, he went to Oxford, when he was about fifteen years old. He was first entered of Queen's College, but after two years was elected a scholar of Magdalen College, having, it is said, been recommended by his skill in Latin versification. He took his master's degree in 1693, and held a fellowship from 1699 till 1711.



The eleven years extending from 1693, or his twenty-first year, to 1704, when he was in his thirty-second, may be set down as the first stage of his life as a man of letters. During this period, embracing no profession, and not as yet entangled in official business, he was a student, an observer, and an author; and though the literary works which he then produced are not those on which his permanent celebrity rests, they gained for him in his own day a high reputation. He had at first intended to become a clergyman; but his talents having attracted the attention of leading statesmen belonging to the Whig party, he was speedily diverted from his earlier views by the countenance which these men bestowed on him. His first patron (to whom he seems to have been introduced by Congreve) was Charles Montague, afterwards Earl of Halifax, who was himself a dabbler in literature, and a protector of literary men; and he became known afterwards to the accomplished and excellent Somers. While both of them were quite able to estimate justly his literary merits, they had regard mainly to the services which they believed him capable of rendering to the nation or the party; and accordingly they encouraged him to regulate his pursuits with a view to public and official employment. For a considerable time, however, he was left to his own resources, which cannot have been otherwise than scanty.

His first literary efforts were poetical. In 1693, a short poem of his, addressed to Dryden, was inserted in the third volume of that veteran writer's *Miscellanies.* The next volume of this collection contained his translation, in tolerable heroic couplets, of "all Virgil's Fourth Georgic, except the story of Aristæus." Two-and-a-half books of Ovid were afterwards attempted; and to his years of early manhood belonged also his prose *Essay on Virgil's Georgics*, a performance which hardly deserved, either for its style or for its critical excellence, the compliment paid it by Dryden, in prefixing it to his own translation of the poem. The most ambitious of those poetical assay-pieces is the "Account of the Greatest English Poets," dated April 1694, and addressed affectionately to Sacheverell, the poet's fellow-collegian, who afterwards became so notorious in the party-quarrels of the time. This piece, spirited both in language and in versification, is chiefly noticeable as shewing that ignorance of old English poetry which was then universal. Addison next, in 1695, published one of those compositions, celebrating contemporary events, and lauding contemporary great men, on which, during the half-century that succeeded the Revolution, there was wasted so much of good writing and of fair poetical ability. His piece, not very meritorious even in its own class, was addressed "To the King," and commemorates the campaign which was distinguished by William's taking of Namur. Much better than the poem itself are the introductory verses to Somers, then lord keeper. This production, perhaps intended as a remembrancer to the writer's patrons, did not at once produce any obvious effect; and we are left in considerable uncertainty as to the manner in which about this time Addison contrived to support himself. He corresponded with Tonson the bookseller about projected works, one of these being a Translation of Herodotus. It was probably at some later time that he purposed compiling a Dictionary of the English language. In 1699 a considerable collection of his Latin verses was published at Oxford, in the "Musæ Anglicanæ." These appear to have interested some foreign scholars; and several of them show curious symptoms of his characteristic humour.

In the same year, his patrons, either having still no office to spare for him, or desiring him to gain peculiarly high qualifications for diplomatic or other important business, provided for him temporarily by a grant, which, though bestowed on a man of great merit and promise, would not pass unquestioned in the present century. He obtained, on the recommendation of Lord Somers, a pension of L.300 a year, designed (as Addison himself afterwards said in a memorial addressed to the crown) to enable him "to travel, and qualify himself to serve His Majesty." In the summer of 1699 he crossed into France, where, chiefly for the purpose of learning the language, he remained till the end of 1700; and after this he spent a year in Italy. In Switzerland, on his way home, he was stopped by receiving notice that he was to be appointed envoy to Prince Eugene, then engaged in the war in Italy. But his Whig friends were already tottering in their places; and, in March 1702, the death of King William at once drove them from power and put an end to the pension. Indeed Addison asserted that he never received but one year's payment of it, and that all the other expenses of his travels were defrayed by himself. He was able, however, to visit a great part of Germany, and did not reach Holland till the spring of 1703. His prospects were now sufficiently gloomy: he entered into treaty, oftener than once, for an engagement as a travelling tutor; and the correspondence in one of these negotiations has been preserved. Tonson had recommended him as the best person to attend in this character the son of the Duke of Somerset, commonly called "The Proud." The duke, a profuse man in matters of pomp, was economical in questions of education. He wished Addison to name the salary he expected; this being declined, he announced, with great dignity, that he would give a hundred guineas a-year; Addison accepted the munificent offer, saying, however, that he could not find his account in it otherwise than by relying on his Grace's future patronage; and his Grace immediately intimated that he would look out for some one else. Towards the end of 1703 Addison returned to England.

Works which he composed during his residence on the Continent, were the earliest that showed him to have attained maturity of skill and genius. There is good reason for believing that his tragedy of *Cato*, whatever changes it may afterwards have suffered, was in great part written while he lived in France, that is, when he was about twenty-eight years of age. In the winter of 1701, amidst the stoppages and discomforts of a journey across the Mount Cenis, he composed, wholly or partly, his *Letter from Italy*, which is by far the best of his poems, if it is not rather the only one among them that at all justifies his claim to the poetical character. It contains some fine touches of description, and is animated by a noble tone of classical enthusiasm. While in Germany, he wrote his *Dialogues on Medals*, which, however, were not published till after his death. These have much liveliness of style, and something of the gay humour which the author was afterwards to exhibit more strongly; but they show little either of antiquarian learning or of critical ingenuity. In tracing out parallels between passages of the Roman poets and figures or scenes which appear in ancient sculptures, Addison opened the easy course of inquiry which was afterwards prosecuted by Spence; and this, with the apparatus of spirited metrical translations from the classics, gave the work a likeness to his account of his travels. This account, entitled *Remarks on Several Parts of Italy, &c.*, he sent home for publication before his own return. It wants altogether the interest of personal narrative: the author hardly ever appears. The task in which he chiefly busies himself is that of exhibiting the illustrations which the writings of the Latin poets, and the antiquities and scenery of Italy, mutually give and receive. Many of the landscapes are sketched with great liveliness; and there are not a few strokes of arch humour. The statistical information is very meagre; nor are there many observations on society; and politics are no further meddled with than to show the moderate liberality of the writer's own opinions.



With the year 1704 begins a second era in Addison's life, which extends to the summer of 1710, when his age was thirty-eight. This was the first term of his official career; and, though very barren of literary performance, it not only raised him from indigence, but settled definitively his position as a public man. His correspondence shows that, while on the Continent, he had been admitted to confidential intimacy by diplomatists and men of rank: immediately on his return he was enrolled in the Kitcat Club, and brought thus and otherwise into communication with the gentry of the Whig party. Although all accounts agree in representing him as a shy man, he was at least saved from all risk of making himself disagreeable in society, by his unassuming manners, his extreme caution, and that sedulous desire to oblige, which his satirist Pope exaggerated into a positive fault. His knowledge and ability were esteemed so highly, as to confirm the expectations formerly entertained of his usefulness in public business; and the literary fame he had already acquired soon furnished an occasion for recommending him to public employment. Though the Whigs were out of office, the administration which succeeded them was, in all its earlier changes, of a complexion so mixed and uncertain, that the influence of their leaders was not entirely lost. Not long after Marlborough's great victory at Blenheim, it is said that Godolphin, the lord treasurer, expressed to Lord Halifax a desire to have the great duke's fame extended by a poetical tribute. Halifax seized the opportunity of recommending Addison as the fittest man for the duty; stipulating, we are told, that the service should not be unrewarded, and doubtless satisfying the minister that his protégé possessed other qualifications for office besides dexterity in framing heroic verse. *The Campaign*, the poem thus written to order, was received with extraordinary applause; and it is probably as good as any that ever was prompted by no more worthy inspiration. It has indeed neither the fiery spirit which Dryden threw into occasional pieces of the sort, nor the exquisite polish that would have been given by Pope, if he had stooped to make such uses of his genius: but many of the details are pleasing; and in the famous passage of the Angel, as well as in several others, there is even something of force and imagination.

The consideration covenanted for by the poet's friends was faithfully paid. A vacancy occurred by the death of another celebrated man, John Locke; and in November 1704, Addison was appointed one of the five commissioners of appeal in Excise. The duties of the place must have been as light for him as they had been for his predecessor; for he continued to hold it with all the appointments he subsequently received from the same ministry. But there is no reason for believing that he was more careless than other public servants in his time; and the charge of incompetency as a man of business, which has been brought so positively against him, cannot possibly be true as to this first period of his official career. Indeed the specific allegations refer exclusively to the last years of his life; and, if he had not really shown practical ability in the period now in question, it is not easy to see how he, a man destitute alike of wealth, of social or fashionable liveliness, and of family interest, could have been promoted, for several years, from office to office, as he was, till the fall of the administration to which he was attached. In 1706, he became one of the under-secretaries of state, serving first under Hedges, who belonged to the Tory section of the government, and afterwards under Lord Sunderland, Marlborough's son-in-law, and a zealous follower of Addison's early patron, Somers. The work of this office however, like that of the commissionership, must often have admitted of performance by deputy. For in 1707, the Whigs having become stronger, Lord Halifax was sent on a mission to the Elector of Hanover; and, besides taking Vanbrugh the dramatist with him as king-at-arms, he selected Addison as his secretary. In 1708 he entered parliament, sitting at first for Lostwithiel, but afterwards for Malmesbury, which, being six times elected, he represented from 1710 till his death. Here unquestionably he did fail. What part he may have taken in the details of business we are not informed; but he was always a silent member, unless it be true that he once attempted to speak and sat down in confusion. In 1709, Lord Wharton, the father of the notorious duke, having been named lord-lieutenant of Ireland, Addison became his secretary, receiving also an appointment as keeper of records. This event happened only about a year and a-half before the dismissal of the ministry; and the Irish secretary would seem to have transacted the business of his office chiefly in London. But there are letters showing him to have made himself acceptable to some of the best and most distinguished persons in Dublin; and he escaped without having any quarrel with Swift, his acquaintance with whom had begun some time before. In the literary history of Addison, those seven years of official service are almost a blank, till we approach their close. He defended the government in an anonymous pamphlet on *The Present State of the War;* he united compliments to the all-powerful Marlborough with indifferent attempts at lyrical poetry in his opera of *Rosamond;* and, besides furnishing a prologue to Steele's comedy of *The Tender Husband*, he perhaps gave some assistance in the composition of the play. Irish administration, however, allowed, it would seem, more leisure than might have been expected. During the last few months of his tenure of office, Addison contributed largely to the *Tatler*. But his entrance on this new field does nearly coincide with the beginning of a new section in his history.

Even the coalition-ministry of Godolphin was too Whiggish for the taste of Queen Anne; and the Tories, the favourites of the court, gained, both in parliamentary power and in popularity out of doors, by a combination of lucky accidents, dexterous management, and divisions and double-dealing among their adversaries. The real failure of the prosecution of Addison's old friend Sacheverell, completed the ruin of the Whigs; and in August 1710, an entire revolution in the ministry had been completed. The Tory administration, which succeeded, kept its place till the Queen's death in 1714; and Addison was thus left to devote four of the best years of his life, from his thirty-ninth year to his forty-third, to occupations less lucrative than those in which his time had recently been frittered away, but much more conducive to the extension of his own fame, and to the benefit of English literature. Although our information as to his pecuniary affairs is very scanty, we are entitled to believe that he was now independent of literary labour. He speaks, in an extant paper, of having had (but lost) property in the West Indies; and he is understood to have inherited several thousand pounds from a younger brother, who was governor of Madras. In 1711 he purchased, for L.10,000, the estate of Bilton, near Rugby; the same place which, in our own day, became the residence of Mr Apperley, better known by his assumed name of "Nimrod."

During those four years he produced a few political writings. Soon after the fall of the ministry, he contributed five numbers to *The Whig Examiner*, a paper set up in opposition to the Tory periodical of the same name, which was then conducted by the poet Prior, and afterwards became the vehicle of Swift's most vehement invectives against the party he had once belonged to. These are certainly the most ill-natured of Addison's writings; but they are neither lively nor vigorous. There is more spirit in his allegorical pamphlet, *The Trial and Conviction of Count Tariff.*



But from the autumn of 1710 till the end of 1714, his principal employment was the composition of his celebrated Periodical Essays. The honour of inventing the plan of such compositions, as well as that of first carrying the idea into execution, belongs to Richard Steele, who had been a school-fellow of Addison at the Charter-house, continued to be on intimate terms with him afterwards, and attached himself with his characteristic ardour to the same political party. When, in April 1709, Steele published the first number of the *Tatler*, Addison was in Dublin, and knew nothing of the design. He is said to have detected his friend's authorship only by recognising, in one of the early papers, a critical remark which he remembered having himself communicated to Steele. He began to furnish essays in a few weeks, assisted occasionally while he held office, and afterwards wrote oftener than Steele himself. He thus contributed in all, if his literary executor selected his contributions correctly, more than sixty of the 271 essays which the work contains. The *Tatler* exhibited, in more ways than one, symptoms of being an experiment. The projector, imitating the news-sheets in form, thought it prudent to give, in each number, news in addition to the essay; and there was a want, both of unity and of correct finishing, in the putting together of the literary materials. Addison's contributions, in particular, are in many places as lively as anything he ever wrote; and his style, in its more familiar moods at least, had been fully formed before he returned from the Continent. But, as compared with his later pieces, these are only what the painter's loose studies and sketches are to the landscapes which he afterwards constructs out of them. In his invention of incidents and characters, one thought after another is hastily used and hastily dismissed, as if he were putting his own powers to the test, or trying the effect of various kinds of objects on his readers; his most ambitious flights, in the shape of allegories and the like, are stiff and inanimate; and his favourite field of literary criticism is touched so slightly, as to show that he still wanted confidence in the taste and knowledge of the public.

The *Tatler* was dropped at the beginning of 1711; but only to be followed by the *Spectator*, which was begun on the 1st day of March, and appeared every week-day till the 6th day of December 1712. It had then completed the 555 numbers usually collected in its first seven volumes. Addison, now in London and unemployed, co-operated with Steele constantly from the very opening of the series; and the two, contributing almost equally, seem together to have written not very much less than five hundred of the papers. Emboldened by the success of their former adventure, they devoted their whole space to the essays. They relied, with a confidence which the extraordinary popularity of the work fully justified, on their power of exciting the interest of a wide audience by pictures and reflections drawn from a field which embraced the whole compass of ordinary life and ordinary knowledge; no kind of practical themes being positively excluded except such as were political, and all literary topics being held admissible, for which it seemed possible to command attention from persons of average taste and information. A seeming unity was given to the undertaking, and curiosity and interest awakened on behalf of the conductors, by the happy invention of the Spectator's Club, in which Steele is believed to have drawn all the characters. The figure of Sir Roger de Coverley, however, the best even in the opening group, is the only one that was afterwards elaborately depicted; and Addison was the author of all the papers in which his oddities and amiabilities are so admirably delineated. To him, also, the *Spectator* owed a very large share of its highest excellences. His were many, and these the most natural and elegant, if not the most original, of its humorous sketches of human character and social eccentricities, its good-humoured satires on ridiculous features in manners, and on corrupt symptoms in public taste; these topics, however, making up a department in which Steele was fairly on a level with his more famous coadjutor. But Steele had neither learning, nor taste, nor critical acuteness, sufficient to qualify him for enriching the series with such literary disquisitions, as those which Addison insinuated so often into the lighter matter of his essays, and of which he gave an elaborate specimen, in his celebrated and agreeable criticism on *Paradise Lost.* Still further beyond the powers of Steele were those speculations on the theory of literature and of the processes of thought analogous to it, which, in the essays *On the Pleasures of the Imagination*, Addison prosecuted, not, indeed, with much of philosophical depth, but with a sagacity and comprehensiveness which we shall undervalue much, unless we remember how little of philosophy was to be found in any critical views previously propounded in England. To Addison, further, belong those essays which (most frequently introduced in regular alternation in the papers of Saturday) rise into the region of moral and religious meditation, and tread the elevated ground with a step so graceful as to allure the reader irresistibly to follow; sometimes, as in the *Walk through Westminster Abbey*, enlivening solemn thought by gentle sportiveness; sometimes flowing on with an uninterrupted sedateness of didactic eloquence; and sometimes shrouding sacred truths in the veil of ingenious allegory, as in the majestic *Vision of Mirza.* While, in a word, the *Spectator*, if Addison had not taken part in it, would probably have been as lively and humorous as it was, and not less popular in its own day, it would have wanted some of its strongest claims on the respect of posterity, by being at once lower in its moral tone, far less abundant in literary knowledge, and much less vigorous and expanded in thinking. In point of style, again, the two friends resemble each other so closely as to be hardly distinguishable, when both are dealing with familiar objects, and writing in a key not rising above that of conversation. But, in the higher tones of thought and composition, Addison showed a mastery of language raising him very decisively, not above Steele only, but above all his contemporaries. Indeed, it may safely be said, that no one, in any age of our literature, has united, so strikingly as he did, the colloquial grace and ease which mark the style of an accomplished gentleman, with the power of soaring into a strain of expression nobly and eloquently dignified.

On the cessation of the *Spectator*, Steele set on foot *The Guardian*, which, started in March 1713, came to an end in October, with its 175th number. To this series Addison gave fifty-three papers, being a very frequent writer during the latter half of its progress. None of his essays here aim so high as the best of those in the *Spectator;* but he often exhibits both his cheerful and well-balanced humour, and his earnest desire to inculcate sound principles of literary judgment. In the last six months of the year 1714, the *Spectator* received its eighth and last volume; for which Steele appears not to have written at all, and Addison to have contributed twenty-four of the eighty papers. Most of these form, in the unbroken seriousness both of their topics and of their manner, a contrast to the majority of his essays in the earlier volumes; but several of them, both in this vein and in one less lofty, are among the best known, if not the finest, of all his essays. Such are the *Mountain of Miseries;* the antediluvian novel of *Shallum and Hilpa;* the *Reflections by Moonlight on the Divine Perfections.*

In April 1713, Addison brought on the stage, very reluctantly, as we are assured, and can easily believe, his tragedy of *Cato.* Its success was dazzling: but this issue was mainly owing to the concern which the politicians took in the exhibition. The Whigs hailed it as a brilliant manifesto in favour of constitutional freedom. The Tories echoed the applause, to show themselves enemies of despotism, and professed to find in Julius Cæsar a parallel to the formidable Marlborough. Even with such extrinsic aids, and the advantage derived from the established fame of the author, Cato could never have been esteemed a good dramatic work, unless in an age in which dramatic power and insight were almost extinct. It is poor even in its poetical elements, and is redeemed only by the finely solemn tone of its moral reflections, and the singular refinement and equable smoothness of its diction.



The literary career of Addison might almost be held as closed soon after the death of Queen Anne, which occurred in August 1714, when he had lately completed his forty-second year. His own life extended only five years longer; and this closing portion of it offers little that is pleasing or instructive. We see him attaining the summit of his ambition, only to totter for a little and sink into an early grave. We are reminded of his more vigorous days by nothing but a few happy inventions interspersed in political pamphlets, and the gay fancy of a trifling poem on Kneller's portrait of George I.

The Lord Justices who, previously chosen secretly by the Elector of Hanover, assumed the government on the Queen's demise, were, as a matter of course, the leading Whigs. They appointed Addison to act as their secretary. He next held, for a very short time, his former office under the Irish Lord-Lieutenant; and, early in 1715, he was made one of the Lords of Trade. In the course of the same year occurred the first of the only two quarrels with friends, into which the prudent, good-tempered, and modest Addison is said to have ever been betrayed. His adversary on this occasion was Pope, who, only three years before, had received, with an appearance of humble thankfulness, Addison's friendly remarks on his *Essay on Criticism;* but who, though still very young, was already very famous, and beginning to show incessantly his literary jealousies, and his personal and party hatreds. Several little misunderstandings had paved the way for a breach, when, at the same time with the first volume of Pope's *Iliad*, there appeared a translation of the first book of the poem, bearing the name of Thomas Tickell. Tickell, in his preface, disclaimed all rivalry with Pope, and declared that he wished only to bespeak favourable attention for his contemplated version of the *Odyssey.* But the simultaneous publication was awkward; and Tickell, though not so good a versifier as Pope, was a dangerous rival, as being a good Greek scholar. Further, he was Addison's under-secretary and confidential friend; and Addison, cautious though he was, does appear to have said (quite truly) that Tickell's translation was more faithful than the other. Pope's anger could not be restrained. He wrote those famous lines in which he describes Addison under the name of Atticus; and, as if to make reconciliation impossible, he not only circulated these among his friends, but sent a copy to Addison himself. Afterwards, he went so far as to profess a belief that the rival translation was really Addison's own. It is pleasant to observe that, after the insult had been perpetrated, Addison was at the pains, in his *Freeholder*, to express hearty approbation of the *Iliad* of Pope: who, on the contrary, after Addison's death, deliberately printed the striking but malignant lines in the Epistle to Dr Arbuthnot. In 1715, there was acted, with little success, the comedy of *The Drummer, or the Haunted House*, which, though it appeared under the name of Steele, was certainly not his, and was probably written in whole or chiefly by Addison. It contributes very little to his fame. From September 1715 to June 1716, he defended the Hanoverian succession, and the proceedings of the government in regard to the rebellion, in a paper called *The Freeholder*, which he wrote entirely himself, dropping it with the fifty-fifth number. It is much better tempered, not less spirited, and much more able in thinking, than his *Examiner*. The finical man of taste does indeed show himself to be sometimes weary of discussing constitutional questions; but he aims many enlivening thrusts at weak points of social life and manners; and the character of the Fox-hunting Squire, who is introduced as the representative of the Jacobites, is drawn with so much humour and force that we regret not being allowed to see more of him.

In August 1716, when he had completed his forty-fourth year, Addison married the Countess-Dowager of Warwick, a widow of fifteen years' standing. She seems to have forfeited her jointure by the marriage, and to have brought her husband nothing but the occupancy of Holland House at Kensington. We know hardly anything positively in regard to the affair, or as to the origin or duration of his acquaintance with the lady or her family. But the current assertion that the courtship was a long one, is very probably erroneous. There are better grounds for believing the assertion, transmitted from Addison's own time, that the marriage was unhappy. The Countess is said to have been proud as well as violent, and to have supposed that, in contracting the alliance, she conferred honour instead of receiving it. To the uneasiness caused by domestic discomfort, the most friendly critics of Addison's character have attributed those habits of intemperance, which are said to have grown on him in his later years to such an extent as to have broken his health and accelerated his death. His most recent biographer, who disbelieves his alleged want of matrimonial quiet, has called in question, with much ingenuity, the whole story of his sottishness; and it must at any rate be allowed that all the assertions which tend to fix such charges on him in the earlier parts of his life, rest on no evidence that is worthy of credit, and are in themselves highly improbable. Sobriety was not the virtue of the day; and the constant frequenting of coffee-houses, which figures so often in the *Spectator* and elsewhere, and which was really practised among literary men as well as others, cannot have had good effects. Addison, however, really appears to have had no genuine relish for this mode of life; and there are curious notices, especially in Steele's correspondence, of his having lodgings out of town, to which he retired for study and composition. But, whatever the cause may have been, his health was shattered before he took that which was the last, and certainly the most unwise step, in his ascent to political power.

For a considerable time dissensions had existed in the ministry; and these came to a crisis in April 1717, when those who had been the real chiefs passed into the ranks of the opposition. Townshend was dismissed; and Walpole anticipated dismissal by resignation. There was now formed, under the leadership of General Stanhope and Lord Sunderland, an administration which, as resting on court-influence, was nicknamed the "German ministry." Sunderland, Addison's former superior, became one of the two principal secretaries of state; and Addison himself was appointed as the other. His elevation to such a post had been contemplated on the accession of George I., and prevented, we are told, by his own refusal; and it is asserted, on the authority of Pope, that his acceptance now was owing only to the influence of his wife. Even if there is no ground, as there probably is not, for the allegation of Addison's inefficiency in the details of business, his unfitness for such an office in such circumstances was undeniable and glaring. It was impossible that a government, whose secretary of state could not open his lips in debate, should long face an opposition headed by Robert Walpole. The decay of Addison's health, too, was going on rapidly; being, we may readily conjecture, precipitated by anxiety, if no worse causes were at work. Ill health was the reason assigned for retirement, in the letter of resignation which he laid before the King in March 1718, eleven months after his appointment. He received a pension of fifteen hundred pounds a-year.



Not long afterwards, the divisions in the Whig party alienated him from his oldest friend. The Peerage bill, introduced in February 1719, was attacked, on behalf of the opposition, in a weekly paper, which was called the *Plebeian*, and written by Steele. Addison answered it temperately enough in the *Old Whig;* provocation from the *Plebeian* brought forth angry retort from the *Whig;* Steele charged Addison with being so old a Whig as to have forgotten his principles; and Addison sneered at Grub Street, and called his friend "little Dicky." How Addison felt after this painful quarrel we are not told directly; but the *Old Whig* was excluded from that posthumous collection of his works, for which his executor Tickell had received from him authority and directions. In that collection was inserted a treatise on the evidences of the faith, entitled *Of the Christian Religion.* Its theological value is very small; but it is pleasant to regard it as the last effort of one who, amidst all weaknesses, was a man of real goodness as well as of eminent genius.

The disease under which Addison laboured appears to have been asthma. It became more violent after his retirement from office; and was now accompanied by dropsy. His death-bed was placid and resigned, and comforted by those religious hopes which he had so often suggested to others, and the value of which he is said, in an anecdote of doubtful authority, to have now inculcated in a parting interview with his stepson. He died at Holland House, on the 17th day of June 1719, six weeks after having completed his forty-seventh year. His body, after lying in state, was interred in the Poets' Corner of Westminster Abbey.

*The Biographia Britannica* gives an elaborate memoir of him; particulars are well collected in the article under his name in the *Biographical Dictionary of the Society for the Diffusion of Useful Knowledge;* and a good many new materials, especially letters, will be found in *The Life of Joseph Addison, by Lucy Aikin,* 1843. (W. S.)

ADDISON, *Lancelot*, father of the preceding, a clergyman, was born in the parish of Crosby-Ravensworth, in Westmorland, in the year 1632. He was educated at Queen's College, Oxford, and at the restoration of King Charles II. accepted of the chaplainship of the garrison of Dunkirk; but that fortress being delivered up to the French in 1662, he returned to England, and was soon after made chaplain to the garrison of Tangier, where he continued seven years, and was greatly esteemed. In 1670 he returned to England, and was made chaplain in ordinary to the king; but his chaplainship of Tangier being taken from him on account of his absence, he found himself straitened in his circumstances, when he seasonably obtained the rectory of Milston in Wiltshire, worth about L.120 per annum. He afterwards became a prebendary of Sarum, took his degree of doctor of divinity at Oxford, and in 1683 was made dean of Lichfield, and the next year archdeacon of Coventry. His life was exemplary, his conversation and writings were pleasing and instructive, and his behaviour as a gentleman, a clergyman, and a neighbour, did honour to the place of his residence. He died 20th April 1703.

ADDISON, a county in the state of Vermont, North America, on the banks of Lake Champlain. It has an area of 700 square miles; and, in 1850, contained 26,549 inhabitants.

ADDITION, in *Law*, is that name or title which is given to a man over and above his proper name and surname, to show of what estate, degree, or mystery he is; and of what town, village, or country.

ADDITIONS *of Place* are, of Thorpe, of Dale, of Woodstock. Where a man has household in two places, he shall be said to dwell in both, so that his addition in either may suffice. By stat. 1st Hen. V., cap. 5, it was ordained, that in such suits or actions where process of outlawry lies, such addition should be made to the name of the defendant, to show his estate, mystery, and place where he dwells; and that the writs not having such additions should abate if the defendant take exception thereto, but not by the office of the court.

ADDIX, a Greek measure of capacity, equal to 4 χοινικες, each of which equalled 4 κοτυλαι. As this last was about half an English pint, the αδδιξ was about a gallon.

ADDLE EGGS, such as have not received impregnation from the semen of the cock.

ADDUCENT MUSCLES, or ADDUCTORS, in *Anatomy*, muscles which pull one part of the body towards another.

ADEIA (*freedom from fear*), at Athens, was an indemnity such persons as possessed not the full rights of citizenship were obliged to obtain, before they could publicly accuse another of an offence. A citizen also having incurred ἀτιμιὰ, or ignominy, was under the same obligation before he could take part in public affairs.

ADELAIDE, a town in a county of the same name in Australia. It has rapidly increased within a few years, and is now the seat of government of the province of *South Australia*. The town occupies the steep banks on both sides of an impetuous stream called the Torrens, which is, however, very scanty of water in the dry season. Adelaide is six miles from the Gulf of St Vincent, and from its two harbours, Port Adelaide on the N., and Glenelg on the S.W. of the town. The reason of fixing its site here is not obvious; for it stands on a rather bare soil, resting on limestone, and is inconveniently distant from the sea. The population in 1850 was about 14,000, although the town was only founded in 1836. It contains several substantial structures of stone and brick, among which we may mention the two Episcopal churches of St John and the Trinity, and four commodious chapels built by other religious bodies. The Government House is a commodious structure in a park of 10 acres, and adjoining a public promenade called N. Terrace. The principal seat of business is Windley street, in which are many substantial mercantile establishments, and the two banks of this rising town. Two bridges cross the Torrens; and there are many good private houses in various streets. The manners and appearance of the inhabitants are quite British, here and there diversified with groups of the sable aborigines,—a race perhaps the least comely, and one of the most degraded of the human family, but not so deficient in estimable qualities as they have been sometimes represented. Adelaide has Presbyterian, Roman Catholic, Baptist, Independent, Methodist, and other chapels, a synagogue, a mechanics' institution, botanical garden, and several schools. It has also manufactories of woollen goods, starch, soap, &c., several breweries, and tanneries. In its vicinity are extensive copper and lead mines. Lat. 34. 57. S. Long. 138. 38. E.

Port Adelaide is about seven miles N.W. from the city, on an inlet of the Gulf of St Vincent. It has a number of warehouses and wharfs, and in 1850 had about 2500 inhabitants. The harbour is safe and commodious; but a bar at its mouth, with a depth varying with the tides from 8 to 16 feet, prevents large vessels from entering. Its principal exports are grain, copper and lead ores, wool, tallow, beer, &c. In 1849, the value of its exports was L.403,167, and of its imports L.599,548.

ADELARD, or ATHELARD, a learned monk of Bath, in the time of Henry I., who travelled much, and translated from the Arabic the *Elements of Euclid*, before the Greek original had been discovered. Some of his MSS. are preserved at Oxford.

ADELFORS, a town in Sweden, in the province of Jönköping and district of Oestra, wherein are two gold mines worked but very sluggishly; whilst the iron mines found there are very productive, and give employment both to the forges in making bar-iron, and to individuals as nail-makers.





ADELIE, a tract of desolate land in the Antarctic Ocean, discovered by the French in 1840. Lat. 66. 30. S. Long. 136. to 142. E.

ADELME. See ALDHELM.

ADELNAU, a circle in the province of Posen, in Prussia. It extends over 357 square miles, or 228,480 acres, and contains, in four cities and 107 villages, 52,530 inhabitants. The river Proszna waters the east side, and the Ollabok the centre of the circle. There are several smaller rivers, and some lakes, the most considerable of which bears the name of the chief place near to which it is found. It is a poor district, abounding with woods and game, and yielding fresh-water fish in plenty. It is very deficient in corn and cattle. The capital, of the same name, contains two Catholic and one Lutheran church, and a synagogue, with 200 houses, and 1930 inhabitants.

ADELPHIANI, in *Church History*, a sect of ancient heretics, who fasted always on Sundays.

ADELSBERG, a market town of Illyria, capital of a circle of the same name in the government of Laybach. Pop. 1500. At the distance of about a mile from the town is the entrance to the famous grotto of Adelsberg, said to be the largest and most magnificent in Europe. It has been explored to the distance of 1310 fathoms, where it is terminated by a lake. About 180 yards from the entrance is the *Dom*, a vast hall upwards of 300 feet long, and 100 feet high; which was the only part of the cavern known previous to 1819, when a partition of stalactite was broken through, and the magnificence of the interior exposed. It consists of a series of chambers of various dimensions, enriched by stalactites of the greatest purity and most fantastic shapes, and frequently uniting with the stalagmites below.

ADELSCALC, in ancient customs, denotes a servant of the king. The word is also written *adelscalche*, and *adelscalus*. It is compounded of the German *adel*, or *edel*, noble, and *scalc*, servant. Among the Bavarians, *adelscalcs* appear to have been the same with royal *thanes* among the Saxons, and those called *ministri regis* in ancient charters.

ADELSO, an island in Sweden, in the same lake in which the city of Stockholm is built, a little to the west of Munso, containing a parish of the same name.

ADELUNG, JOHN CHRISTOPHER, a very eminent German grammarian, philologer, and general scholar, was born at Spantekow in Pomerania, on the 30th of August 1734. He acquired his elementary instruction at the public school of Anclam, and that of Closterbergen, near Magdeburg, and completed his academical education at the university of Halle. In the year 1759 he was appointed professor at the gymnasium of Erfurt, but relinquished this situation two years after, and went to reside in a private capacity at Leipsic, where he continued to devote himself for a long period to the cultivation of letters, and particularly to those extensive and laborious philological researches which proved so useful to the language and literature of his native country. In 1787 he received the appointment of principal librarian to the elector of Saxony at Dresden, with the honorary title of Aulic Counsellor. Here he continued to reside during the remainder of his useful life, discharging with diligence and integrity the duties of his situation, and prosecuting his laborious studies to the last with indefatigable industry and unabated zeal. He died at Dresden on the 10th of September 1806, at the age of 72.

The life of a mere scholar is generally destitute of interest; and that of Adelung, which was spent entirely in literary seclusion, presents no variety of incident to the pen of the biographer. Of his private character and habits, few memorials have been preserved; but in these few he is represented as a man of an amiable disposition. He was never married. His constitution, which was remarkably robust, rendered him capable of the most intense and unremitted application to study, insomuch that, down to the period of his death, he is said to have devoted fourteen hours of every day to literary labour. He was a lover of good cheer, and spared neither pains nor expense in procuring a variety of foreign wines, of which his cellar, which he facetiously denominated his *Bibliotheca Selectissima*, is said to have contained no less than forty different kinds. His manners were easy and affable, and the habitual cheerfulness of his disposition rendered his society most acceptable to a numerous circle of friends.

The works of Adelung are very voluminous; and there is not one of these, perhaps, which does not exhibit some proofs of the genius, industry, and erudition of the author. But although his pen was usefully employed upon a variety of subjects in different departments of literature and science, it is to his philological labours that he is principally indebted for his great reputation; and no man ever devoted himself with more zeal and assiduity, or with greater success, to the improvement of his native language.

In a country which is subdivided into so many distinct sovereign states, possessing no common political centre, and no national institution whose authority could command deference in matters of taste,—in a country whose indigenous literature was but of recent growth, and where the dialect of the people was held in contempt at the several courts,—it was no easy task for a single writer to undertake to fix the standard of a language which had branched out into a variety of idioms, depending in a great measure upon principles altogether arbitrary. Adelung effected as much in this respect as could well be accomplished by the persevering labours of an individual. By means of his excellent grammars, dictionary, and various works on German style, he contributed greatly towards rectifying the orthography, refining the idiom, and fixing the standard of his native tongue. Of all the different dialects, he gave a decided preference to that of the margraviate of Misnia, in Upper Saxony, and positively rejected every thing that was contrary to the phraseology in use among the best society of that province, and in the writings of those authors whom it had produced. In adopting this narrow principle, he is generally thought to have been too fastidious. The dialect of Misnia was undoubtedly the richest, as it was the earliest cultivated, of any in Germany; but Adelung probably went too far in restraining the language within the limits of this single idiom, to the exclusion of others, from which it might have, and really has, acquired additional richness, flexibility, and force.

His dictionary of the German language is generally allowed to be superior to our English dictionary by Dr Johnson. It is eminently so in its etymologies; and is, perhaps, upon the whole, the best work of the kind of which any nation can boast. Indeed, the patient spirit of investigation which Adelung possessed in so remarkable a degree, together with his intimate knowledge of the ancient history and progressive revolutions of the different dialects from which the modern German is derived, rendered him peculiarly qualified for the successful performance of the duties of a lexicographer.

It would greatly exceed our limits, and lead us into far too wide a field, were we to attempt to present our readers with an analysis of the several productions of this voluminous author; but we should do injustice to his memory, were we to pass over in total silence his last very learned work, entitled *Mithridates, or a General History of Languages, with the Lord's Prayer, as a specimen, in nearly five hundred languages and dialects.* The hint of this work appears to have been taken from a publication, with a similar title, published by the celebrated Conrad Gesner in 1555; but the plan of Adelung is much more extensive. Unfortunately, he did not live to finish what he had undertaken; but the work has been continued with much ability by that eminent philologer, Professor Vater, formerly of Halle, now of Königsberg. The first volume, which contains the Asiatic languages, was published immediately after the death of Adelung; the second, which comprehends the European dialects, was published by Professor Vater in 1809; the first part of the third volume, which is almost entirely the work of the last-mentioned scholar, appeared in 1812. This third and last volume contains the languages of Africa and America, and is enriched with some very valuable materials, communicated to the editor by Baron Humboldt.



Many of the works of Adelung were published anonymously, but we believe the following list will be found to be complete and correct.

1. Neue Schaubühne der vorfallenden Staats-Kriegs und Friedenshändel.—Erfurt, 1759–61, 8vo.—2. Neues Lehrgebäude der Diplomatik, aus dem Franz. übersetzt, und mit Anmerk. versehen. Vols. i. ii. iii. Erfurt, 1760–63, 4to.—3. Neue Denkwürdigkeiten der gegenwärtigen Geschichte von Europa. 1761, 2 vols. 8vo.—4. Geschichte der Streitigkeiten zwischen Dänemark und den Herzogen von Holstein-Gottorp. Frankf. Leipsic, 1762, 4to.—5. Pragmatische Staatsgeschichte Europens von dem Ableben Kaiser Karls des 6ten an. Vols. i.–ix. Gotha, 1762–9, 4to.—6. Auserlesene Staatsbriefe. . Gotha, 1763–4, 3 vols. 8vo.—7. Vollständige Geschichte der Schifffahrten nach den Südländern. Halle, 1767, 4to.—8. Mineralogische Belustigungen. Vols. i.–vi. Copenhagen and Leipsic, 1767–71, 8vo.—9. Einleitung zur allgemeinen Weltgeschichte. Berlin, 1767, 2 vols. (*The first volume by Prof. Franz.*)—10. Werke des Philosophen von Sans Souci. (*Translated from the French.*) Erfurt, 1768.—11. Staatsmagazin, 14 Stücke. Leipsic, 1766–8.—12. Geschichte der Schiffahrten und Versuche, welche zur Entdeckung des nordöstlichen Wegs nach Japan und China unternommen worden. Halle, 1768, 4to.—13. Versuch einer neuen Geschichte des Jesuiter-ordens. Vols. i. and ii. Berlin and Halle, 1769–1770, 8vo.—14. Natürliche und bürgerliche Geschichte von Californien. (*Translated from the English.*) Lemgo, 1769–70, 3 vols. 4to.—15. Unterweisung in den vornehmsten Künsten und Wissenschaften, zum Nutzen der niedern Schulen. Frankfort and Leipsic, 1771, 8vo.—16. Glossarium Manuale ad Scriptores mediæ et infimæ Latinitatis, ex magnis Glossariis Caroli du Fresne Domini Ducange et Carpentarii, in compendium redactum, multisque verbis et dicendi formulis auctum. Tomi v. Halle, 1772–78.—17. Versuch eines vollständigen grammatisch-kritischen Wörterbuchs der Hoch Teutschen Mundart, mit beständiger Vergleichung der übrigen Mundarten, besonders aber der Ober Teutschen. 1774–86, 5 vols. 4to.—18. Wallerius Chemie. (*Translated from the Latin.*)—19. Allgemeines Verzeichniss neuer Bücher, mit kurzen Anmerkungen, nebst einem gelehrten Anzeiger. Leipsic, 1776–81, 8vo.—20. Schauplatz des Baierischen Erbfolge Kreigs, u. s. w. Leipsic, 1778, 1780, 4to.—21. Militarisches Taschenbuch auf das Jahr 1780. Leipsic, 12mo.—22. J. Williams Ursprung, Wachsthum und Gegenwärtiger Zustand der Nordischen Reiche. (*Translated and corrected from the English.*) Leipsic, 1779–81, 2 vols. 8vo.—23. Kurzer Begriff menschlicher Kenntnisse und Fertigkeiten, so fern sie auf Erwerbung des Unterhalts, auf Vergnügen, auf Wissenschaft, und auf Regierung der Gesellschaft abzielen. Leipsic, 1778–81, 4 vols. 8vo.—24. Ueber die Geschichte der Teutschen Sprache, über Teutsche Mundarten und Teutsche Sprachlehre. *Ibid.* 1781, 8vo.—25. Ueber den Ursprung der Sprache und den Bau der Wörter. *Ibid.* 1781, 8vo.—26. Teutsche Sprachlehre, zum Gebrauch der Schulen in den Königl. Preuss. Landen. Berlin, 1781.—27. Auszug aus der Teutschen Sprachlehre für Schulen. 1781, 8vo.—28. Lehrgebäude der Teutschen Sprache, zur Erläuterung der Teutschen Sprachlehre für Schulen.—29. Tindals und Mores Anmerkungen zu Rapins Geschichte von England. (*Trans-*

*lated from the English.)* 30. Versuch einer Geschichte der Cultur des Menschlichen Geschlechts. 1782, 8vo.—31. Leipziger Politische Zeitung und Allerlei.—32. Neues Grammatisch-kritisches Wörterbuch der Englischen Sprache, für die Teutschen. Leipsic, 1783, 8vo.—33. Beyträge zur Bürgerlichen Geschichte, zur Geschichte der Cultur, zur Naturgeschichte, Naturlehre, und dem Feldbaue; aus den Schriften der Akademie der Wissenschaften zu Brüssel. Leipsic, 1783, 8vo.—34. Fortsetzung und Ergänzungen zu Christ. Gottl. Jöchers allgemeinem Gelehrten Lexico. Leipsic, 1784, 2 vols. 4to.—35. Ueber den Teutscheu Styl. Berlin, 1785, 3 vols. 8vo.—36. Neue Leipziger Gelehrte Zeitung. 1785, &c.—37. Grundsätze der Teutschen Orthographie. Leipsic, 1782, 8vo.—38. Geschichte der Menschlichen Narrheit oder Lebens beschreibungen berühmter Schwarzkünstler, Goldmacher, Teufelsbanner, Zeichen und Liniendeuter, Schwärmer, Wahrsager, und anderer philosophischer Unholden. Leipsic, 1785–87–89, 7 vols.—39. Geschichte der Philosophie für Liebhaber. 1786–87, 3 vols.—40. Vollständige Anweisung zur Teutschen Orthographie, nebst einem kleinen Wörterbuche für die Aussprache, Orthographie, Biegung und Ableitung. Leipsic, 1786, 2 vols.—41. Jacob Püterich von Reicherzhausen, ein Kleiner Beytrag zur Geschichte der Teustchen Dichtkunst im Schwäbischen Zeitalter. Leipsic, 1788, 4to.—42. Auszug aus dem Grammatisch-kritischen Wörterbuch der Hohen Teutscheu Mundart. Leipsic, 1793, 1 vol. 1795, 2 vols. 8vo.—43. Mithridates, oder Allgemeine Sprachenkunde. 3 vols. Berlin, 1806–1812.

It is observed by Madame de Stael, that the English are much better acquainted than the French with the literature of Germany; but we have met with very few possessed of any knowledge of the works of this learned and celebrated writer; and, with the exception of one or two of his smaller essays, none of them, we believe, has ever been translated into the language of this country. In the above list there are more works than one which might probably be published with advantage in the English tongue. (J. C.)

ADEMPTION, in the *Civil Law*, implies the revocation of a grant, donation, or the like.

ADEN, a town and sea-port of Arabia, in the province of Yemen, situate to the east of the Straits of Bab-El-Mandeb. According to the Arabians, it derives its name from Aden the son of Saba, and grandson of Abraham. It was formerly an opulent and flourishing city, covering as much space as Mocha, Jedda, or Suez, but subsequently dwindled into insignificance. It is built on a small flat, probably the bottom of a crater, surrounded by precipitous rocks, on the east side of a peninsula formed by two fine bays, in the one of which, opposite the town, is the fortified island of *Sirah*, which commands the approach. The peninsula consists chiefly of a mass of volcanic rocks, extending five miles east and west, and three broad, and having as its most southern point, *Ras Sanailah* or *Cape Aden*, in Lat. 12. 45. 10. N. Long. 45. 3. E. The highest part of the peninsula is *Jebel Shamshan*, a rocky promontory of limestone, rising 1776 feet above the level of the sea. The peninsula is connected with the mainland by a neck of flat sandy ground only a few feet high. But both the peninsula and the mainland present the most desolate aspect; not a tree or a shrub is to be seen; and the heat is intolerable. The place, however, is healthy. In a military point of view, Aden presents one of the strongest positions in Arabia. Its possession affords the means of blockading the Red Sea, and of controlling the trade of the coast of Malabar. Its commercial advantages are superior to those of the neighbouring port of Mocha. Since its occupation by the British, Aden has been constituted a free port, and no duties of customs are now levied there; its trade has steadily increased, and there seems little doubt that it must again become the principal emporium for the products of Arabia and the shores of the Red Sea. As a coal depot no place on the coast is so advantageous; it divides the distance between Bombay and Suez, and steamers may load and unload at all seasons with perfect security.



Aden has not unfrequently changed its rulers. At the commencement of the sixteenth century, a Portuguese naval force proceeding to the Red Sea, touched at Aden. The Arabian chief offered to surrender the town, but the Portuguese proposed to defer its occupation till the return of the expedition. In the meantime, however, reinforcements were received, and the chief refused to fulfil his engagement. Subsequently, however, the Portuguese became its possessors, but after a brief tenure were expelled by the Turks in 1538. In the following century the Turks relinquished their conquests in Yemen, and withdrew their troops from the province, when the sultan of Senna established a supremacy over Aden, which was maintained until towards the middle of the last century. The sheik of Lahidge then threw off his allegiance, and established in his own family the line of independent sultans of Aden. The circumstances under which the British became masters of the place may be briefly stated. In 1837 a ship under British colours was wrecked near Aden, her cargo plundered, and the crew and passengers grievously maltreated by the sultan's people. An explanation of the outrage being demanded by the Bombay government, the sultan promised compensation for the plunder of the vessel, and moreover agreed to make a formal cession of the town and port of Aden to the British for a pecuniary consideration. Captain Haines of the Indian navy had been deputed to Aden to complete these arrangements, but the sultan's son, who now exercised the powers of government, met the requisition of the British agent by language and conduct the most violent and insulting. A combined naval and military force was thereupon despatched to Aden, and the place was captured on the 16th January 1839, with trifling loss on the part of the British. A stipendiary allowance was made to the sultan in consideration of his loss, he, however, retaining the whole of his other territories. (E. T.)

ADENAU, a circle in the department of Coblentz, in the Prussian province of the Lower Rhine. It extends over 212 square miles, and in 1849 contained 21,882 inhabitants, all Catholics, except 8 Jews and 64 Protestants, in one city, four market towns, and 104 villages. It is watered by the river Ahr. It is generally a hilly and woody country, where little corn except oats grows, and where the chief subsistence is potatoes. Cattle and sheep are bred with tolerable success; and potashes and charcoal are made from the forests. There is some little employment furnished by spinning and weaving both linens and woollens on a small scale. The chief place of the same name contains 1450 inhabitants.

ADEPTS, a term among alchemists for those who pretended to have found the panacea and philosopher's stone.

ADERNO, a city at the foot of Mount Ætna in Sicily, in the intendancy of Catania. It is built in an unhealthy situation, but contains 8000 inhabitants. It has several churches, the chief of which is supported by beautiful pillars of polished lava. It is the site of the ancient city Hadranum, whose ruins are still visible. On the river Giarretta, which passes the city, is a remarkable waterfall.

ADERSBACH FELSEN, a remarkable group of rocks in the form of detached or isolated columnar rocks in a valley of the Riesengebirge, in the district of Glatz in Silesia. The mountain for several miles appears divided into detached masses by perpendicular cuts, varying in depth from 600 to 1200 feet. These masses have a diameter from a few feet to several hundred yards. The part called the labyrinth consists of smaller masses confusedly grouped into columnar forms, from 100 to 200 feet in height, resting on each other. The descent into this wild scene is by a few narrow footpaths of great sublimity. Geologists suppose that the whole area has once been a tabular mass of sandstone, of unequal hardness; that the soft parts, which formed perpendicular veins or seams, have been washed away by water, leaving the harder portions in their natural position. Others suppose that this process has been begun by some subterranean commotion that split the rock, and that the fissures have been enlarged by the action of water.

ADES, or HADES, denotes the invisible state. In the heathen mythology, it comprehends all those regions that lie beyond the river Styx, viz. Erebus, Tartarus, and Elysium. (See HELL.)

ADESSENARIANS, ADESSENARII, in *Church History*, a sect of Christians who hold the real presence of Christ's body in the eucharist, though not by way of transubstantiation. They differ considerably as to this presence; some holding that the body of Christ is in the bread, others that it is about the bread, and others that it is under the bread.

ADHA, a festival which the Mahometans celebrate on the 10th day of the month *Dhoulhegiat*, which is the 12th and last of their year. This month being particularly destined for the ceremonies which the pilgrims observe at Mecca, it derives its name from this; for the word signifies *the month of Pilgrimage*. On that day they sacrifice with great solemnity, at Mecca, and nowhere else, a sheep, which is called by the same name as the festival itself. The Turks commonly call the festival the *Great Bairam*, to distinguish it from the lesser, which ends their fast, and which the Christians of the Levant call the *Easter of the Turks*. The Mahometans celebrate this festival, out of the city of Mecca, in a neighbouring valley; and sometimes they sacrifice there a camel.

ADHESION, a term chiefly used to denote the force with which the surface of a solid remains attached to the surface of a liquid, after they have been brought into contact. Suppose a polished glass plate to be suspended horizontally from one extremity of a balance, and to be exactly counterpoised by weights put into the opposite scale; if we bring this plate in contact with the surface of a quantity of mercury, we shall find that a certain additional weight must be placed in the opposite scale in order to separate the glass from the mercury. The force which kept the two bodies in contact is called *adhesion*. Three sets of experiments on this subject have been published by different philosophers.

Dr Brook Taylor, in a paper on *Magnetism*, inserted in the Philosophical Transactions for 1721, describes the result of his trials to determine the weight necessary to separate fir-boards of different sizes from the surface of water. The result of his experiments was, that the weight necessary is proportional to the surface of the fir-board to be raised.

In the year 1773, Guyton-Morveau ascertained experimentally the force of adhesion of eleven different metals of mercury. The metals which he employed were pure. The surface of each was an inch (French) in diameter, and polished. The following table exhibits the weight in French grains necessary to separate each metal from the mercury.

| | | | |
|---|---|---|---|
| Gold | 446 | Zinc | 204 |
| Silver | 429 | Copper | 142 |
| Tin | 418 | Antimony | 126 |
| Lead | 397 | Iron | 115 |
| Bismuth | 372 | Cobalt | 8 |
| Platinum | 282 | | |

M. Morveau ascertained likewise that the adhesive force is not diminished by removing the pressure of the air.

A great number of experiments on the same subject were made at a still later period by Mr Achard of Berlin. He measured the force of adhesion between various substances and water. He found that when the temperature was increased, the adhesion proportionally diminished. He even attempted to determine the diminution occasioned by the elevation of temperature, amounting to a single degree of the thermometer; and gives us a formula denoting that diminution. But it is not necessary to enter into any details respecting his experiments here, for a reason that will appear immediately.



Besides these three philosophers, many others have examined the rise of liquids in capillary tubes, a phenomenon which is nothing else than a peculiar case of adhesion, though we cannot with propriety treat of it here. Laplace published a dissertation on the subject in the year 1805, in which he has given us an historical detail, which, however, is far from accurate. His reasoning appears to us in general correct; though several very plain propositions are rather obscured than elucidated by his mathematical demonstrations.

When we make experiments on the adhesion of solids to liquids, and endeavour to ascertain the force requisite to separate them from each other, two cases may occur: the solid body may separate from the liquid *dry*, or its surface may be covered with a thin coating of the liquid, which it retains. If a surface of tallow be placed in contact with water, and separated from it by weights successively introduced into the opposite scale, we shall find, after the separation has taken place, that the surface of the tallow is *dry*, or that it has not carried along with it a thin coating of the water. But when we employ a fir-board, as Dr Brook Taylor did in his experiments, and as Mr Achard did in many of his, the case is very different; we shall find the whole surface of the board thoroughly *wetted;* that is to say, a thin film of the liquid remains adhering to the wood. Now, it is only the first of these two cases that can be considered as exhibiting the true force of adhesion. In the second case, it is not the solid which separates from the liquid, but one portion of the liquid which separates from the other. Such experiments, therefore, really show the force of cohesion between the particles of the liquid, not the force of adhesion between the solid and the liquid. Now, as the experiments of Brook Taylor and Achard belong all to this last case, it is obvious that they cannot be considered as experiments on adhesion. We must therefore leave them out of our consideration at present. The cohesion of the particles of liquids is well known to diminish as the temperature increases, till at a certain temperature this cohesion disappears altogether, and the liquids assume the state of elastic fluids, the particles of which repel each other. Hence the reason why, in Achard's experiments, the adhesive force diminished as the temperature increased.

Adhesion is obviously an attractive force, by which the two surfaces are kept in contact. It must evidently increase as the surfaces adhere, because the number of adhering particles increases in the same ratio. This force is insensible when the two surfaces are at any perceptible distance from one another; so that it acts only at insensible distances. From Morveau's experiments it appears, that it differs very much in intensity when different solids are made to adhere to the same liquid. Thus, gold adheres to mercury with a force more than twice as great as zinc does, and almost fifty-six times as great as cobalt does. Now these two properties, namely, acting only at insensible distances, and varying in intensity in different bodies, characterize that peculiar force known by the name of *chemical affinity*. But there is one particular in which chemical affinity appears at first sight to differ from adhesion. Chemical affinity is confined to the ultimate particles or atoms of bodies; whereas adhesion takes place between surfaces of any size whatever.

But if we consider that these surfaces consist each of a congeries of atoms united into a large mass by the force of cohesion; that adhesion is not sensible at any perceptible distance, however great the extent of surfaces may be; and that its strength increases in proportion to the surfaces;—if we consider these phenomena, we shall find reason to conclude that adhesion is a force which acts only between the atoms or integrant particles of bodies. It is therefore merely a case of *chemical affinity*.

The phenomena of adhesion depend upon the strength of affinity between the adhering bodies. If the affinity be weak, the two surfaces will separate by a small force applied, and the solid will retain no impression of the liquid whatever. This happens when cobalt is brought in contact with mercury, or tallow with water. If the affinity be strong, a considerable force will be requisite to separate the two surfaces. This is the case when gold or silver is brought in contact with mercury. So great is the affinity, indeed, in these cases, that if the adhesion continue for a short time, a combination actually takes place between the two metals. In that case the gold comes away white, or coated over with a film of mercury; the experiment is no longer an example of the force of adhesion between mercury and gold, but exhibits the cohesive force of the particles of mercury to each other. We have even found that this holds with platinum, though it be a metal which has a much weaker affinity for mercury than gold has. If a clean surface of platinum be kept for some time in contact with that of mercury, a very evident amalgamation takes place.

When a surface of wood, marble, or metal, comes in contact with water, on removing it we find that surface moist; that is to say, it has carried with it a thin film of water. This shows us that the adhesive force of water, or the affinity of water to these different bodies, is greater than the cohesive force of the particles of water to each other. Yet this force is not sufficiently strong to produce a chemical combination between the respective bodies. When a surface of sugar or common salt comes in contact with water, this surface is not merely wetted. If the contact be continued for a sufficient time, the solid loses its cohesion, and is dissolved by the liquid. This is a complicated case. The water by capillary attraction insinuates itself through the pores of the sugar. The minute crystals of sugar are deprived of their cohesion to each other by this intervening liquid. Being separated from each other, they gradually dissolve or enter into a chemical combination with the water. (T. T.)

ADHIL, in *Astronomy*, a star of the sixth magnitude, upon the garment of Andromeda, under the last star in her foot.

ADIABENE, one of the provinces into which the country of Assyria was divided. It was situate east of the Tigris, between the rivers Lycus, or Zabatus, and Caprus; and was so important as sometimes to give name to the whole of Assyria.

ADIANTUM, a family of widely-diffused ferns, being found in Europe, Asia, America, the South Sea Islands, Australia, and New Zealand; but the greatest number are natives of tropical forests. Our *Maiden-Hair* belongs to this genus.

ADIAPHORISTS, in *Church History*, a name importing lukewarmness, given in the 16th century to the moderate Lutherans, who embraced the opinion of Melancthon, whose disposition was much more pacific than that of Luther.

ADIGE, the ancient *Athesis*, a large river of Italy, formed by several rivulets which rise in the Rhætian Alps and unite near Glarus, where it has the name of Etsch. After flowing eastward to Bolsano it takes the name of Adige, and, receiving the Eisach, becomes navigable. Then flowing southwards, and afterwards in an eastern direction, it passes Trent and Verona, and at length falls into the Gulf of Venice, after a course of about 250 miles.



ADIMANTIUS, a Greek physician about A.D. 415, wrote a treatise on Physiognomy. See *Scriptores Physiognomiæ Veteres*, edited by Franzius, 1780.

ADIPOCIRE, derived from *adeps*, fat, and *cera*, wax, denotes a substance which has been lately examined by chemists. It is formed by a certain change which the soft parts of animal bodies undergo when kept for some time in running water, or when animals are buried, especially in damp soil, as in a common churchyard. Great quantities of this substance were found on removing the animal matters from a burial-ground at Paris in the year 1787. In this burial-ground 1200 or 1500 bodies were thrown together into the same pit, and being decomposed, were converted into this substance. It has some of the properties of wax or spermaceti.

ADIPOSE, a term used by anatomists for any cell, membrane, &c., that is remarkable for its fatness.

ADIRONDACK, a name recently given to a group of mountains in the north-eastern part of the state of New York, in North America, and to the south-west of Lake Champlain. They are connected with the Catskill Mountains. Their chief summits are Whiteface, 5000 feet; and Mount Marcy, 5460.

ADIT, in a general sense, the passage to, or entrance of, any thing.

ADIT *of a Mine*, the hole or aperture whereby it is entered and dug, and by which the water and ores are carried away. The term is sometimes used for the *air-shaft*, which is a hole driven perpendicularly from the surface of the earth into some part of the mine, to give entrance to the air.

ADJAZZO, ADRAZZO. See AJACCIO.

ADJECTIVE, in *Grammar*, a kind of noun joined with a substantive, either expressed or implied, to denote its qualities or incidents.

ADJOURNMENT, the putting off a court or other meeting till another day. There is a difference between the adjournment and the prorogation of parliament; the former not only being for a shorter time, but also done by the house itself; whereas the latter is an act of royal authority.

ADJUDICATION, in *Scottish Law*, the name of that action by which a creditor attaches the heritable estate of his debtor, or his debtor's heir, in order to appropriate it to himself either in payment or security of his debt; or that action by which the holder of an heritable right, labouring under any defect in point of form, may supply that defect.

ADJUSTMENT, the act of adjusting; a reducing to just form or order, a making fit, or conformable to, any assumed standard.

ADJUSTMENT, in *Commerce*, the settlement of a loss incurred at sea on insured goods. If the policy be what is called an *open one*, and the loss of the goods be total, the insurer must pay for them, at the value of prime cost, which includes not only the invoice price of the goods, but all duties paid, the premium of insurance, and all expenses incurred on them when put on board. In the case of a loss, the insurer is to be put in just the same position in regard to the property insured, as he was before the policy was effected. If the policy be a *valued one*, and a total loss be incurred, then they are settled for at the valuation fixed at the time of the insurance, unless the insurers can prove that the insured had not a real interest in the goods, or that they were overvalued. In case of a partial loss, the value of the goods must be proved. See Park on *Marine Insurance, &c.*

ADJUTAGE. The effect of a tube fitted to an aperture on a vessel from which water is flowing, as in a jet or fountain. The term seems to have been derived from the effect of pipes, dilated at their extremity, in promoting the discharge of the fluid. (See *Venturi & Michelotti Sperimenti Idraul.—Gilb. An. II. III.—Prony, Recher. Phys. Math.*)

ADJUTANT, in the *Military Art*, is an officer whose business it is to assist the major. Each battalion of foot and regiment of horse has an adjutant, who receives the orders every night from the brigade-major; which, after carrying them to the colonel, he delivers out to the serjeants. When detachments are to be made, he gives the number to be furnished by each company or troop, and assigns the hour and place of rendezvous.

*Adjutants-general*, among the Jesuits, a select number of fathers, who resided with the general of the order, each of whom had a province or country assigned him, as England, Holland, &c.; and their business was to inform the father-general of state occurrences in such countries. To this end they had their correspondents delegated, emissaries, visitors, regents, provincials, &c.

ADLEGATION, a term formerly used in the public law of the German empire, to denote the right claimed by the states of the empire of adjoining plenipotentiaries, in public treaties and negotiations, to those of the emperor, for the transacting of matters which relate to the empire in general; in which sense *adlegation* differs from *legation*, which is the right of sending ambassadors on a person's own account.

ADLOCUTION, Adlocutio, in *Antiquity*, is chiefly understood of speeches made by Roman generals to their armies, to encourage them before a battle. We frequently find those adlocutions expressed on medals by the abbreviature Adlocut. Coh.—The general is sometimes represented as seated on a tribunal, often on a bank or mound of turf, with the cohorts ranged in order around him, in *manipuli* and *turmæ*. The usual formula in adlocutions was, *Fortis esset ac fidus.*

ADMINICLE, a term used chiefly in old law-books to imply an aid, help, assistance, or support. The word is Latin, *adminiculum;* and derived from *adminiculor*, to prop or support.

Adminicle, in *Scottish Law*, signifies any writing or deed referred to by a party, in an action of law, for proving his allegations.

ADMINISTRATOR, in *English Law*, he to whom the ordinary commits the administration of the goods of a person deceased, in default of an executor. The origin of administrators is derived from the civil law. Their establishment in England is owing to a statute made in the 31st year of Edward III. Till then, no office of this kind was known besides that of executor; in default of whom, the ordinary had the disposal of goods of persons intestate, &c.

Administrator, in *Scottish Law*, a person legally empowered to act for another whom the law presumes incapable of acting for himself.

Administrator is sometimes used for the president of a province; for a person appointed to receive, manage, and distribute the revenues of an hospital or religious house; for a prince who enjoys the revenues of a secularized bishop; and for the regent of a kingdom during the minority of a prince or a vacancy of the throne.

ADMIRABILIS Sal, the same with Glauber's Salt.

ADMIRAL, a great officer or magistrate, who has the government of a navy, and the hearing of all maritime causes.

Anciently there were generally three or four admirals appointed for the English seas, all of them holding the office *durante beneplacito*, and each of them having particular limits under his charge and government; as admirals of the fleet of ships from the mouth of the Thames, northward, southward, or westward. Besides these, there were admirals of the Cinque Ports. We sometimes find that one person had been admiral of the fleets to the southward, northward, and westward; but the title of *Admiralis Angliæ* was not frequent till the reign of Henry IV., when the king's brother had that title given him, which in all commissions afterwards was granted to the succeeding admirals. It may be observed, that there was a title above that of admiral of England, which was, *locum tenens regis super mare*, the king's lieutenant-general of the sea: this title we find mentioned in the reign of Richard II. Before the use of the word *admiral* was known, the title of *custos maris* was made use of.



Of the rank of admiral there are three degrees; admiral, vice-admiral, rear-admiral. Each of these degrees consists of three divisions, which are distinguished by as many different colours or flags; hence all admirals assume the common title of *flag-officers*, and take rank and command in the following order:—

Admirals of the Red, of the White, of the Blue Squadrons, bearing their respective flags at the main-top-gallant-mast head; Vice-admirals of the Red, of the White, of the Blue Squadrons, bearing their respective flags at the fore-top-gallant-mast head; Rear-admirals of the Red, of the White, of the Blue Squadrons, bearing their respective flags at the mizen-top-gallant-mast head.

It may be remarked, that for nearly a century we had no Admiral of the Red Squadron; that flag, according to a vulgar error, having been taken from us by the Dutch in one of those arduous struggles for naval superiority which that nation was once able to maintain against the naval power of England. But the fact is, the red flag was laid aside on the union of the two crowns of England and Scotland, when the Union flag was adopted in its place, and usually hoisted by the admiral commanding in chief. The red flag, however, has recently been revived, on an occasion worthy of the event; namely, on the promotion of naval officers which took place in November 1805, in consequence of the memorable victory off Trafalgar. (See Navy.)

Admiral of the Fleet is a mere honorary distinction, which gives no command, but an increase of half-pay, his being three guineas a day, and that of an admiral two guineas. It is sometimes conferred, but not always, on the senior admiral on the list of naval officers, and was a short time held by the duke of Clarence, afterwards William IV. In 1851 were appointed, for the first time, two admirals of the fleet, Sir Thomas Byam Martin, G.C.B., and Sir George Cockburn, G.C.B., the last having been appointed for his long and highly distinguished services. If the admiral of the fleet should happen to serve afloat, he is authorised to carry the union flag at the main-top-gallant-mast head; which was the case when the duke of Clarence escorted Louis XVIII. across the Channel to take possession of the throne of France.

The comparative rank which flag-officers hold with officers in the army has been settled as follows by his Majesty's order in council, in the reign of George IV.

The admiral and commander-in-chief of the fleet has the rank of a field-marshal in the army; admirals with flags at the main take rank with generals of horse and foot; vice-admirals with lieutenant-generals; rear-admirals with major-generals; commodores of the first and second class with broad pendants with brigadier-generals. (See Navy.)

On the active list of admirals, there are at present (1853) seven of the Red, seven of the White, and seven of the Blue squadron. Of the vice-admirals nine of each squadron, and of the rear-admirals seventeen.

In addition to these, there are on the *reserved half-pay list*, fifty-eight flag-officers; thirty-six *retired* rear-admirals (to be reduced to twenty-five), and eighty-two *additional retired* rear-admirals, with the pay of *retired captains.*

ADMIRAL, THE LORD HIGH, OF ENGLAND, an ancient officer of high rank in the state, who not only is vested with the government of the navy, but who, long before any regular navy existed in England, presided over a sovereign court, with authority to hear and determine all causes relating to the sea, and to take cognizance of all offences committed thereon.

There can be little doubt of the Asiatic origin of the name given to this officer, which does not appear to have been known in the languages of Europe before the time of the holy wars. *Amir*, in Arabic, is a chief or commander of forces; it is the same word as the *ameer* of the peninsula of India (as *ameer al omrah*, the chief of lords or princes), and the *emir* of the Turks or Saracens, who had, and still have, their *emir* or *ameer'l dureea*, commander of the sea, *amir'l asker dureea*, commander of the naval armament. The incorporation of the article with the noun appears, we believe, for the first time in the Annals of Eutychius, patriarch of Alexandria, in the tenth century, who calls the Caliph Omar *Amirol munumim*, seu, *Imperator fidelium*. Spelman says, "In regno Saracenorum quatuor prætores statuit, qui *admiralli* vocabantur." The *d* is evidently superfluous, and is omitted by the French, who say *Amiral*. The Spanish write *Almirante;* the Portuguese the same. Milton would seem to have been aware of the origin of the word, when he speaks of "the mast of some great Ammiral." It is obvious, then, that the supposed derivations of αλμυρος from the Greek, *aumer* from the French, and *aen mereal* from the Saxon, are fanciful and unauthorised etymologies.

The period of time about which this officer first makes his appearance in the governments of European nations, corroborates the supposition of its having been adopted in imitation of the Mediterranean powers, at the return of the Christian heroes from the holy wars. According to Moreri, Florent de Varenne, in the year 1270, was the first admiral known in France; but by the most approved writers of that nation, the title was unknown till, in 1284, Enguerand de Coussy was constituted Admiral. The first admiral by name that we know of in England was W. de Leybourne, who was appointed to that office by Edward I. in the year 1286, under the title of *Admiral de la mer du Roy d'Angleterre*. Mariana, in his *History of Spain*, says that Don Sancho, having resolved to make war on the barbarians (Moors), prepared a great fleet; and as the Genoese were at that time very powerful by sea, and experienced and dexterous sailors, he sent to Genoa to invite, with great offers, Benito Zacharias into his service; that he accepted those offers, and brought with him twelve ships; that the king named him his admiral (*Almirante*), and conferred on him the office for a limited time. This happened in the year 1284. Several Portuguese authors observe, that their office of *Almirante* was derived from the Genoese, who had it from the Sicilians, and these from the Saracens; and it appears, from Souza's *Historia Genealogica da Caza Real*, that, in 1322, Micer Manuel Piçagow was invited from Genoa into Portugal, and appointed to the office of *Almirante*, with a salary of three thousand pounds (*livras*) a year, and certain lands, &c., on condition that he should furnish, on his part, twenty men of Genoa, all experienced in sea affairs, and qualified to be *alcaidis* (captains) and *arraises* (masters) of ships: all of which terms, *almirante*, *alcaidi*, and *arrais*, are obviously of Arabic derivation.

Edward I. who began his reign in 1272, went to the Holy Land, and visited Sicily on his return. He must therefore have had an opportunity of informing himself concerning the military and naval science of the various countries bordering on the Mediterranean—an opportunity which so able and warlike a prince would not neglect; but whether the title and office of admiral existed in England before his time, as some are inclined to think, or whether W. de Leybourne was first created to that office in 1286, as before mentioned, we believe there is no authentic record to enable us to decide. Supposing him, however, to be the first, Edward may either have adopted the office and title from the Genoese, or the Sicilians, or the Spaniards, or the French; or even had it directly from the Saracens, against whom he had fought, and with whom he had afterwards much amicable intercourse. It would seem, however, that the office was in Edward's time merely honorary; for that monarch, in 1307, orders the lord mayor of London, at his peril and without delay, to provide a good ship, well equipped, to carry his pavilions and tents; and, in the same year, another order is addressed to the *Vicecomes Kantiæ*, to provide, for immediate passage across the seas, *tot et tales pontes et claias* as the constable of Dover Castle should demand, without one word being mentioned of the admiral. (Rymer, vol. iii. p. 32.)

Admiral.

From the 34th Edward II. we have a regular and uninterrupted succession of admirals. In that year he appointed Edward Charles Admiral of the North, from the mouth of the river Thames northward, and Gervase Allard Admiral of the West, from the mouth of the Thames westward; and these two admirals of the north and the west were continued down to the 34th Edward III., when John de Beauchamp, lord warden of the Cinque Ports, constable of the Tower of London, and of the Castle of Dover, was constituted *High Admiral of England;* but nine years afterwards the office was again divided into north and west, and so continued until the 10th Richard II., when Richard, son of Alain earl of Arundel, was appointed Admiral of England. Two years after this it was again divided as before; and in the 15th year of the same reign, Edward earl of Rutland and Cork, afterwards duke of Albemarle, was constituted *High Admiral of the North and West;* and after him the marquis of Dorset, and earl of Somerset, son of John of Gaunt, duke of Lancaster; Percy earl of Winchester next succeeded to the same title, which once more was dropped in the 2d of Henry IV., and divided as before. But in the 6th of the same reign the office of Admiral of England became permanently vested in one person. In the 14th Henry VI., John Holland duke of Exeter was created Admiral of England, Ireland, and Aquitaine, for life; and in the third year of Edward VI., John Dudley earl of Warwick was constituted High Admiral of England, Ireland, Wales, Calais, Boulogne, the marches of the same, Normandy, Gascony, and Aquitaine, also Captain-general of the navy and seas of the king, &c. In the 27th Elizabeth, Charles Lord Howard had all the aforesaid titles, with the addition of Captain-general of the navy and seas of the said kingdoms.

On the 20th November 1632, the office of high admiral was for the first time put in commission, all the great officers of state being the commissioners. During the Commonwealth, a committee of parliament managed the affairs of the admiralty. At the Restoration, in 1660, his royal highness James duke of York was constituted *Lord High Admiral of England*. The commission was revoked on the 22d May 1684, and King Charles II. held the admiralty in his own hands, and managed it by the great officers of his privy council until his death. He took this occasion of reserving for his own use all the droits and perquisites claimed by the lord high admiral. King James II. declared himself in council *Lord High Admiral and Lord General;* and he managed the affairs of the admiralty and navy by Mr Secretary Pepys all the time of his reign. In the 1st William and Mary, the admiralty was again put in commission. In the 6th Anne (1707), his royal highness George prince of Denmark was appointed *High Admiral of Great Britain* (in consequence of the union of the two crowns), with a council to assist him;

Admiral. and at his death the queen acted in the office by Mr Burchett. On the 29th November 1708, it was again put in commission, or rather, the earl of Pembroke was constituted High Admiral, with a council to assist him; since which time the office of lord high admiral continued to be executed by lords commissioners of the admiralty, until the 2d of May 1827, when his royal highness the duke of Clarence was appointed *Lord High Admiral*, with a council of four members to assist him; in which office he continued to act, to the great satisfaction of the navy at large, until, at his own request, he was permitted by his Majesty to resign his high office, on the 19th September 1828, when it was again put in commission, and so it still remains.

Prince George of Denmark, when lord high admiral, having surrendered, by a formal instrument, all the rights, profits, perquisites, and advantages whatsoever, appertaining to the office, for the benefit and use of the public, with the exception of the sum of L.2500 a-year, to be disposed of in such manner, and for such particular uses, as her Majesty, under her sign manual, should direct; the salary of the lord high admiral, which had hitherto been no more than 300 marks, was now fixed, by warrant under privy seal, at L.7000 a-year; which sum, by 1st George II. was divided equally among seven commissioners, and continued to be so down to the present time, the part of the commissioner who stood first in the patent having, however, been made up from other funds to L.3000 a-year, and, in the year 1806, further increased by Lord Howick, then first lord commissioner, to L.5000 a-year. Since the surrender above mentioned, all the *droits of admiralty*, as they are called, with all the fees, emoluments, perquisites, &c. whatsoever, have been taken from the admiral, and applied to public purposes.

These droits and perquisites are by no means inconsiderable. As enumerated in the patent, they consist of flotson, jetson, lagon, treasure, deodands, derelicts, found within his jurisdiction; all goods picked up at sea; all fines, forfeitures, ransoms, recognizances, and pecuniary punishments; all sturgeons, whales, porpesses, dolphins, rigs, and grampusses, and all such large fishes; all ships and goods of the enemy coming into any creek, road, or port, by stress of weather, mistake, or ignorance of the war; all ships seized at sea, salvage, &c. together with his shares of prizes; which shares were afterwards called *tenths*, in imitation probably of the French, who gave their admiral, for supporting the dignity of his office, *son droit de dixième*. All prizes are now wholly given up by the crown to the captors, and such share of the *droits* as from circumstances may be thought proper. The lord high admiral also claimed, and enjoyed as his due, the cast ships; and the subordinate officers of the navy, as their perquisites, all other decayed and unserviceable stores.

Though by act of 2d William and Mary, st. 2, c. 2 (extended by the 1st Geo. IV., c. 90, and 7th and 8th Geo. IV., c. 65), the lords commissioners of the admiralty are vested with all and singular authorities, jurisdictions, and powers, which have been and are vested, settled, and placed in the lord high admiral of England for the time being, to all intents and purposes, as if the said commissioners were lord high admiral of England; yet there is this remarkable difference in the two patents by which they are constituted, that the patent of the lord high admiral mentions very little of the military part of his office, but chiefly details his judicial duties as a magistrate; whilst, on the contrary, the patent to the lords commissioners of the admiralty is very particular in directing them to govern the affairs of the navy, and is almost wholly silent as to their judicial powers.

These powers, as set forth in the patent to the earl of Pembroke in 1701, are, the power to act by deputy; to take cognizance of all causes, civil and maritime, within his jurisdiction; to arrest goods and persons; to preserve public streams, ports, rivers, fresh waters, and creeks whatsoever, within his jurisdiction, as well for the preservation of the ships, as of the fishes; to reform too straight nets, and unlawful engines, and punish offenders; to arrest ships, mariners, pilots, masters, gunners, bombardiers, and any other persons whatsoever, able and fit for the service of the ships, as often as occasion shall require, and wheresoever they shall be met with; to appoint vice-admirals, judges, and other officers, *durante beneplacito;* to remove, suspend, or expel them, and put others in their places, as he shall see occasion; to take cognizance of civil and maritime laws, and of death, murder, and maim. Admiralty.

It was by no means necessary that the lord high admiral should be a professional man. Henry VIII. made his natural son, the duke of Richmond, lord high admiral of England, when he was but six years old. When the high admiral, however, went to sea in person, he had usually a commission under the great seal, appointing him Admiral and Captain-general of the fleet, sometimes with powers to confer knighthood, and generally to punish with life and limb. Such a commission was granted by Henry VIII. to Sir Edward Howard, who executed indenture with the king to furnish 3000 men, 18 captains, 1750 soldiers, 1232 mariners and gunners; his own pay to be 10s. a day, that of a captain 1s. 6d., of the rest 5s. as wages, and 5s. for victuals each man for twenty-eight days, together with certain dead shares.

It appears, from Mr Pepys's *Naval Collections*, that the lord high admiral did anciently wear, on solemn occasions, a gold whistle, set with precious stones, hanging at the end of a gold chain. The whistle, it would seem, has long since descended to the boatswain and his mates.

The salary of the first lord commissioner is L.4500 a-year, and of each of the five lords L.1000. (J. B—W.)

Admiral is also an appellation given to the most considerable ship of a fleet of merchantmen, or of the vessels employed in the cod fishery of Newfoundland. This last has the privilege of choosing what place he pleases on the shore to dry his fish; gives proper orders, and appoints the fishing places to those who come after him; and as long as the fishing season continues, he carries a flag on his main-mast.

Admiral, in *Conchology*, the English name of a species of mollusca belonging to the order of *Gasteropoda*, *conus ammiralis*.

ADMIRALTY, High Court of. This is a court of law, in which the authority of the lord high admiral is exercised, in his *judicial* capacity. Very little has been left on record of the ancient prerogative of the admirals of England. For some time after the first institution of the office, they judged all matters relating to merchants and mariners, which happened on the main sea, in a summary way, according to the laws of Oleron (so called because promulgated by Richard I. at that place). These laws, which were litttle more than a transcript of the Rhodian laws, became the universally received customs of the western part of the world. "All the sea-faring nations," says Sir Leoline Jenkins, "soon after their promulgation, received and entertained these laws from the English, by way of deference to the sovereignty of our kings in the British ocean, and to the judgment of our countrymen in sea affairs."

In the patents granted to the early admirals between the latter end of the reign of Henry III., and until the close of that of Edward III., no mention is made of marine perquisites or of civil power, nor does it appear that the admirals enjoyed either; but after the death of the latter, new and extraordinary powers were granted to them, and it would appear that they usurped others. The preamble to the statute of 13th Richard II., stat. 1, c. 5, sets forth, that "forasmuch as a great and common clamour and complaint hath been oftentimes made before this time, and yet is, for that

Admiralty. the admirals and their deputies hold their sessions within divers places of this realm, as well within the franchise as without, accroaching to them greater authority than belongeth to their office, in prejudice of our lord the king, and the common law of the realm, and in diminishing of divers franchises, and in destruction and impoverishing of the common people;" and it is therefore directed "that the admirals and their deputies shall not meddle from henceforth of any thing done within the realm, but only of a thing done upon the sea." And two years afterwards (15th R. II., c. 3), in consequence, as stated in the preamble of the statute, "of the great and grievous complaint of all the commons," it was ordained that the admiral's court should have no cognizance of any contracts, pleas, or quarrels, or of any thing done or arising within the bodies of counties, whether by land or by water, nor of wreck of the sea; but that the admiral should have cognizance of the death of a man, and of maihem done in great ships being and hovering in the main stream of great rivers, yet only beneath the bridges of the same rivers nigh to the sea. He may also arrest ships in the great flotes for the great voyages of the king and of the realm, saving always to the king all maroner of forfeitures and profits thereof coming, and have jurisdiction over the said flotes, but during the said voyages only. But if the admiral or his lieutenant exceed that jurisdiction, then, by 2d Henry IV., c. 11, the statute and the common law may be holden against them; and if a man pursues wrongfully in the admiralty court, his adversary may recover double damages at common law, and the pursuant, if attainted, shall incur the penalty of L.10 to the king.

The place which, according to Spelman, is absolutely subject to the jurisdiction of the admiral, is the sea; which, however, comprehends public rivers, fresh waters, creeks, and all places whatsoever, within the ebbing and flowing of the sea, at the highest water, the shores or banks adjoining, from all the first bridges to the seaward; and in these, he observes, the admiralty hath full jurisdiction in all causes, criminal and civil, except treasons and the right of wreck. Lord Coke observes (5 Rep. 107), that between the high water mark and the low water mark, the admiral hath jurisdiction *super aquam, ad plenitudinem maris*, and as long as it flows, though the land be *infra corpus comitatus* at the reflow, so as of one place there is *divisum imperium* interchangeably.

But though the statute restraineth the lord high admiral, that he shall not hold plea of a thing rising in the body of a county, he is not restrained from making execution upon the land, but is empowered to take either body or goods upon the land; otherwise his jurisdiction would often prove a dead letter. He also can and does hold his court in the body of a county. So, likewise, the civil power may apprehend and try persons who may have been guilty of offences cognizable at common law, though committed in the fleet, in any port or harbour of Great Britain, or at sea, provided such persons have not already been tried for such offences, either by court-martial or in the admiralty court; and in all ports, harbours, creeks, &c. lying in any county, the high admiral and the sheriff, or coroner, as the case may be, have concurrent jurisdiction.

By the 6th and 7th Will. IV., c. 53, the admiralty jurisdiction is extended to Prince of Wales' Island, Singapore, and Malacca; and under the 3d and 4th Vict., c. 65, the court has jurisdiction in the following cases:—

Whenever a vessel is arrested by process issuing from the said court, or the proceeds of any vessel are brought into the registry, to take cognisance of all claims in respect of any mortgage of such vessel.

To decide all questions as to the title to, or ownership of, such vessel, or the proceeds thereof remaining in the registry, arising in any cause of possession, salvage, damage, wages, or bottomry, instituted in the said court.

To decide all claims and demands whatsoever in the nature of salvage, or in the nature of towage, or for necessaries supplied to any foreign vessel, and enforce the payment of the same, whether such vessel may have been in the body of the county, or upon the high seas at the time when the service was rendered, or damage received, or necessaries furnished, in respect of which claim is made.

To decide all matters and questions concerning booty of war, or the distribution thereof, which it shall please her Majesty by the advice of the privy council, to refer to the judgment of the said court, who shall proceed therein as in cases of prize of war.

And under § 40 of the 9th and 10th Vict., c. 99, to decide on all claims and demands whatsoever in the nature of salvage for services performed, whether on sea or land.

The Lord High Admiral was assisted in his *judicial* functions by the following principal officers:—1. The Vice-admiral; 2. the Judge; 3. the Registrar: 4. the Marshal; 5. Advocate-general; 6. Procurator-general; 7. Counsellor; 8. Solicitor; which officers are continued.

1. *The Vice-admiral.* This officer is the admiral's deputy or lieutenant, mentioned in the statutes of 13th and 15th Richard II., and was the person, most probably, who presided in the court. At present the office of vice-admiral of England is a perfect sinecure, generally conferred on some naval officer of high rank and distinguished character in the service, having a salary of L.434, 1s. 9d. per annum, attached to it in addition to his half-pay. That of rear-admiral of England is the same, and the salary in addition to his half-pay is L.342, 9s. per annum. Each county of England has its vice-admiral, which is little more than an honorary distinction, though the patent gives to him all the powers vested in the admiral himself. Similar powers were also granted to the judges of the admiralty county-courts; but this was found so inconvenient and prejudicial to those who had suits to commence or defend before them, that the duke of York, when lord high admiral, in 1663, caused instructions to be drawn up in order to ascertain to each his province, whereby the whole judicial power remained with the judge, and the upholding of the rights of the admiral, and levying and receiving the perquisites, &c. appertained to the vice-admiral.

Each of the four provinces of Ireland has its vice-admiral. There is one vice-admiral for all Scotland, who has a salary of L.1000 a year on the ordinary estimate of the navy, and one for the Shetland and Orkney islands. The governor of most of our colonies had a commission of vice-admiral granted to him by the lord high admiral or lords commissioners of the admiralty, and generally a commission from the king under the great seal, grounded on the 11th and 12th William III., c. 7, and further confirmed by 46th Geo. III., c. 54, by which he was authorized to try all treasons, piracies, felonies, robberies, murders, conspiracies, and other offences, of what nature or kind soever, committed on the seas, where the parties were taken into custody in places remote from England. The court consisted of seven persons at the least, of whom the governor, the lieutenant-governor, the vice-admiral, the flag-officer, or commander-in-chief of the squadron, the members of the council, the chief-justice, judge of the vice-admiralty court, captains of men-of-war, and secretary of the colony, were specially named in the commission; but any three of these, with four others selected from known merchants, factors, or planters, captains, lieutenants, or warrant officers of men-of-war, or captains, masters, or mates of merchant ships, constituted a legal court of piracy. By the 12th and 13th Vict., c. 96, all persons charged in any colony with offences committed on the sea may be dealt with in the same manner as if the offences had been committed on waters within the local jurisdiction of the courts of the colony.

The vice-admiralty courts in the colonies are of two descriptions. The one has power to inquire into the causes of detention of enemies or neutral vessels, to try and condemn the same for the benefit of the captors, as well as to take cognizance of all matters relating to the office of the lord high admiral. The other has power only to institute inquiries into misdemeanours committed in merchant vessels, and to determine petty suits, &c., and to guard the privileges of the admiral. The former are usually known by the name of *Prize Courts*, the latter by that of *Instance Courts.*

The following are the colonies and foreign possessions in which *Prize Courts* have been established in the course of the last war:—Gibraltar, Malta, Newfoundland, Halifax, Bermuda, Bahama Islands, Barbadoes, Antigua, Tortola, Jamaica, Cape of Good Hope, Ceylon, Bombay, Madras, and Calcutta. The following colonies had *Instance Courts* only:—Dominica, Grenada, St Vincent, St Christopher, Trinidad, St Cervix, Martinique, Berbice, Demerara, and Essequibo; in addition to which is a court established at Sierra Leone for the trial and condemnation of captured slaves only; and since that time, Gibraltar, Malta, St Helena, Berbice, Demerara, and Essequibo, Sierra Leone (this court has jurisdiction only over ships concerned in the slave trade), Newfoundland, Halifax, Nova Scotia, Prince Edward's Island, Lower Canada, Barbadoes, Tobago, and St Lucca, Antigua, Montserrat, and Barbadoes, Tortola, Jamaica, Bahamas, Falkland Islands, Cape of Good Hope, Gambia, Gold Coast, Ceylon, Bombay, Calcutta, Madras, New South Wales, Van Diemen's Land, Western Australia, South Australia, New Zealand, Vancouver's Island, Hong Kong, Lahuan.

In none of the patents to the lord high admiral, vice-admiral, or judge, is any mention made of prize jurisdiction. Lord Mansfield had occasion to search into the records of the court of admiralty in Doctors' Commons, to ascertain on what foundation this jurisdiction was exercised by the judge of the admiralty; but he could not discover any prize-act books farther back than 1643; no sentences farther back than 1648. The registrar could go no farther back than 1690. "The prior records," says his lordship, "are in confusion, illegible, and without index." The prize jurisdiction may therefore be considered as of modern authority, and distinct altogether from the ancient powers given to the admiral. To constitute the authority for trying prize causes, a commission under the great seal issues to the lord high admiral, at the commencement of every war, to will and require the court of admiralty, and the lieutenant and judge of the said court, his surrogate or surrogates, to proceed upon all manner of captures, seizures, prizes, and reprisals, of all ships and goods that are or shall be taken; and to hear and determine according to the course of the admiralty, or the law of nations; and a warrant issues to the judge of the admiralty accordingly.

The admiralty court being in this respect a court in which foreigners of all nations may become suitors, an appeal may be had from its decisions to a committee of the lords of the privy council, who hear and determine according to the established laws of nations.

At the breaking out of a war, the lord high admiral also receives a special commission from the crown, under the great seal, to empower him to grant letters of marque and reprisals against the enemy, he having no such power by his patent. These letters are either general or special; general, when granted to private men to fit out ships at their own charge to annoy the enemy; special, when in the case of any of our merchants being robbed of their estates or property by foreigners, the king grants them letters of reprisal against that nation, though we may be in amity with it. Before the latter can be sued for, the complainant must have gone through the prosecution of his suit in the courts of the state whose subjects have wronged him; where, if justice be denied, or vexatiously delayed, he must first make proof of his losses and charges in the admiralty court here; whereupon, if the Crown is satisfied he has pursued all lawful means to obtain redress, and his own interceding should produce no better effect, special letters of reprisal are granted; not, however, as must be evident, until a very strong case has been made out. This custom, which we may now consider as obsolete, seems to be a remnant of the law of ancient Greece, called *androlepsia*, by which, if a man was slain, the friends and relations of the deceased might seize on any three citizens of the place where the murderer took refuge, and make them slaves, unless he was delivered up. Both Oliver Cromwell and King Charles II. granted letters of reprisal. In 1638 the Duc d'Epernon seized on the ship Amity of London, for the service of the French king against the Spaniards, promising full satisfaction; but none being made, the owners obtained letters of reprisal from the usurper, and afterwards, in 1665, from Charles II. In 1666 Captain Butler Barnes had letters of reprisal against the Danes. The Dutch having burnt six English merchant vessels in the Elbe, within the territories of Hamburg, which city, instead of giving any assistance or protection, hindered the English from defending themselves, letters of reprisal were granted to the sufferers against that city. Lastly, one Justiniani, a noble Genoese, being indebted in a great sum to Joseph Como, a merchant in London, which he had several years solicited for, but could get no satisfaction, Captain Scott, commander of his Majesty's ship the Dragon, stationed at that time in the Mediterranean, received orders to make reprisals upon the ships of that republic; upon which the debt was paid.

2. *The Judge.* The patents to the judge of the admiralty and vice-admiralty courts run pretty nearly in the same manner as those of the lord high admiral, and point out the several matters of which he can take cognizance. The parliament of 1640 established the office of judge of the admiralty court in three persons, with a salary of L.500 a year to each. At the Restoration there were two judges of the high court of admiralty, which sometimes proved inconvenient; for when they differed in opinion no judgment could be had. These judges, before the Revolution, held their appointment only during pleasure. At that period Sir Charles Hedges was constituted judge under the great seal of England, *quamdiu se bene gesserit*, with a salary of L.400 a year, and an additional L.400 out of the proceeds of prizes and perquisites of the admiralty; but in the year 1725 the latter sum was diminished from the ordinary estimate by the House of Commons. Lord Stowell, the late judge, in consequence of the extraordinary increase of the business in the admiralty court, had a salary of L.2500 a year on the ordinary estimate of the navy. Under the 3d and 4th Vict., c. 66, § 1, the salary is fixed at L.4000 per annum.

The judges of the vice-admiralty courts in certain of the colonies, limited by 41st George III., c. 96, are allowed a salary not exceeding to each the sum of L.2000 a year, to be paid out of the consolidated fund of Great Britain; together with profits and emoluments not exceeding to each the further sum of L.2000 *per annum*, out of the fees to be taken by the said judges, of which a table is directed to be hung up in some conspicuous place in the court; and no judge is to take any fee beyond those specified, directly or indirectly, on pain of forfeiture of his office, and being proceeded against for extortion; and on his retirement from office, after six years' service, or from some permanent infirmity, the Crown may, by authority of the act above mentioned, grant unto such judge an annuity for the term of his life, not exceeding L.1000 *per annum*. This liberal provision puts the judges of the colonial courts of vice-admiralty above all suspicion of their decisions being influenced by unworthy motives; a suspicion they were not entirely free from when their emoluments depended mainly on their fees.

During the late war, a session of oyer and terminer to try admiralty causes was held at the Old Bailey, now the central criminal court, twice a year. The commission for this purpose is of the same nature with those which are granted to the judges when they go the circuits; that is to say, to determine and punish all crimes, offences, and misdemeanours, and abuses; the *end* of both being the same, their *limits* different; the one relating to things done upon the land, the other to things done upon the water. The lords commissioners of the admiralty, all the members of the privy council, the chancellor and all the judges, the lords of the treasury, the secretary of the admiralty, the treasurer and commissioners of the navy, some of the aldermen of London, and several doctors of the civil law, are the members of this commission; any four of whom make a court, the quorum being the lords of the admiralty, judge of the admiralty, the twelve judges, and the doctors of the civil law.

The proceedings of the court are continued *de die in diem*, or, as the style of the court is, from tide to tide.

3. *The Registrar of the Admiralty* has hitherto held his place by patent from the lord high admiral generally for life, though the admiral himself and the lords commissioners of admiralty hold their places only during pleasure; and, what is still more remarkable, the office of registrar has sometimes been granted, and is now vested in reversion. He had no salary, the amount of his emoluments depending on the number of captures, droits, &c. condemned by the court; which, during the late war, were so enormous, that in 1810 an act was passed for regulating the offices of registrars of admiralty and prize courts, by which it is enacted, "that no office of registrar of the high court of admiralty, or of the high court of appeals for prizes, or high court of delegates in Great Britain, shall, after the expiration of the interest now vested in possession or reversion therein, be granted for a longer term than during pleasure, nor be executed by deputy; that an account be kept in the said offices respectively of all the fees, dues, perquisites, emoluments, and profits received by and on account of the said registrars, out of which all the expenses of their offices are to be paid; that one-third of the surplus shall belong to the registrar and to his assistant (if an assistant should be necessary), and the remaining two-thirds to the consolidated fund of Great Britain, to be paid quarterly into the exchequer; the account of such surplus to be presented to the court at least fourteen days before each quarter day, and verified on oath. Under the 3d and 4th Vict. c. 66, § 2, a yearly salary of L.1400 is substituted for "all fees, dues, perquisites, emoluments, and profits," and which may be increased in time of war to L.2000.

4. *The Advocate-general.* This officer is appointed by warrant of the lords commissioners of the admiralty. His duties are, to appear for the lord high admiral in his court of admiralty, court of delegates, and other courts; to move and debate in all causes wherein the rights of the admiral are concerned; for which he had anciently a salary of twenty marks (L.13, 6s. 8d.) a year. In May 1803, Dr William Battine, who was appointed in 1791, had an addition of L.200 to his salary, "for his extraordinary trouble and attendance during the present hostilities." His salary was continued to him and his successor, Dr Arnold, till 1816; since that time the allowance has been reduced to its original amount of L.13, 6s. 8d. Formerly the admiral's advocate was always retained as leading counsel, but since the droits were transferred to the crown, he has gradually been supplanted by the king's advocate, who is generally retained in all cases, the admiralty advocate acting only as junior counsel; and while the former, during the war, made sometimes from L.15,000 to L.20,000 a year, the latter rarely received from his professional duties more than from L.1500 to L.2000 a year. 

5. *The Counsel of the Admiralty* is the law officer who is chiefly consulted on matters connected with the military duties of the lord high admiral; his salary is L.100 a year, besides his fees, which in time of war may be reckoned to amount to from L.1200 to L.1800 a year.

6. *The Solicitor to the Admiralty* is also an officer more immediately connected with the military functions of the admiralty. He is styled sometimes assistant to the counsel: his salary is L.1600 a year, in lieu of all fees, bills, and disbursements, with an allowance of L.1000 a year for an office and assistance of clerks.

7. *The Procurator.* The admiralty's proctor stands precisely in the same situation to the king's proctor that his advocate does to that of the king, though there is not quite so great a difference in their emoluments. They act as the attorneys or solicitors in all causes concerning the king's and the lord high admiral's affairs in the high court of admiralty and other courts. All prize causes are conducted by the king's proctor, which the captors are disposed to consider as a grievance, but which the gentlemen of Doctors' Commons, on the contrary, maintain to be for their convenience and advantage. It is supposed that in some years of the war the king's proctor did not receive less than L.20,000 a year.

8. *The Marshal.* This officer receives his appointment from the lord high admiral or lords commissioners of the admiralty, and holds his situation by patent under the seal of the high court of admiralty during pleasure. His duties are, to arrest ships and persons, to imprison in the Marshalsea, to bear the mace before the judge, and to attend executions. His emoluments depended chiefly on the number of prizes brought into port for condemnation, and the number of ships embargoed, and might probably be reckoned in time of war. *communibus annis*, from L.1500 to L.2000 a year, out of which he had to pay about L.400 a year to a deputy. The office can, however, be no longer performed by deputy, except in case of illness, § 9 of the 3d and 4th Vict., c. 66. He is now paid by a salary of L.500, besides his travelling expenses of attending the judge, which may be raised to L.800 in time of war.

*The Judge Advocate* of the fleet is a sinecure appointment, with a salary of L.182, 10s. a year, on the ordinary estimate of the navy; but the *Deputy Judge Advocate* resides at Portsmouth, and assists at all courts-martial held at that port, for which he is allowed an annual salary of L.146. See Navy. (J. B—W.)

*Admiralty Bay*, a spacious bay, with good anchorage, on the west coast of Cook's straits, in the southern island of New Zealand. Long. 174. 54. E. Lat. 40. 37. S.—There is a bay of the same name on the north-west coast of America, in Long. 140. 81. W. Lat. 59. 31. N.

*Admiralty Inlet*, the entrance to the supposed straits of Juan de Fuca, on the west coast of New Georgia, in Long. 124. 15. W. Lat. 48. 30. N. It was visited by Captain Vancouver in 1792, who found the soil on the shores rich and fertile, well watered, and clothed with luxuriant vegetation.

*Admiralty Island*, in Russian America, is about 90 miles in length from north to south, and 25 in breadth. Lat. 58. N. Long. 134. W.—See *Vancouver's Voyage*, vol. iii.

*Admiralty Islands* lie in about Long. 146. 44. E. and Lat. 2. 18. S. There are between 20 and 30 islands said to be scattered about here, the largest of which is about 60 miles in length. Captain Carteret, who first discovered them, was prevented from touching at them, although their

Admiralty || Adonia.

appearance was very inviting, on account of the condition of his ship, and his being entirely unprovided with the articles of barter which suit an Indian trade. He describes them as clothed with a beautiful verdure of woods, lofty and luxuriant, interspersed with spots that have been cleared for plantations, groves of cocoa-nut trees, and houses of the natives, who seem to be very numerous.

*Admiralty, Scotland.* At the Union, while the National functions of the lord high admiral were merged in the English office, there remained a separate court of admiralty, with subsidiary local courts, having civil and criminal jurisdictions in maritime questions. The separate courts were abolished in 1831, and their powers merged in the courts of session and justiciary, and the local courts.

ADMONITION, in *ecclesiastical affairs*, a part of discipline much used in the ancient church. It was the first act or step towards the punishment or expulsion of delinquents. In private offences it was performed, according to the evangelical rule, privately; in case of public offence, openly, before the church. If either of these sufficed for the recovery of the fallen person, all further proceedings in the way of censure ceased: if they did not, recourse was had to excommunication.

*Admonitio Fustium*, a military punishment among the Romans, not unlike our whipping, but performed with vine branches.

ADMORTIZATION, the settling of lands or tenements in mortmain.

ADNATA, in *Anatomy*, one of the coats of the eye, called also *albuginea*. See Anatomy.

Adnata is also used for any hair, wool, or the like, which grows upon animals or vegetables.

Adnata, or *Adnascentia*, among gardeners, denote those offsets which, by a new germination under the earth, proceed from the lily, narcissus, hyacinth, and other flowers, and afterwards become true roots.

ADOLESCENCE, the state of growing youth, or that period of a person's age commencing from his infancy and terminating at his full stature or manhood. The word is formed of the Latin *adolescere*, to grow. The state of adolescence lasts so long as the fibres continue to grow either in magnitude or firmness. The fibres being arrived at the degree of firmness and tension sufficient to sustain the parts, no longer yield or give way to the efforts of the nutritious matter to extend them; so that their further accretion is stopped, from the very law of their nutrition. Adolescence is commonly computed to be between 15 and 25, or even 30 years of age; though in different constitutions its terms are very different. The Romans usually reckoned it from 12 to 25 in boys, and to 21 in girls, &c. And yet, among their writers, *juvenis* and *adolescens* are frequently used indifferently for any person under 45 years.

ADONAI, one of the names of the Supreme Being in the Scriptures. The proper meaning of the word is *my lords* in the plural number, as *Adoni* is *my lord* in the singular. The Jews, who, either from reverence or superstition, do not pronounce the name of *Jehovah*, read *Adonai* in the room of it as often as they meet with Jehovah in the Hebrew text. But the ancient Jews were not so scrupulous; nor is there any law which forbids them to pronounce the name of God in a religious service.

ADONIA, in *Antiquity*, solemn feasts in honour of Venus, and in memory of her beloved Adonis. The Adonia were observed with great solemnity by the Greeks, Phœnicians, Lycians, Syrians, Egyptians, &c. From Syria they are supposed to have passed into India. The prophet Ezekiel[1] is understood to speak of them. They were still observed at Alexandria in the time of St Cyril, and at Antioch in that of Julian the Apostate, who happened to enter that city during the solemnity, which was taken for an ill omen. The Adonia lasted two days; on the first of which certain images of Venus and Adonis were carried, with all the pomp and ceremonies practised at funerals: the women wept, tore their hair, beat their breasts, &c. imitating the cries and lamentations of Venus for the death of her paramour. This lamentation they called Αδωνιασμος. The Syrians were not contented with weeping, but subjected themselves to severe discipline, shaved their heads, &c. The second day was spent in merriment and feasting. This festival was a symbol of the dying and revival of nature; hence Adonis is said to have spent a part of the year in the lower world, and part in the upper, with Aphrodite, who represented the fructifying principle. See Adonis.

[1] Ch. viii. 14.

Adonic || Adoptiani.

ADONIC VERSE, consists of a dactyle, and a spondee or trochee, as *rāră jŭvēntūs*, and is adapted to gay and sprightly poetry. It is seldom used alone, but construed with other kinds of verse. The adonic verse of the Anglo-Saxons consisted of one long, two short, and two long syllables.

ADONIJAH, fourth son of David king of Israel, put to death by his brother Solomon, for conspiring against the throne, 1 Kings i. ii. 13–25.

ADONIS, son of Cinyras, king of Cyprus, the favourite of Venus. Being killed by a wild boar in the Idalian woods, he was turned into a flower of a blood-colour, supposed to be the anemone. Venus was inconsolable; and no grief was ever more celebrated than this, most nations having perpetuated the memory of it by a train of anniversary ceremonies.[1] The text of the Vulgate, in Ezekiel viii. 14, says that this prophet saw women sitting in the temple and weeping for Adonis; but according to the reading of the Hebrew text, they are said to weep for Thammuz, or *the hidden one.* Among the Egyptians, Adonis was adored under the name of Osiris, the husband of Isis. But he was sometimes called by the name of Ammuz, or Thammuz, *the concealed*, to denote probably his death or burial. The Hebrews, in derision, call him sometimes *the dead*, Psal. cvi. 28. and Lev. xix. 28, because they wept for him, and represented him as one dead in his coffin; and at other times they call him the *image of jealousy*, Ezek. viii. 3, 5, because he was the object of the god Mars' jealousy. The Syrians, Phœnicians, and Cyprians, called him Adonis; and F. Calmet is of opinion that the Ammonites and Moabites gave him the name of Baal-peor.

[1] See Adonia.

Adonis, *Adonius*, in *Ancient Geography*, a river of Phœnicia, rising in Mount Lebanon, and falling into the sea, after a south-west course, at Byblus. When in flood, its waters exhibited a deep red tinge; hence the legend that connects the river with the wound of Adonis the minion of Venus. (*Vide Lucian.*)

> "While smooth Adonis from his native rock,
> Ran purple to the sea, suppos'd with blood
> Of Thammuz yearly wounded."—Milton.

Adonis, in *Botany*, *Bird's Eye*, or *Pheasant's Eye.*

ADONISTS, a sect or party among divines and critics, who maintain that the Hebrew points ordinarily annexed to the consonants of the word Jehovah are not the natural points belonging to that word, nor express the true pronounciation of it, but are the vowel points belonging to the words *Adonai* and *Elohim*, applied to the consonants of the ineffable name Jehovah, to warn the readers, that instead of the word Jehovah, which the Jews were forbidden to pronounce, and the true pronounciation of which had been long unknown to them, they are always to read *Adonai.* They are opposed to *Jehovists;* of whom the principal are Drusius, Capellus, Buxtorf, Alting, and Reland, who has published a collection of their writings on this subject.

ADOPTIANI, in *Church History*, a sect of ancient heretics, followers of Felix of Urgel and Elipand of Toledo, who, towards the end of the eighth century, advanced the notion that Jesus Christ in his human nature is the Son of God, not by nature, but by adoption.

ADOPTION, an act by which any one takes another into his family, owns him for his son, and appoints him for his heir.

The custom of adoption was very common among the ancient Greeks and Romans; yet it was not practised but for certain causes expressed in the laws, and with certain formalities usual in such cases. It was a sort of imitation of nature, intended for the comfort of those who had no children: wherefore, he that was to adopt was to have no children of his own, and to be past the age of getting any; nor were eunuchs allowed to adopt, as being under an actual impotency of begetting children: neither was it lawful for a young man to adopt an elder, because that would have been contrary to the order of nature; nay, it was even required that the person who adopted should be eighteen years older than his adopted son, that there might at least appear a probability of his being the natural father.

Among the Greeks it was called υἱοτης, *filiation.* It was allowed to such as had no issue of their own, excepting those who were not *κυριοι ἑαυτων, their own masters, e. g.* slaves, women, madmen, infants, or persons under twenty years of age; who being incapable of making wills, or managing their own estates, were not allowed to adopt heirs to them. Foreigners being incapable of inheriting at Athens, if any such were adopted, it was necessary first to make them free of the city. The ceremony of adoption being over, the adopted had his name enrolled in the tribe and ward of his new father; for which entry a peculiar time was allotted, viz. the festival *θαργηλια*. To prevent rash and inconsiderate adoptions, the Lacedemonians had a law, that adoptions should be transacted, or at least confirmed, in the presence of their kings. The children adopted were invested with all the privileges, and obliged to perform all the duties, of natural children. Being thus provided for in another family, they ceased to have any claim of inheritance or kindred in the family which they had left, unless they first renounced their adoption, which by the laws of Solon they were not allowed to do, unless they had first begotten children to bear the name of the person who had adopted them. This provided against the ruin of the families, which would otherwise have been extinguished by the desertion of those who had been adopted to preserve them. If the children adopted happened to die without children, the inheritance could not be alienated from the family into which they had been adopted, but returned to the relations of the adopter. It would seem that, by the Athenian law, a person, after having adopted another, was not allowed to marry without permission from the magistrate; and there are instances of persons who, being ill used by their adoptive children, petitioned for such leave. However this may be, it is certain that some men married after they had adopted sons; in which case, if they begat legitimate children, their estates were equally shared between the begotten and the adopted.

The Romans had two forms of adoption; the one before the prætor, the other at an assembly of the people, in the times of the commonwealth, and afterwards by a rescript from the emperor. In the former, the natural father addressed himself to the prætor, declaring that he emancipated his son, resigned all his authority over him, and consented that he should be translated into the family of the adopter. The latter was practised where the party to be adopted was already free; and this was called *adrogation.* The person adopted changed all his names, assuming the prename, name, and surname, of the person who adopted him.

Besides the formalities prescribed by the Roman law, various other methods have taken place, which have given denominations to different species of adoption among the Gothic nations, in different ages. Thus,



*Adoption by Arms* was when a prince made a present of arms to a person, in consideration of his merit and valour. The obligation here laid on the adoptive son was to protect and defend the father from injuries, affronts, &c. And hence, according to Selden, the ceremony of dubbing knights took its origin as well as name.

*Adoption by Baptism* is that spiritual affinity which is contracted by godfathers and godchildren in the ceremony of baptism. This kind of adoption was introduced into the Greek church, and came afterwards into use among the ancient Franks, as appears by the capitulars of Charlemagne.

*Adoption by Hair* was performed by cutting off the hair of a person, and giving it to the adoptive father. It was thus that Pope John VIII. adopted Boson, king of Arles, which perhaps is the only instance in history of adoption in the order of the ecclesiastics; a law that professes to imitate nature not daring to give children to those in whom it would be thought a crime to beget any.

*Adoption by Matrimony* is the taking of the children of a wife or husband by a former marriage into the condition of proper or natural children, and admitting them to inherit on the same footing with those of the present marriage.

*Adoption by Testament*, that performed by appointing a person heir by will, on condition of his assuming the name, arms, &c. of the adopter; of which kind we meet with several instances in the Roman history. Among the Turks, the ceremony of adoption is performed by obliging the person adopted to pass through the shirt of the adopter. Hence, among that people, to adopt is expressed by the phrase, *to draw another through my shirt.* It is said that something like this has also been observed among the Hebrews, where the prophet Elijah adopted Elisha for his son and successor, and communicated to him the gift of prophecy, by letting fall his cloak or mantle on him. But adoption, properly so called, does not appear to have been practised among the ancient Jews. Moses says nothing of it in his laws; and Jacob's adoption of his two grandsons, Ephraim and Manasseh, is not so properly an adoption as a kind of substitution, whereby those two sons of Joseph were allotted an equal portion in Israel with his own sons.

ADOPTIVE denotes a person or thing adopted by another. Adoptive children, among the Romans, were on the same footing with natural ones, and accordingly were either to be instituted heirs or expressly disinherited, otherwise the testament was null. The emperor Adrian preferred adoptive children to natural ones; because we choose the former, but are obliged to take the latter at random.—M. Menage has published a book of eloges or verses addressed to him, which he calls *Liber Adoptivus*, an adoptive book, and adds it to his other works. Heinsius, and Furstemberg of Munster, have likewise published adoptive books.—In ecclesiastical writers we find adoptive women or sisters (*adoptivæ fœminæ* or *sorores*) used for those handmaids of the ancient clergy, otherwise called *sub-introductæ.*

*Adoptive Arms* are those which a person enjoys by the gift or concession of another, and to which he was not otherwise entitled.—They stand contradistinguished from arms of alliance. We sometimes meet with adoptive *heir* by way of opposition to natural heir, and adoptive *gods* by way of contradistinction to domestic ones. The Romans, notwithstanding the number of their domestic, had their adoptive gods, taken chiefly from the Egyptians: such were Isis, Osiris, Anubis, Apis, Harpocrates, and Canopus.

ADORAIM, in Judah, one of the cities fortified by Rehoboam. It is called Adora in the *Apocrypha*, and by Josephus; since which time it was unknown, until its recent discovery by the American traveller, the Rev. Dr. Robinson, under the name of Dura. It is now a large village about five miles W.S.W. of Hebron, on the eastern slope of a cultivated hill.—*Biblical Researches.*

ADORATION, the act of rendering divine honours, or of addressing a being, as supposing it a god. The word is compounded of *ad*, to, and *os*, *oris*, mouth; and literally signifies to apply the hand to the mouth; *manum ad os admovere*, to kiss the hand; this being in the eastern countries one of the great marks of respect and submission.—The Romans practised adoration at sacrifices and other solemnities; in passing by temples, altars, groves, &c.; at the sight of statues, images, or the like, whether of stone or wood, wherein anything of divinity was supposed to reside. Usually there were images of the gods placed at the gates of cities, for those who went in or out to pay their respects to. The ceremony of adoration among the ancient Romans was thus:—The devotee, having his head *coverd*, applied his right hand to his lips, the fore-finger resting on his thumb, which was erect, and thus bowing his head, turned himself round from left to right. The kiss thus given was called *osculum labratum;* for ordinarily they were afraid to touch the images of their gods themselves with their profane lips. Sometimes, however, they would kiss their feet, or even knees, it being held an incivility to touch their mouths; so that the ceremony passed at some distance. Saturn, however, and Hercules, were adored with the head *bare;* whence the worship of the last was called *institutum peregrinum*, and *ritus Græcanicus*, as departing from the customary Roman method, which was to sacrifice and adore with the face veiled, and the clothes drawn up to the ears, to prevent any interruption in the ceremony by the sight of unlucky objects.—The Jewish manner of adoration was by prostration, bowing, and kneeling. The Christians adopted the Grecian rather than the Roman method, and adored always *uncovered*. The ordinary posture of the ancient Christians was kneeling, but on Sundays standing; and they had a peculiar regard to the east, to which point they ordinarily directed their prayers.

Adoration is also used for certain extraordinary *civil honours* or respects which resemble those paid to the Deity, yet are given to men.

The Persian manner of adoration, introduced by Cyrus, was by bending the knee and falling on the face at the prince's feet, striking the earth with the forehead, and kissing the ground. This ceremony, which the Greeks called προσκυνειν, Conon refused to perform to Artaxerxes, and Callisthenes to Alexander the Great, as reputing it impious and unlawful.

The adoration performed to the Roman and Grecian emperors consisted in bowing or kneeling at the prince's feet, laying hold of his purple robe, and presently withdrawing the hand and pressing it to the lips. Some attribute the origin of this practice to Constantius. It was only persons of some rank or dignity that were entitled to the honour. Bare kneeling before the emperor to deliver a petition was also called adoration.

The practice of adoration may be said still to subsist in England, in the ceremony of kissing the king or queen's hand, and in some other acts which are performed kneeling.

Adoration is also used among Roman writers for a high species of *applause* given to persons who had spoken or performed well in public. See Acclamation. We meet with adoration paid to orators, actors, musicians, &c. The method of expressing it was by rising, putting both hands to the mouth, and then returning them towards the person intended to be honoured.

Adoration is also used in the court of Rome for the ceremony of *kissing the pope's feet.* It is said of Diocletian, that he had gems fastened to his shoes that divine honours might be more willingly paid him, by kissing his feet. The like usage was afterwards adopted by the popes, and is observed to this day. These prelates, finding a vehement disposition in the people to fall down before them and kiss their feet, procured crucifixes to be fastened on their slippers; by which stratagem the adoration intended for the pope's person is supposed to be transferred to Christ.



Adoration is also used for a method of *electing a pope.* The election of popes is performed two ways; by *adoration* and by *scrutiny*. In election by adoration, the cardinals rush hastily, as if agitated by some spirit, to the adoration of some one among them to proclaim him pope. When the election is carried by scrutiny, they do not adore the new pope till he is placed on the altar.

*Barbarous Adoration* is a term used, in the laws of king Canute, for that performed after the manner of the heathens, who adored idols. The Romish church is charged with the adoration of saints, martyrs, images, crucifixes, relics, the virgin, and the host; all which by Protestants are generally aggravated into idolatry, on a supposition that the honour thus paid to them is absolute and supreme, called by way of distinction *Latria*, which is due only to God. The Roman Catholics, on the contrary, explain them as only a relative or subordinate worship, called *Dulia* and *Hyperdulia*, which terminates ultimately in God alone. But may not the same be said of the idol worship of the heathens? The Phœnicians adored the winds, on account of the terrible effects produced by them: the same was adopted by most of the other nations, Persians, Greeks, Romans, &c. The Persians chiefly paid their adorations to the sun and fire; some say also to rivers, the wind, &c. The motive of adoring the sun was the benefits they received from that glorious luminary, which of all creatures has doubtless the best pretensions to such homage.

ADOREA, in *Roman Antiquity*, a word used in different senses: sometimes for all manner of grain; sometimes for a kind of cakes made of fine flour, and offered in sacrifice; and finally, for a dole or distribution of corn, as a reward for some service; whence by metonymy it is put for praise or rewards in general.

ADORF, the chief town of a district of the same name in the circle of Zwickau in Saxony. In 1849 the town contained 2829 inhabitants, and the district 18,737, of whom 18,604 were Lutherans, and the rest Romanists. Its chief manufactures are cottons, woollens, and musical instruments.

ADOSCULATION, a term used by Dr Grew to imply a kind of impregnation without intromission; and in this manner he supposes the impregnation of plants is effected, by the falling of the farina fœcundans on the pistil.

ADOSSEE, in *Heraldry*, signifies two figures or bearings being placed back to back.

ADOUR, the name of a river of France, which rises in the mountains of Bigorre, in the department of the Upper Pyrenees, and running north by Tarbes through Gascony, afterwards turns west, and passing by Dax, falls into the Bay of Biscay below Bayonne.

ADOWA, the capital of Tigré in Abyssinia, is situate on the declivity of a hill, on the west side of a small plain, which is surrounded on every side by mountains. The name, signifying *pass* or *passage*, is characteristic of its situation; for the only road from the Red Sea to Gondar passes by Adowa. The town consists of 500 houses, is the residence of the governor, and has a manufactory of coarse cotton cloth, which circulates in Abyssinia as the medium of exchange in place of money. Long. 39. 5. E. Lat. 14. 7. N.

ADOXA, in *Botany*, Tuberous Moschatel, Hollow-root, or Inglorious.

ADRA, a seaport town of the province of Granada, in Spain, 47 miles south-east of Granada. In its vicinity are extensive lead mines. Population 9113.

ADRACHNE, in *Botany*, a species of the strawberry tree.

ADRAMMELECH, one of the gods of the inhabitants of Sepharvaim, who were settled in the country of Samaria in the room of those Israelites who were carried beyond the Euphrates. The Sepharvaites made their children pass through the fire in honour of this idol and another called *Anammelech*. It is supposed that Adrammelech meant the sun, and Anammelech the moon.

ADRAMYTTIUM, in *Ancient Geography*, now *Adramiti*, a town of Mysia, at the foot of Mount Ida, an Athenian colony, with a harbour and dock.

ADRASTEA, in *Mythology*, was the daughter of Jupiter and Necessity, and, according to Plutarch, the only fury who executed the vengeance of the gods. The name is derived from King Adrastus, who first erected a temple to that deity.

*Adrastea Certamina*, in *Antiquity*, a kind of Pythian games instituted by Adrastus, king of Argos, in the year of the world 2700, in honour of Apollo, at Sicyon. These are to be distinguished from the Pythian games celebrated at Delphi.

ADRASTUS, in *Ancient History*, king of Argos, son of Talaus and Lysianassa, daughter of Polybus, king of Sicyon, acquired great honour in the famous war of Thebes, in support of Polynices his son-in-law, who had been excluded from the sovereignty of Thebes by Eteocles his brother, notwithstanding their reciprocal agreement. Adrastus, followed by Polynices, and Tydeus his other son-in-law, by Capaneus and Hippomedon his sister's sons, by Amphiaraus his brother-in-law, and by Parthenopæus, marched against the city of Thebes; and this is the expedition of the *Seven Worthies*, which the poets have so often sung. They all lost their lives in this war except Adrastus, who was saved by his horse *Arion*. This war was revived ten years after by the sons of those deceased warriors, which was called the *war of the Epigones*, and ended with the taking of Thebes. None of them perished in this war except Ægialeus, the son of Adrastus; which afflicted him so much that he died of grief in Megara, as he was leading back his victorious army.

ADRAZZO. See Ajaccio.

ADRIA, a town of Lombardy, in the government of Venice, and delegation of Rovigo; situate between the rivers Po and Adige, in Lat. 45. 3. 22. N. Long. 12. 3. 40. E. This is a very ancient city, and was, at an early period, a seaport of such importance and celebrity as to give name to the sea on which it stood. It is said by some Greek writers to have been of Grecian origin; but the Roman writers, who are of much greater authority, agree in describing it as an Etruscan colony. Under the Romans it appears never to have been of much importance, and after the fall of the Western Empire it rapidly declined. The dykes which protected the surrounding country from inundation were neglected, and it became marshy and unhealthy. The mud and other deposits brought down by the waters of the Po and Adige, caused a gradual extension of the land into the Adriatic; so that Adria ceased to be a seaport, and is now 16 miles from the sea, on whose shores it formerly stood. By the draining of the neighbouring lands, the place has latterly been much improved, and has now begun to revive. It has a population of 10,400, and some trade in grain, cattle, fish, wine, and earthenware; is the seat of a bishopric; and has a museum of Greek and Roman antiquities. A little to the south of the present town, remains of the ancient city have been discovered at a considerable depth. They are all of Roman date, and include part of the ancient walls, ruins of a theatre, baths, and mosaic pavements.



ADRIAN, Publius Ælius. See Hadrian.

Adrian I. *Pope*, ascended the papal throne a. d. 772. He was the son of Theodore, a Roman nobleman, and possessed considerable talents for business. He maintained a steady attachment to Charlemagne, which provoked Desiderius, a king of the Lombards, to invade the state of Ravenna, and to threaten Rome itself. Charlemagne rewarded his attachment by marching with a great army to his aid; and having gained many considerable advantages over Desiderius, he visited the pope at Rome, and expressed his piety by the humiliating ceremony of kissing each of the steps as he ascended to the church of St Peter. The affairs of the church now claimed Adrian's particular attention; for Irene, who in 780 assumed the regency at Constantinople, during the minority of her son Constantine, wishing to restore the worship of images, applied to Adrian for his concurrence. The pontiff readily acquiesced in her proposal for calling a council, and commissioned two legates to attend it. The first council, however, was dispersed by an insurrection of the citizens; but at the next meeting in the city of Nice, in 787, which was protected by a military force, a decree was passed for restoring the worship of images. Adrian approved the decree, but in the western church it was deemed heretical and dangerous. Charlemagne condemned the innovation, and the French and English clergy concurred in opposing it. A treatise, containing 120 heads of refutation, was circulated as the work of Charlemagne, under the title of *The Caroline Books*, in opposition to the decree of the council. This work was presented to the pope by the king's ambassador, and the pope wrote a letter to Charlemagne by way of reply. The king, and also the Gallican and English churches, retained their sentiments; and in 794 a council was held at Frankfort-on-the-Maine, consisting of about 300 western bishops, by which every kind of image-worship was condemned. Adrian did not live to see a termination of this contest; for he died in 795, after a pontificate of nearly 24 years. Adrian seems to have directed his chief attention to the embellishment of the churches and the improvement of the city of Rome; and he was probably furnished by Charlemagne, out of the plunder of his conquests, with ample means for this purpose.

Adrian II. *Pope*, succeeded Nicholas I. a. d. 867. Having twice refused the dignity, he accepted it in the 76th year of his age, at the united request of the clergy, nobility, and people. The contest for power between the Greek and Latin churches had been very violent some years before his accession to the papal chair. Adrian, during this contest with the eastern patriarch, was extending his authority over the kings and princes of the west. He employed his whole interest to induce Charles the Bald, who had taken possession of the kingdom of Lorraine, and who had been crowned at Rheims by the archbishop Hincmar, to relinquish it in favour of the emperor; and he even sent legates to the king, after having attempted to engage Hincmar, the clergy, and the nobility, to desert him, ordering him to surrender to the emperor's right. The king was invincible; and the pope was obliged to give up the contest. He also further interfered in the concerns of princes, by taking Charles's rebellious son Carloman, and the younger Hincmar, bishop of Laon, under the protection of the Roman see. He proceeded in this business so far, that he was under the necessity of submitting without gaining his point. Death terminated his ambitious projects and his life of inquietude a. d. 872, after a pontificate of five years.

Adrian III. *Pope*, was a Roman by birth, and succeeded

Marinus, or Martin II. in 884. His virtue, zeal, and firmness, gave favourable presages of his future career; but he was cut off by death in the 13th month of his pontificate, during a journey to Worms, whither he was proceeding to hold a diet. He was at variance, like his predecessor, with the patriarch Photius, who rejected the doctrine that the Holy Ghost proceeds from the Father *and the Son.*

Adrian IV. *Pope*, the only Englishman who ever had the honour of sitting in the papal chair. His name was Nicholas Brekespere, and he was born at Langley, near St Albans, in Hertfordshire. His father having left his family and taken the habit of the monastery of St Albans, Nicholas was obliged to submit to the lowest offices in that house for daily support. After some time he desired to take the habit in that monastery, but was rejected by the abbot Richard. Upon this he resolved to try his fortune in another country, and accordingly went to Paris; where, though in very poor circumstances, he applied himself to his studies with great assiduity, and made a wonderful proficiency. But having still a strong inclination to a religious life, he left Paris and removed to Provence, where he became a regular clerk in the monastery of St Rufus. He was not immediately allowed to take the habit, but passed some time by way of trial, recommending himself to the monks by a strict attention to all their commands. This behaviour, together with the beauty of his person and prudent conversation, rendered him so acceptable to the monks, that after some time they entreated him to take the habit of the canonical order. Here he distinguished himself so much by his learning and strict observance of the monastic discipline, that upon the death of the abbot he was chosen superior of that house; and we are told that he rebuilt the convent. Pope Eugenius III. being apprised of the great merit of Nicholas, and thinking he might be serviceable to the church in a higher station, created him cardinal-bishop of Alba in 1146. In 1148 the Pope sent him as legate to Denmark and Norway, where, by his fervent preaching and diligent instructions, he converted those barbarous nations to the Christian faith, and erected Upsal into an archiepiscopal see. When he returned to Rome, he was received by the pope and cardinals with great marks of honour; and Pope Anastasius, who succeeded Eugenius, happening to die at this time, Nicholas was unanimously chosen to the holy see in November 1154, and assumed the name of *Adrian.* When the news of his promotion reached England, King Henry II. sent Robert, abbot of St Albans, and three bishops, to Rome, to congratulate him on his election; upon which occasion Adrian granted very considerable privileges to the monastery of St Albans, particularly an exemption from all episcopal jurisdiction, excepting to the see of Rome. In virtue of the pretensions of the Roman see in those days to dispose of kingdoms, Adrian, by a papal bull, conferred on Henry II. of England the sovereignty of Ireland; and that prince, stimulated by the success with which some of his own subjects had established themselves in that distracted country, eagerly closed with the pope's proposal to resign for this bull the long-contested point of lay investiture to ecclesiastical offices. The consequence of this agreement was the speedy reduction of Ireland, by a trifling force, to the crown of England. Adrian, in the beginning of his pontificate, boldly withstood the attempts of the Roman people to recover their ancient liberty under the consuls, and obliged those magistrates to abdicate their authority, and leave the government of the city to the pope. In 1155 he drove the heretic Arnold of Brescia, and his followers, out of Rome. The same year he excommunicated William, king of Sicily, who ravaged the territories of the church, and absolved that prince's subjects from their allegiance. About the same time Frederick, king of the Romans, having entered Italy with a powerful army, Adrian met him near Sutrium, and concluded a peace with him. At this interview Frederick consented to hold the pope's stirrup whilst he mounted on horseback. After this, his holiness conducted that prince to Rome, and in St Peter's church placed the imperial crown on his head, to the great mortification of the Roman people, who assembled in a tumultuous manner, and killed several of the imperialists. The next year a reconciliation was brought about between the pope and the Sicilian king, that prince taking an oath to do nothing further to the prejudice of the church, and Adrian granting him the title of *King of the Two Sicilies.* He built and fortified several castles, and left the papal dominions in a more flourishing condition than he found them. But notwithstanding all his success, he was extremely sensible of the disquietudes attending so high a station; and declared to his countryman, John of Salisbury, that all the former hardships of his life were mere amusement to the misfortunes of the popedom, that he looked upon St Peter's chair as the most uneasy seat in the world, and that his crown seemed to be clapped burning on his head.[1] He died September 1. 1159, in the fourth year and tenth month of his pontificate, and was buried in St Peter's church, near the tomb of his predecessor Eugenius. There are extant several letters and some homilies written by this pope.

[1] Baronii *Annales*, tom. xii. ann. 1154.

Adrian V. *Pope*, a Genoese, whose name was Ottoboni Fiesci, succeeded Innocent V. A. D. 1276. He was by his uncle Innocent IV. created cardinal-deacon of St Adrian, and in 1254 sent by him to England, to settle the disputes between Henry III. and his barons. He was employed again for the same purpose by Clement III., when he issued a sentence of excommunication against the king's enemies. When he was congratulated on his accession to the papal chair, he said, "I wish you had found me a healthy cardinal rather than a dying pope." After his election he went to Viterbo to meet the emperor Rodolphus, for the purpose of opposing the usurpation of Charles, king of the Two Sicilies; but died soon after his arrival, having enjoyed his dignity only 38 days. He zealously encouraged the crusade to the Holy Land, and upon his election sent a large sum to Constantinople towards building galleys.

Adrian VI. *Pope*, was born at Utrecht in 1459. His father was not able to maintain him at school, but he got a place at Louvain, in a college in which a certain number of scholars were maintained *gratis.* It is reported that he used to read in the night-time by the light of the lamps in the churches or streets. He made considerable progress in all the sciences, led an exemplary life, and there never was a man less intriguing or less forward than he. He took his degree of doctor of divinity at Louvain, was soon after made canon of St Peter's and professor of divinity at Utrecht, and then dean of St Peter's and vice-chancellor of the university. He was obliged to leave an academical life to be tutor to the archduke Charles. This young prince made no great progress under him: but never was a tutor more eminently rewarded; for it was by Charles V.'s interest that he was raised to the papal throne. Leo X. had given him the cardinal's hat in 1517. After this pope's death, several cabals in the conclave ended in the election of Adrian, with which the people of Rome were very much displeased. He would not change his name, and in every thing he showed a dislike to all ostentation and sensual pleasures, in marked contrast to the general temper of the times. He was very partial to Charles V., and did not enjoy much tranquillity under the triple crown. He lamented much the wicked morals of the clergy, and wished to establish a reformation of manners among them. He died September 14. 1523, it is said, by poison.

Adrian || Adrianople.

Adrian, *Cardinal*, an Italian of great learning and ability, was a native of Cornetto, in Tuscany, and studied at Rome. He was sent by Innocent VIII. as nuncio into England, where Henry VII. rewarded his services with the bishopric of Hereford, and afterwards with that of Bath and Wells; but he never resided in either of these dioceses. On his return to Rome, he became secretary to Pope Alexander VI., who employed him in various missions, and subsequently invested him with the purple. He narrowly escaped death on the day that Alexander VI. fell a victim to his own wickedness, in the plot which he had contrived, in concert with his son Cæsar Borgia, against Adrian and several other cardinals, in order to seize upon their possessions; but although Adrian likewise partook of the poison, he recovered. He then took refuge in the mountains of Trent, where he remained until the elevation of Leo X. to the papal chair; but, not long after, he was implicated in the conspiracy of cardinal Petrucci against that pontiff, and obliged a second time to fly from Rome. His subsequent history has not been ascertained; but it is generally supposed that he was murdered by a domestic, who coveted his wealth. Adrian was one of the first who restored the Latin tongue to its original purity. He wrote two good works,—*De Vera Philosophia*, a religious treatise, printed at Cologne in 1548; and *De Sermone Latino*, a learned work, published at Rome in 1515, in folio.

ADRIANI, Giambattista, was born of a patrician family of Florence in 1503. He wrote a history of his own times in Italian, which is a continuation of Guicciardini, beginning at the year 1536, and continued to 1574; to which Thuanus acknowledges himself greatly indebted: besides which, he composed six funeral orations on the Emperor Charles V. and other noble personages; and is thought to have been the author of a long letter on ancient painters and sculptors, prefixed to the third volume of Vasari. He died at Florence in 1579, at the age of seventy-six.

ADRIANISTS, in *Ecclesiastical History*, a sect of heretics, divided into two branches. The first were disciples of Simon Magus, and flourished about the year 34. Theodoret is the only person who has preserved their name and memory, but he gives us no account of their origin. Probably this sect, and the six others which sprung from the Simonians, took their name from the particular disciples of Simon. The second were the followers of Adrian Hamstead the anabaptist, and held some particular errors concerning Christ.

ADRIANOPLE (called by the Turks Edreneh), a city of European Turkey, in the province of Rumelia 137 miles W.N.W. of Constantinople; Lat. 41. 41. 26. N.; Long. 26. 35. 41. It is pleasantly situated partly on a hill and partly on the banks of the Tundja, near its confluence with the Maritza. Next to Constantinople, it is the most important city of the empire. The streets are narrow, crooked, and filthy; and its ancient citadel, with the walls which formerly surrounded the town, are now in ruins. Of its public buildings the most distinguished are the ancient palace of the sultans, now in a state of decay; the famous bazaar of Ali Pacha, appropriated to the warehousing and sale of various kinds of commodities; and the mosque of Sultan Selim II., a magnificent specimen of Turkish architecture, and ranked among the finest Mohammedan temples. It has numerous baths, caravanseries, and bazaars, and considerable manufactures of silk, leather, tapestry, woollens, linen, and cotton, and an active general trade. Its exports include raw silk, cotton, opium, rose-water, attar of roses, fruits, and agricultural produce. The city is supplied with fresh water by means of a noble aqueduct carried by arches over an extensive valley. There is also a fine stone bridge here over the Tundja. During winter and spring the Maritza is navigable up to the town, but Enos at the mouth of that river is properly its seaport, and formerly admitted large vessels; but owing to the carelessness of the Turks, a sand-bank has accumulated, so that now it is accessible only to vessels of comparatively small burden. The population is said to amount to 130,000, of whom about 30,000 are Greeks. Adrianople was called Uskadama previous to the time of the Emperor Hadrian, who improved and embellished the town, and changed its name to Hadrianopolis. Uskadama was the capital of the Bessi, a fierce and powerful Thracian people. In 1360 it was taken by the Turks, who, from 1366 till 1453, when they got possession of Constantinople, made it the seat of their government. In the campaign of 1829, so disastrous to the Turks, Adrianople surrendered on the 20th of August to the Russians, under Diebitsch, without making any resistance. It was restored after the treaty of peace, definitively signed on the 14th September 1829. For the terms of this treaty, so humiliating to the Porte, see Turkey.

Adriatic Sea || Adule.

ADRIATIC SEA, or Gulf of Venice, the *Adriaticum Mare* of the ancients, is an arm of the Mediterranean which separates Italy from Illyria, Croatia, Dalmatia, and Albania. It extends from N. Lat. 40. to 45. 50. in a N.W. direction. Its western or Italian coasts are generally low and deficient in harbours; but the eastern shores are steep, rocky, and abounding in creeks and inlets, forming numerous islands. The prevalence of sudden squalls from the N.E., and sometimes from the S.E., renders its navigation hazardous. Its ebbs and flows are inconsiderable, but more observable than in the Mediterranean generally; and its saltness is a little greater than that of the ocean. The Adriatic receives no considerable rivers, except the Po, Adige, and Narenta. Its chief emporia of trade are Venice, Trieste, and Ancona. The ancients seem to have originally applied the name of Adriaticum to that part of the sea which is in the vicinity of Adria, or to the northern part of the modern Adriatic; but in its extended signification it corresponded to the modern sea, and sometimes even included that part of the Mediterranean which lies between Sicily and Crete. There is no doubt that its name is derived from the town of Adria, which was situate on its coast, between the mouths of the Po and Adige, and not from Adria in Picenum as some writers have supposed.—See *Livy*, *Pliny*, *Strabo*, &c.

ADRIPALDA, a city in the province of Principato Ulteriore, in the kingdom of Naples. It is situate on the river Sabato, near Avellino. The number of inhabitants is 4236, who carry on trade in cloth and paper, in iron and copper goods, and make large quantities of nails.

ADROGATION, in *Roman Antiquities*, a species of adoption, whereby a person who was capable of choosing for himself was admitted by another into the relation of a son. The word is compounded of *ad*, to, and *rogare*, to ask, on account of a question put in the ceremony, Whether the adopter would take such a person for his son? and another to the adoptive, Whether he consented to become such a person's son?

ADSIDELÆ, in *Antiquity*, the tables at which the flamens sat during the sacrifices.

ADSTRICTION, among *Physicians*, a term used to denote the rigidity of any part.

ADULA, in *Ancient Geography*, a mountain in Rhætia, or the country of the Grisons, part of the Alps, in which are the fountains of the Rhine; now *St Gothard*.

ADULE, or Adulis, in *Ancient Geography*, a town of Æthiopia, built by fugitive slaves, distant from its port on the Red Sea 20 stadia. Pliny calls the inhabitants *Adulitæ*. The epithet is either *Adulitanus*, as *Monumentum Adulitanum*, on the pompous inscription of the statue of Ptolemy Euergetes, published by Leo Allatius at Rome in 1631, and to be found in Spon and Thevenot; or *Adulicus*, as *Adulicus Sinus*, a part of the Red Sea.

ADULLAM, an ancient city in the plain country of the tribe of Judah, and one of those fortified by Rehoboam. The "cave of Adullam," in which David took refuge when pressed by the Philistines, is believed not to have been near the city, but towards the Dead Sea, not far from Bethlehem.

ADULT, an appellation given to any thing that is arrived at maturity: thus, we say an adult person, an adult plant, &c. Among civilians, it denotes a youth between 14 and 25 years of age.

ADULTERATION, the act of debasing, by mixing with any pure and genuine commodity a spurious article, or an inferior one of the same kind, for pecuniary profit; but it may also occur accidentally, as, for instance, by the action of acids and oils on vessels of copper or lead in culinary and other operations. (See *Medical Jurisprudence*.) But few articles of commerce, comparatively, are exempt from fraudulent deterioration; and although the adulteration of exciseable commodities and of food are offences punishable by law, the risk too frequently is outweighed by the temptation of gain. In Paris, malpractices connected with the adulteration of food are investigated by the Conseil de Salubrité, and punished; but our laws are directed chiefly to the protection of such articles as affect the revenue. Adulterations of food, when wilful, have been made punishable by the laws of most countries. In Great Britain numerous acts have been passed for the prevention of adulterations: they are usually punished by a fine, determined by a summary process before a magistrate. In Turkey a culprit baker has his ears nailed to his door. By 5th and 6th Vict. c. 93, §§ 1, 3, 8, manufacturers of tobacco or snuff are liable to a penalty of L.200 for having in their possession any substance or liquid to be used, or capable of being used, as a substitute for tobacco or snuff, or to adulterate or give them weight. The preparer, vender, or disposer of such articles, is liable to the same. For actual adulteration the penalty is L.300, and for having such adulterated goods in possession, L.200. After a similar manner beer is protected by still heavier penalties; which laws extend to chemists, druggists, and beer retailers. See *56th Geo. III. c.* 58, *1st Will. IV. c.* 51, 64, *4th and 5th Will. IV. c.* 85. Tea, coffee, cocoa, pepper, &c. are protected by law, but the adulterations of these, as of most other articles of food, are almost endless. The mixture of chicory with coffee, is, however, authorized under certain conditions. A treasury minute of 27th July 1852 prohibiting the sale of "chicory or other vegetable substances mixed with coffee," was rescinded by a subsequent minute of 25th Feb. 1853, which permits dealers in coffee "to keep and sell chicory prepared and mixed with coffee, provided the packages in which such mixture is delivered to purchasers have printed distinctly thereon, according to directions which will be given by the Board of Inland Revenue, the whole of the following words, 'Mixture of Coffee and Chicory.'"

The following results were obtained by a recent series of analyses of some articles of common domestic consumption, purchased from different dealers, chiefly in the metropolis. In the several kinds of tea were found (partly, perhaps, accidentally present) exhausted tea-leaves, leaves of the beech, elm, horse-chestnut, plane, bastard-plane, fancy oak, willow, poplar, hawthorn, and sloe; catechu, rose-pink, blacklead, soapstone, sulphate of iron, logwood, indigo, starch, rice husks, excrement of silkworms, Prussian blue, sulphate of lime, verdegris, &c. Of 18 samples of chicory procured from manufactories, 5 were adulterated with roasted wheat-flour; and of 16 samples of chicory purchased from different grocers, several were coloured with Venetian red, or reddle. Of 68 samples of cocoa and chocolate, 39 contained coloured earthy substances; in some samples of cocoa, sugar and starch constituted more than half the article. Of 24 samples of bread, all contained more or less alum; and it may be observed that the quartern loaf, as delivered at houses by 13 different bakers, showed deficiency in weight, the maximum being between 3 and 4 ounces. Out of 30 samples of oatmeal, 16 were adulterated with barley-meal; in one instance, apparently, much more than one-half. Of 36 samples of arrowroot, 18 were mixed with potato-flour, or potato-starch, sago-powder, or tapioca-starch, &c.; and 5 were almost entirely potato-starch. Of 26 samples of milk, 11 were mixed with water, in proportions varying from 10 to 50 per cent. Of 28 samples purchased as isinglass, 10 consisted entirely of gelatine. (See *Lancet*, vol. i. 1851.) It is well known that quack medicines frequently contain ingredients they are guaranteed not to contain; hence the evils resulting from their indiscriminate use. Nor are woollen, linen, and silk goods, exempt from inferior admixture; various substances are employed to give body to silk fabrics; as in China a gluey preparation from the *Fucus Tenax* is used to give them weight and gloss. The above facts will give some idea of the extent to which adulteration is practised in the most common articles of consumption. We may add that all legislative enactments on the subject will prove ineffectual unless the public exercise their own discrimination, and dealers who are discovered to have imposed spurious commodities are made to feel that honesty is the best policy.

*Adulteration of Wines.* The various substances used in the manufacture to flavour and to colour wines (such as almonds, raisins, orris root, burnt sugar, brandy, logwood, whortleberries, elderberries, &c.), must be distinguished from others which are directly deleterious, such as alum, used to impart astringency, and litharge and ceruse, to dulcify "pricked" or sour wines. The following is an excellent test for any of the preparations of lead: mix an aqueous solution of tartaric acid with liquid sulphuretted hydrogen; when added to the suspected wine, should any copper or iron be present, they are kept in solution by the tartaric acid, while the lead is thrown down by the sulphuretted hydrogen as a dark precipitate. Red wine should be decolorized before using the test, which is conveniently done by mixing the wine with an equal weight of milk, and filtering it. When the tartrate of lead is found in the bottom of the cask, it may easily be detected by calcining a portion of the insoluble matter, and reducing it by the blowpipe on charcoal. A portion of the sediment may be digested with vinegar, which would give, by evaporation, acetate of lead; and it may be tried by sulphuretted hydrogen. Alum may be precipitated from white wine by carbonate of soda gradually added until no more falls down; filter; on the filter will be found alumine. The sulphate of potassa remains in the solution; but the quantity present may be found by precipitating the sulphuric acid by muriate of baryta. Iron is sometimes accidentally present in wines; but it is not dangerous, and may be detected by nutgalls. Copper sometimes occurs from the use of copper stopcocks: it is detected by the addition of ammonia; and, if much, by a plate of polished iron left some time in the wine. Arsenic has occasionally occurred from the sulphuring of the cask. After decoloration by animal charcoal, pass a stream of sulphuretted hydrogen through the wine, and a yellow precipitate will fall, which may be reduced to the metallic state by charcoal and soda. The same tests are applicable to all fermented liquors. —See *Henderson's Hist. of Ancient and Modern Wines.*

*Adulteration of Coin.* This has been accounted among all nations, both in ancient and modern times a very grave offence, and punishable by death in several ways. It was formerly considered as treason in Great Britain, and rigorously punished with death; but in the amelioration of our criminal code by Lord John Russell's act (Will. IV., c. 34, Vict. 1), the punishment has been commuted to transportation for any period not less than seven years, or by imprisonment for not more than four years, at the discretion of the judge.

The specific gravity of pure gold = 19·30; standard gold = 18·88; pure silver = 10·51; standard silver = 10·34. The proportion of alloy in the gold and silver coin of Britain is $\frac{1}{12}$ copper, which gives durability, A genuine coin, unless it be cracked, is quite sonorous; yet even this quality is not an invariable test for counterfeit money. Much false coin is in circulation, especially in the metropolis, a statement confirmed by its very frequent reception as change. Besides the frauds by clipping, filing, casing, electroplating, &c. the debasement of coin has been effected by boring the edge of a piece, and plugging the cavity with inferior metal: in this manner has platinum been inserted in gold. Another method has been practised by sawing a gold piece laterally, and skilfully filling the centre with platinum; a fraud which cutting alone could detect.

To ascertain the adulteration of silver and gold coin by excess of copper, the following processes will suffice: dissolve a given weight of the silver in nitric acid, and precipitate by a solution of common salt; dry, and weigh the precipitate, which is the *chloride of silver*, and contains 75·5 per cent. of the metal; or it may be reduced on charcoal before the blowpipe, when a button of pure silver will be obtained, by weighing which, the proportions of silver and of copper will be known. Silver coin is very frequently imitated by some white alloy, generally of tin, antimony, and lead: it may be known by its pliancy and dull appearance, or it may be tested for silver, as described above. German silver, a beautiful imitation of silver by nickel and copper, may be detected by its deficient specific gravity, and its emitting, when briskly rubbed, a faint, coppery odour; or by dissolving it in nitric acid, and adding a solution of common salt, when it will give no precipitate. The amount of alloy in gold may readily be ascertained, for ordinary purposes, by the *streak* on touchstone, and comparing that with the streak of the gold needles made for the purpose; or more nicely by this process; file off a given weight of the gold, and dissolve in *aqua regia*, then precipitate the gold by immersing in the solution a plate of silver or copper; or more quickly, by weak galvanic action; or the gold may be thrown down by addition of an alkaline solution, or by adding the muriate of tin, which throws down the purple powder of Cassius, from which the quantity of gold may be easily ascertained, by oxidating with the blowpipe a given weight of the powder, and so obtaining a button of pure gold.

The purity of copper is ascertained by dissolving a given weight in any of the mineral acids, and obtaining copper of cementation by immersing a plate of iron or zinc in the solution; or by decomposing the salt of copper by charcoal, alkali, and heat, in the usual way. See CHEMISTRY. It may be noticed as a curious fact, that the copper coinage of Will. IV. was found to contain gold, from which discovery these coins speedily became scarce.

ADULTERINE, in the *Civil Law*, is particularly applied to a child issued from an adulterous amour or commerce. Adulterine children are more odious than the illegitimate offspring of single persons. The Roman law even refuses them the title of natural children, as if nature disowned them, and the Canon law discouraged their admission to orders. Those are not deemed adulterine who are begotten of a woman openly married through ignorance of a former wife being alive. By a decree of the parliament of Paris, adulterine children are declared not legitimated by the subsequent marriage of the parties, even though a papal dispensation be had for such marriage, wherein is a clause of legitimation.



*ADULTERINE Marriages*, in St Augustine's sense, denote second marriages contracted after a divorce.

ADULTERY, an unlawful commerce between one married person and another, or between a married and unmarried person.

Punishments have been annexed to adultery in most ages and nations, though of different degrees of severity. In many it has been capital; in others venial, and attended only with slight pecuniary mulcts. Some of the penalties are serious, and even cruel; others of a jocose and humorous kind. Even contrary things have been enacted as punishments for adultery. By some laws the criminals are forbidden marrying together in case they become single; by others they are forbidden to marry any besides each other; by some they are incapacitated from ever committing the like crime again; by others they are glutted with it till it becomes nauseous.

Among the rich Greeks, adulterers were allowed to redeem themselves by a pecuniary fine; the woman's father, in such cases, returned the dower he had received from her husband, which some think was refunded by the adulterer. Another punishment was putting out the eyes of adulterers.

The Athenians had an extraordinary way of punishing adulterers, called αποραφανιδωσις και παρατιλμος, practised at least on the poorer sort who were not able to pay the fines. This was an awkward sort of empalement, performed by thrusting one of the largest radishes up the anus of the adulterer, or, in defect thereof, a fish with a large head, called *mugil*, mullet. One Alcæus is said to have died in this way, though it is doubted whether the punishment was reputed mortal. Juvenal and Catullus speak of this custom as received also among the Romans, though not authorized by an express law, as it was among the Greeks.

There are various conjectures concerning the ancient punishment of adultery among the Romans. Some will have it to have been made capital by a law of Romulus, and again by the twelve tables; others, that it was first made capital by Augustus; and others, not before the time of Constantine. The truth is, the punishment of it in early days was very various, much being left to the discretion of the husband and parents of the adulterous wife, who exercised it differently, rather with the acquiescence and countenance of the magistrate, than by any formal authority from him. Thus, we are told the wife's father was allowed to kill both parties, when caught in the fact, provided he did it immediately, killed both together, and as it were with one blow. The same power ordinarily was not indulged the husband, except the crime were committed with some mean or infamous person; though, in other cases, if his rage carried him to put them to death, he was not punished as a murderer. On many occasions, however, revenge was not carried so far; but mutilating, castrating, cutting off the ears, noses, &c. served the turn. The punishment allotted by the *lex Julia* was not, as many have imagined, death, but rather banishment or deportation, being interdicted fire and water, though Octavius appears in several instances to have gone beyond his own law, and to have put adulterers to death. Under Macrinus, many were burnt at a stake. Constantine first by law made the crime capital. Under Constantius and Constans, adulterers were burnt, or sewed in sacks and thrown into the sea. Under Leo and Marcian, the penalty was abated to perpetual banishment, or cutting off the nose. Under Justinian, a further mitigation was granted, at least in favour of the wife, who was only to be scourged, lose her dower, and be shut up in a monastery. After two years, the husband was at liberty to take her back again: or, if he refused, she was shaven, and made a nun for life. In the case of the husband the crime continued capital. The reason alleged for this difference was, that the woman is the weaker vessel. Matthæus declaims against the Empress Theodora, who is supposed to have been the cause of this law, as well as of others in favour of that sex by the emperor.

Under Theodosius, women convicted of this crime were punished after a very singular manner; being locked up in a narrow cell, and forced to admit to their embraces all the men that would offer themselves. This custom was abolished by the same prince.

By the Jewish law, adultery was punished with death in both parties, where they were both married, or only the woman. The Jews had a particular trial or ordeal for a woman suspected of the crime, by making her drink the bitter waters of jealousy; which were supposed, in the case of guilt, to cause the body to swell.

Amongst the Mingrelians, according to Chardin, adultery is punished with the forfeiture of a hog, which is usually eaten in good friendship between the paramour, the adulteress, and the husband. In some parts of the East, it is said any man's wife is permitted to prostitute herself to him who will give an elephant for the use of her; and it is reputed no small glory to her to have been rated so high. Adultery is said to be so frequent in Ceylon, that there is not a woman who does not practise it, notwithstanding its being punishable with death. Among the Japanese, and divers other nations, adultery is only penal in the woman. In the Marian islands, the woman is not punishable for adultery; but if the man go astray he pays severely; the wife and her relations waste his lands, turn him out of his house, &c.

In Spain they punished adultery in men by cutting off the instrument of the crime. In Poland, before Christianity was established, they punished adultery and fornication in a peculiar manner: they carried the criminal to the market-place, and there fastened him by the offending part with a nail, laying a razor within his reach, and leaving him under a necessity either of doing justice upon himself, or of perishing in that condition.

In England adultery by the ancient laws was severely punished. King Edmund the Saxon ordered it to be punished in the same manner as homicide; and Canute the Dane ordered that a man who committed adultery should be banished, and that the woman should have her nose and ears cut off. In the time of Henry I. it was punished with the loss of eyes and genitals.

In Britain adultery is now reckoned a spiritual offence, that is, cognizable by the spiritual courts, where it is punished by fine and penance. The common law takes no farther notice of it than to allow the party aggrieved an action and damages. This practice is often censured by foreigners, as making too light of a crime, the bad consequences of which, public as well as private, are so great. It has been answered, that perhaps this penalty, by civil action, joined with the ignominy attached to it, is more calculated to prevent the frequency of the offence, which ought to be the end of all laws, than a severer punishment.

Adultery is, both in England and Scotland, a ground of divorce. In England, a *complete* divorce or dissolution of the marriage can only be obtained through an act of parliament; but in Scotland, a complete divorce may be effected by proceedings in the Court of Session, as succeeding to the old commissary jurisdiction. The adulterous parties are by the law of Scotland prohibited from intermarrying. Fraser *on Personal and Domestic Relations*, vol. i. p. 82. See Divorce.

Adultery is used in Scripture for idolatry, or departing from the true God to the worship of a false one.

Adultery is used by ecclesiastical writers for a person's invading or intruding into a bishopric during the former bishop's life. The reason of the appellation is, that a bishop is supposed to contract a kind of spiritual marriage with his church. The translation of a bishop from one see to another was also reputed a species of adultery, on the supposition of its being a kind of second marriage, which in those days was esteemed a degree of adultery. This conclusion was founded on the text of St Paul, *Let a bishop be the husband of one wife;* by a forced construction of church for wife, and of bishop for husband.



Adultery is used by ancient naturalists for the act of ingrafting one plant upon another; in which sense Pliny speaks of the adulteries of trees, *arborum adulteria*, which he represents as contrary to nature, and a piece of luxury or needless refinement.

ADUNATI, ἀδυνατοι, those persons at Athens who from bodily defects or infirmity, were unable to support themselves, and had a maintenance from the state.

ADVANCED, in a general sense, denotes something posted or situated before another. Thus,

*Advanced Ditch*, in *Fortification*, is that which surrounds the glacis or esplanade of a place.

*Advanced Guard*, or *Vanguard*, in the art of war, the first line or division of an army, ranged or marching in the order of battle; or, it is that part which is next the enemy, and marches first towards them.

*Advanced Guard* is more particulary used for a small party of horse stationed before the main guard.

ADVENT, in the calendar, properly signifies the approach of the feast of the nativity. It includes four Sundays, and begins on St Andrew's day, or on the Sunday before or after it. During advent, and to the end of the octaves of epiphany, the solemnizing of marriage is forbidden without a special licence. It is intended to direct the thoughts of Christians to the first advent or coming of Christ in the flesh, and to his second advent or coming to judge the world. The primitive Christians practised great austerity during this season.

Ad ventrem inspiciendum, in *Law*, a writ by which a woman is to be searched whether she be with child by a former husband, on her withholding lands from the next, failing issue of her own body.

*Adventure Bay*, the name of a bay in Van Diemen's Land, so called by Captain Cook. Lat. 43. 20. S. Long. 147. 30. E.

ADVENTURER, in a general sense, denotes one who hazards something.

Adventurers is particularly used for an ancient company of merchants and traders, erected for the discovery of lands, territories, trades, &c. unknown. The society of adventurers had its rise in Burgundy, its first establishment from John duke of Brabant, in 1248, being known by the name of the *Brotherhood of St Thomas a Becket*. It was afterwards translated into England, and successively confirmed by Edwards III. and IV. Richard III. Henries IV. V. VI. and VII. who gave it the appellation of *Merchant Adventurers*.

ADVERB, in *Grammar*, a particle joined to a verb, adjective, or participle, to explain their manner of acting or suffering, or to mark some circumstance or quality signified by them. The word is formed from the preposition *ad*, to, and *verbum*, a verb; and signifies literally a word joined to a verb, to show how, when, or where, one is, does, or suffers; as, the boy paints *neatly*, writes *ill;* the house stands *there*, &c.

ADVERSARIA, among the ancients, a book of accounts not unlike our journals or day-books. It is also used as a title for books of miscellaneous remarks and observations.

ADVERSATIVE, in *Grammar*, a word expressing some difference between what goes before and what follows it.

Thus in the phrase, *he is an honest man, but a great enthusiast*, the word *but* is an adversative conjunction.

ADVERSITOR, in *Antiquity*, a servant who attended the rich in returning from supper, to give them notice of any obstacles in the way, which might cause them to stumble.

ADVERTISEMENT, in a general sense, denotes any information given to individuals or the public. In a commercial sense it refers to intimations of the sale of articles, and to other matters connected with trade, inserted in the newspapers.

To advertise advantageously requires both experience and judgment; without a knowledge of the character and circulation of the public journals, much expenditure may be wasted, by either advertising in papers that have a very limited circulation, or are generally read by persons to whom the intimation is inappropriate. The expense of advertising falls very heavily on particular commodities, especially, and very deservedly, on quack medicines, on some of which it has been said that if the vender has the courage to continue advertising to the extent of L.20,000, he will make his fortune by the worthless drug.

Advertising is also a very heavy burden on books, as it is absolutely necessary that notice of new publications should be circulated if they are to be sold: on small low priced books the expense is particularly heavy, one advertisement of a book which sells at two shillings costing as much as one of a work that sells at two guineas. From this, and their generally ephemeral character, it may be said that ninety-nine pamphlets out of a hundred are published at a loss.

The advertising of the last edition of the Encyclopædia Britannica, during its publication, cost above L.3000.

It is the profit derived from advertisements which supports the large number of newspapers (533) published in the United Kingdom. While some of these drag out a sickly existence, others of them yield a princely revenue from this source; the lowest price for an advertisement in a London daily newspaper being 5s. (for servants wanting places 4s.) The *Times*, whose daily circulation reaches nearly 40,000, had, on 1st February 1853 (which was a fair average number), 1086 advertisements, of which 125 were from servants wanting places, and 185 from masters wanting servants.

The duty upon advertisements is one of those which has been branded as a tax upon knowledge. It is certainly very unequal and oppressive, being the same upon that of the sale of an estate worth L.100,000, and that of a servant wanting a place; the same upon an advertisement of a sixpenny pamphlet and of the Encyclopædia Britannica.

Previous to 1833 the duty was, on each advertisement, 3s. 6d. in Great Britain, and 2s. 6d. in Ireland; in which year it was reduced to 1s. 6d. in Great Britain, and 1s. in Ireland. In 1832, the last year of the high duty, the total number of newspaper advertisements in the United Kingdom was 921,943: viz. 787,649 in England, 108,914 in Scotland, and 125,380 in Ireland; the amount of duty paid in that year was L.172,570. In 1841 the number of advertisements had increased to 1,778,957: viz. 1,386,625 for England, 188,189 for Scotland, and 204,143 for Ireland; and the total duty paid amounted to L.128,318. The amount of duty in 1851 had risen to L.175,094, 10s. 8d.; being for England, L.142,365, 3s. 6d.; Scotland, L.19,940, 11s.; Ireland, L.12,788, 16s. 2d.

It is now proposed to reduce the duty to 6d. for each advertisement; but it would be better that this obstacle to the circulation of information of much importance to the community were entirely removed. See NEWSPAPERS.

ADVICE, in *Commercial Language*, signifies information communicated, generally by letter, on matters of business; as between bankers and merchants.

ADVICE *Boat*, in *Nautical Affairs*, is a small vessel employed to convey despatches or information between places, corresponding to the *Naves Tabellariæ* of the Romans.—*Senecæ Epist.* 77.



ADVOCATE, a lawyer authorised to plead the causes of litigants in courts of law. The word is used technically in Scotland, and a derivative from the same Latin source is so used in most of the countries of Europe where the civil law is in force. In England, the word is used colloquially instead of barrister. The *advocatus* of the Romans meant, as the word implies, a person whose assistance was called in or invoked. The word is not often used among the earlier jurists, and appears not to have had a strict meaning. It is not always associated with legal proceedings, and might apparently be applied to a supporter or coadjutor in the pursuit of any desired object. When it came to be applied with a more specific limitation to legal services, the position of the *advocatus* was still uncertain. It was different from, and evidently inferior to, that of the *juris-consultus*, who gave his opinion and advice in questions of law, and may be identified with the consulting counsel of the present day. Nor is the merely professsional advocate to be confounded with the more distinguished *orator*, who came forward in the guise of the disinterested vindicator of justice. This distinction, however, appears to have arisen in later times, when the profession became mercenary. By the *lex Cincia*, passed about two centuries before Christ, and subsequently renewed, the acceptance of remuneration for professional assistance in law suits was prohibited. This law, like all others of the kind, was evaded. The skilful debater was propitiated with a present; and though he could not sue for the value of his services, it was ruled that any *honorarium* so given could not be demanded back, even though he died before the anticipated service was performed. The traces of this evasion of a law may be found in the existing practice of rewarding counsel by fees in anticipation of services. In the Justinian collection, we find that legal provisions had been made for the remuneration of advocates. (*Dig. Lib.* 50. *Tit.* 12 §, 10–13. *Brissonius de verb. Sig. Heineccius ad Pand. Lib.* III. *Tit.* I.) The *advocatus fisci*, or fiscal advocate, was an officer, whose function, like that of a solicitor of taxes at the present day, was connected with the collection of the revenue.

The term advocate is of frequent use in the chronicles, capitularies, chartularies, and other records of ecclesiastical matters, during the middle ages. Whoever wishes to have a key to the learning on this subject may consult Du Cange, who affords a profuse supply of references to original authorities. It appears that the term was applied in the primitive church to those who defended the Christians against malignants or persecutors. As the church waxed rich and powerful, its temporal supporters assumed a more important position. The advocate, defender, or patron, was of a temporal rank, corresponding to the power of the ecclesiastical body who sought his advocacy. Princes sought the distinction from Rome; and it was as a relic of the practice of propitiating temporal sovereigns by desiring their protection, that Henry VIII. received his title of *Defender of the Faith.* The office of advocate to any of the great religious houses, possessed of vast wealth, was one of dignity and emolument, generally held by some feudal lord of power and influence. This kind of protection, however, was sometimes oppressive. In the authorities quoted by Du Cange, we find that, so early as the twelfth century, the advocates were accused of rapine and extortion; and by a capitulary of the popedom of Innocent III., they are prohibited from taking and usurping rewards and privileges beyond use and wont. The office at length assumed a fixed character in its powers and emoluments; and it became the practice for the founders of churches and other ecclesiastical endowments to reserve the office of advocate to themselves and their representatives.

The term advocate was subsequently superseded by the word patron; but a relic of it still exists in the term *advowson*, and the word *advowee*, which is the form in which the Latin *advocatus* found its way into the technicalities of English law. The term advocate came afterwards to be applied in ecclesiastical, as in other matters, to those who gave their clients professional legal assistance.

In France, corporations or faculties of avocats were attached to the parliaments and other tribunals. They formed, before the revolution, a part of the extensive and powerful body commonly called the nobility of the robe. It was not necessary that the avocat should be born noble, and his professional rank was little respected by the hereditary aristocracy; but as a middle rank, possessed of great powers and privileges, which it jealously guarded, the profession acquired great influence. In the *Encyclopédie Methodique*, the avocat is called "the tutelary genius of the repose of families, the friend of man, his guide and protector." The avocats, as a body, were re-organised under the empire by a decree of 15th December 1810.

The Faculty of Advocates is the collective term by which the members of the bar are known in Scotland. They professionally attend the supreme courts in Edinburgh; but they are privileged to plead in any cause before the inferior courts, where counsel are not excluded by statute. They may act in cases of appeal before the House of Lords, and in some of the British colonies where the civil law is in force, it is customary for those who practise as barristers to pass as advocates in Scotland. This body has existed by immemorial custom. Its privileges are constitutional, and are founded on no statute or charter of incorporation. The body formed itself gradually, from time to time, on the model of the French corporations of avocats, appointing like them a Dean or doyen, who is their president and principal officer. No curriculum of study, residence, or professional training, is required on entering this profession; but the faculty have the power, believed to be liable to control by the Court of Session, of rejecting any candidate for admission. The candidate undergoes two private examinations; the one in Roman law, and the other, at the interval of a year, in Scottish law. He has then to undergo the old academic form of the public impugnment of theses on some title of the pandects; but this ceremony, called the public examination, has degenerated into a mere form. The fees of entrance are considerable, the greater part of them being devoted to the magnificent library belonging to the faculty, which literary investigators in Edinburgh find so eminently useful. The number of members is fluctuating; but for some years past (1852), it has been upwards of four hundred. (J. H. B.)

*Lord Advocate*, or *King's Advocate*, is the principal law-officer of the crown in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the crown. He is at the head of the system of public prosecutions by which criminal justice is administered in Scotland, and thus his functions are of a far more extensive character than those of the English law-officers of the crown. He is aided by a solicitor-general and subordinate assistants called advocates-depute. The office of king's advocate is not very ancient: it seems to have been established about the beginning of the sixteenth century. Originally he had no power to prosecute crimes without the concurrence of a private party; but, in the year 1597, he was empowered to prosecute crimes at his own instance. He has the privilege of pleading in court with his hat on.

ADVOCATION, in *Scottish Law*, a mode of appeal from certain inferior courts to the supreme court. The writ employed is called a *Note of Advocation.*

ADVOWEE. See ADVOCATE; ADVOWSON.



ADVOWSON, or ADVOWZEN, in *Common Law*, signifies a right to present to a vacant benefice. Advowson is so called because the right of presenting to the church was first gained by such as were founders, benefactors, or maintainers of the church. Though the nomination of fit persons to officiate in every diocese was originally in the bishop, yet they were content to let the founders of churches have the nomination of the persons to the churches so founded, reserving to themselves a right to judge of the fitness of the persons nominated.—Advowsons formerly were most of them appendant to manors, and the patrons were parochial barons. The lordship of the manor and patronage of the church were seldom in different hands, until advowsons were given to religious houses. But of late times the lordship of the manor and advowsons of the church have been divided.—Advowsons are *presentative, collative,* or *donative: presentative,* where the patron presents or offers his clerk to the bishop of the diocese, to be instituted in his church; *collative,* where the benefice is given by the bishop, as original patron thereof, or by means of a right he has acquired by lapse; *donative,* where the king or other patron does, by a single donation in writing, put the clerk into possession, without presentation, institution, or induction.

Sometimes, anciently, the patron had the sole nomination of the prelate, abbot, or prior, either by investiture (*i.e.* delivery of a pastoral staff) or by direct presentation to the diocesan; and if a free election was left to the brotherhood, yet a *congé d'élire*, or licence of election, was first to be obtained of the patron, and the person elected was confirmed by him. If the founder's family became extinct, the patronage of the convent went to the lord of the manor.—Advowsons are temporal inheritances and lay fees: they may be granted by deed or will, and are assets in the hands of heirs or executors. Presentations to advowsons for money or other reward are void. (31st Eliz. cap. 6.) In Scotland this right is called *patronage.*

ADY, a name that has been given to a species of palm which grows at St Thome, on the coast of Calabar. It is a tall tree, with a bare, upright stem, growing single on its root, of a thin light timber, and full of juice. The head of this tree shoots into a multitude of leaves, which on being cut off, or having an incision made in them, afford a great quantity of sweet juice; and this, when fermented, supplies the place of wine among the Indians. The fruit of this tree is called by the Portuguese *caryoces* and *cariosse*, and by the black natives *abanga.* This fruit is of the size and shape of a lemon, and contains a kernel, which is good to eat. The fruit itself is eaten roasted, and the raw kernels are often mixed with mandioc meal. These kernels are esteemed very cordial. An oil is also prepared from the fruit, which answers the purpose of butter. This oil is also used for anointing stiff and contracted parts of the body.

ADYNAMIA, in *Medicine* (α, privative, and δυναμις, *strength*), want of power, debility or weakness from sickness.

ADYNAMON, among *Ancient Physicians*, a kind of weak factitious wine, prepared from must boiled down with water, to be given to patients to whom genuine wine might be hurtful.

ADYTUM, in *Pagan Antiquity*, the most retired and sacred place of temples, into which none but the priests were allowed to enter. The *Sanctum Sanctorum* of the temple of Solomon was of the nature of the pagan adytum, none but the high-priest being admitted into it, and he but once a year.

ADZE, or ADDICE, a cutting tool of the axe kind, having its blade made thin and arching, and its edge at right angles to the handle; chiefly used for taking off thin chips of timber or boards, and for paring away certain irregularities which the axe cannot come at. The adze is used by carpenters, but more by coopers, as being convenient for cutting the hollow sides of boards, &c. It is ground from a base on its inside to its outer edge; so that, when it is blunt, they cannot conveniently grind it without taking its helve out of the eye.

AE, or Æ, a diphthong compounded of A and E. Authors are by no means agreed as to the use of the *æ* in English words. Some, out of regard to etymology, insist on its being retained in all words, particularly technical ones, borrowed from the Greek and Latin; while others, from a consideration that it is no proper diphthong in our language (its sound being no other than that of the simple *e*), contend that it ought to be entirely disused; and in fact the simple *e* has of late been adopted instead of the Roman *æ*, as in the word *equator*, &c.

ÆACEA, in *Grecian Antiquity*, solemn festivals and games celebrated at Ægina in honour of Æacus.

ÆACUS, the son of Jupiter by Ægina. When the isle of Ægina was depopulated by a plague, his father, in compassion to his grief, changed all the ants upon it into men and women, who were called *Myrmidones*, from μυρμηξ, *an ant*. The foundation of the fable is said to be, that when the country had been depopulated by pirates, who forced the few that remained to take shelter in caves, Æacus encouraged them to come out, and by commerce and industry to recover what they had lost. His character for justice was such, that, in a time of universal drought, he was nominated by the Delphic oracle to intercede for Greece, and his prayer was answered. See the article Ægina. The Pagans also imagined that Æacus, on account of his impartial justice, was chosen by Pluto one of the three judges of the dead; and that it was his province to judge the Europeans.

ÆCHMALOTARCHA (αιχμαλωτος and αρχος), a title given to the principal leader or governor of the Hebrew captives residing in Chaldea, Assyria, and the neighbouring countries. This magistrate was called by the Jews *rasch-galuth*, *i. e.* the chief of the captivity; but the above term, of like import in the Greek, is that used by Origen and others who wrote in the Greek tongue.

ÆDES, in *Roman Antiquity*, besides its more ordinary signification of a house, likewise signified an inferior kind of temple, consecrated to some deity.

ÆDICULA, a term used to denote the inner part of the temple, where the altar or statue of the deity stood.

ÆDILE (*ædilis*), in *Roman Antiquity*, a magistrate whose chief business was to superintend buildings of all kinds, but more especially public ones, as temples, aqueducts, bridges, &c. To the ædiles likewise belonged the care of the highways, public places, weights and measures, &c. They also fixed the prices of provisions, took cognizance of debauches, punished lewd women and such persons as frequented gaming-houses. The custody of the *plebiscita*, or decrees of the people, was likewise committed to them. They had the inspection of comedies and other pieces of wit; and were obliged to exhibit magnificent games to the people, at their own expense, whereby many of them were ruined. They had the power, on certain occasions, of issuing edicts, and by degrees they procured to themselves a considerable jurisdiction. All these functions, which rendered the ædiles so important, belonged at first to the ædiles of the people, *ædiles plebeii*, or *minores*. These were only two in number, and were first created in the same year as the tribunes, B.C. 494; for the tribunes, finding themselves oppressed with the multiplicity of affairs, demanded of the senate to have officers to whom they might intrust matters of less importance; and accordingly two ædiles were created; and hence it was that the ædiles were elected every year at the same assembly as the tribunes. But these plebeian ædiles having refused, on a signal occasion, to treat the people with shows, pleading that they were unable to support the expense, the patricians made an offer to do it, provided they would admit them to the honours of the *ædilate*. On this occasion there were two new ædiles created, of the number of the patricians, in the year of Rome 388. They were called *ædiles curules*, or *majores*, as having a right to sit on a curule chair, enriched with ivory, when they gave audience; whereas the plebeian ædiles only sat on benches. Besides that the curule ædiles shared all the ordinary functions with the plebeian, their chief employment was to procure the celebration of the grand Roman games, and to exhibit comedies, shows of gladiators, &c. to the people; and they were also appointed judges in all cases relating to the selling or exchanging of estates. To assist these first four ædiles, Cæsar (B.C. 45) created a new kind, called *ædiles cereales*, as being deputed chiefly to take care of the corn, which was called *donum Cereris;* for the heathens honoured Ceres as the goddess who presided over corn, and attributed to her the invention of agriculture. These ædiles cereales were also taken out of the order of patricians. In the municipal cities there were ædiles, and with the same authority as at Rome.



We also read of an *ædilis alimentarius*, expressed in abbreviature by *Ædil. alim.* whose business seems to have been to provide diet for those who were maintained at the public charge, though others assign him a different office. —In an ancient inscription we also meet with *ædile* of the camp, *ædilis castrorum.*

ÆDILITIUM Edictum, among the Romans, was that whereby a remedy was given to a buyer in case a vicious or unsound beast or slave was sold to him. It was called *ædilitium*, because the preventing of frauds in sales and contracts belonged especially to the curule ædiles.

ÆDITUUS, in *Roman Antiquity*, an officer belonging to the temple, who had the charge of the offerings, treasure, and sacred utensils. The female deities had a female officer of this kind called *Æditua.*

ÆGADES or Ægates, islands off the western coast of Sicily, between Trapani and Marsala, consisting of Maritimo, Levanso, and Favignana, which were of some note during the first Punic war.

ÆGAGROPILA, a ball composed of hair, generated in the stomach of the chamois goat, and very similar to those found in cows, hogs, &c. There is another species of ball found in some animals, particularly horses, which is a calculous concretion.

ÆGEAN SEA, in *Ancient Geography*, now the *Archipelago*, a part of the Mediterranean, bounded on the north by Thrace and Macedonia, on the west by Greece, and on the east by Asia Minor. The origin of the name is greatly disputed. Festus advances three opinions: one, that it is so called from the many islands therein appearing at a distance like so many goats; another, because Ægea, queen of the Amazons, perished in it; a third, because Ægeus, the father of Theseus, threw himself headlong into it. See Archipelago.

ÆGEUS, in *Fabulous History*, was king of Athens, and the father of Theseus. The Athenians having basely killed the son of Minos, king of Crete, for carrying away the prize from them, Minos made war upon them; and being victorious, imposed this severe condition on Ægeus, that he should annually send into Crete seven of the noblest of the Athenian youths, chosen by lot, to be devoured by the Minotaur. On the fourth year of this tribute, the choice fell on Theseus; or, as others say, he himself entreated to be sent. The king, at his son's departure, gave orders, that as the ship sailed with black sails, it should return with the same in case he perished; but, if he came back victorious, he should change them into white. When Theseus returned to Crete, after killing the Minotaur, and forgot to change the sails in token of his victory, according to the agreement with his father, the latter, who watched the return of the vessel, supposing by the black sails that his son was dead, cast himself headlong into the sea, which afterwards obtained the name of the *Ægean Sea*. The Athenians decreed Ægeus divine honours, and sacrificed to him as a marine deity and adopted son of Neptune.

ÆGIAS, among *Physicians*, a white speck on the pupil of the eye, which occasions a dimness of sight.

ÆGIDA, now *Capo d'Istria*, the principal town on the north of the territory of Istria, situate in a little island, joined to the land by a causeway. In an inscription it is called *Ægidis Insula*. Long. 13. 43. E. Lat. 45. 31. N. It was afterwards called *Justinopolis*, after the emperor Justinus II.

ÆGILOPS, the name of a tumour in the great angle of the eye, either with or without an inflammation. The word is compounded of αιξ, *goat*, and ωψ, *eye;* as goats are supposed to be extremely liable to this distemper. If the ægilops be accompanied with an inflammation, it is supposed to take its rise from the abundance of blood which a plethoric habit discharges on the corner of the eye. If it be without an inflammation, it is supposed to proceed from a viscous pituitous humour thrown upon this part. The method of cure is the same as that of the ophthalmia. But before it has reached the lachrymal passages, it is managed like other ulcers. If the ægilops be neglected, it bursts, and degenerates into a fistula, which eats into the bone.

ÆGIMURUS, in *Ancient Geography*, an island in the bay of Carthage, about 30 miles distant from that city, (Livy); now *Zowamour*. This island being afterwards sunk in the sea, two of its rocks remained above water, which were called *Aræ*, because the Romans and Carthaginians entered into an agreement or league to limit their respective boundaries by these rocks.

ÆGINA, in *Fabulous History*, the daughter of Asopus, king of Bœotia, was beloved by Jupiter, who ravished her in the similitude of a lambent flame, and then carried her from Epidaurus to a desert island called *Œnopia*, which afterwards obtained her own name.

ÆGINA, or EGINA, or ENGIA, an island in the Saronic gulf, 20 miles distant from the Piræus, formerly vying with Athens in naval power, and, at the sea-fight of Salamis, disputing the palm of victory with the Athenians. It was the country and kingdom of Æacus, who called it *Ægina*, from his mother's name, it being before called *Œnopia*. (Ovid.) The inhabitants were called *Æginetæ* and *Æginenses*.

Ægina is about 8 miles from N.W. to S.E., and about 6 in a transverse direction. Strabo states its periphery at 180 stadia, which would give a circumference of about 22½ English miles. Its western side consists of stony but yet fertile plains, which are well cultivated, and produce luxuriant crops of grain, with some cotton, vines, almonds, and figs. The rest of the island is mountainous: the southern end rises in the conical Mount Oros; and the Panhellenian ridge stretches to the north; from which fertile narrow valleys descend on either hand. From the absence of marshes, and its insularity, the climate is mild, and the most salubrious of Greece.

The ruins of the ancient Ægina extend along two small ports, still protected by well-built ancient moles, and the shores of an open bay, defended by an ancient breakwater, near the N.W. cape of the island. On the land side, the city-walls are still distinctly traceable, 10 feet in thickness, strengthened by towers at unequal distances, and pierced by three gates. They abutted on those of the ports, which were thus included within the line of fortifications; as at Athens and elsewhere in ancient Greece. Two elegant Doric columns and sub-structures are all that remain of the buildings noticed by Pausanias within the precincts of a city that was long the greatest and most opulent maritime power of Greece; but the ruins of seventeen Christian churches, still visible, prove that after the glories of the proud city had passed away,—after what it suffered from the jealousy of its rival, Athens, and from an earthquake about the beginning of our era,—a considerable modern town had occupied its site. Some of these may perhaps only date from the time that Ægina remained under its Venetian masters, as does a tower erected at the entrance of the largest port; but they resigned possession of the island to the Turks in 1715, under whom it became the prey of Mainote and other pirates; until the emancipation of Greece made it, in 1828-29, the seat of the Greek government. On a hill near the N.E. corner of the island, stands the modern little town of Ægina (as it is pronounced by the modern Greeks). It is separated by a ravine from the hill, on which rises in lonely majesty the ruins of the noble temple of *Jupiter Panhellenius*, occupying, at the extremity of the mountain ridge known by that name, the rocky summit of a hill, in the midst of a forest of pines. The temple was a ruin in the days of Cicero, as mentioned in one of his letters; and seems to have been thrown down by an earthquake at an unknown epoch. This temple is conspicuous from a distance, and was visited by Chandler in the last century; but has been chiefly known to us by the successful excavations of our countrymen Cockerell and Foster, assisted by Baron Haller, and M. Linckh of Stuttgard in 1811. These gentlemen united in clearing away the rubbish which the lapse of 2000 years had accumulated on the basement and floor of the cell; and after 20 days exertion they were rewarded by the discovery not only of many interesting details relating to Grecian architecture, but also of many statues in most wonderfully energetic action, that had once adorned the fallen pediments of this celebrated temple. These consist of the 11 figures of the eastern, and 5 statues of the western pediment, almost entire; besides fragments of the rest, and two statuettes, and other ornaments of the acroteria. These sculptures supply an important link in the history of ancient art, and connect the schools of early Greece with that of Etruscan sculpture. The efforts of Messrs Cockerell and Foster to secure those treasures to their country are well known; and how they were defeated by the unlucky mistake of the agent sent out to purchase them for the British Museum. They now form one of the most interesting acquisitions of the magnificent *Glyptothek* of Munich.

The temple stands on a stylobate of 94 feet by 45 feet. The original number of columns in the peristyle was 32, of which 12 were ranged on each side, and six in each front; 17 feet 2 inches high, including the wide-spreading ovolo of the capital, and a diameter of 3 feet 3 inches at the base. Two other columns of 3 feet 2 inches between antæ, are in the pronaos, and two similar in the opisthodomos or *posticum*. The cella had a door at each end; a double row of smaller columns 2 feet 4 inches in diameter, were within the cella to support its partial roof; but the greatest portion of the cella was open, as this temple was *hypæthral*. There still remain 21 columns of the peristyle with their architraves; six of the eastern front, and continuously with them are five columns of the north side; the four columns of the pronaos and opisthodomos; and the lower part of the shafts of five within the cella. The tympana had been painted of a bright azure to give relief to the statues, and the drapery of Minerva, the middle figure of each group, had been painted red and blue. The whole of the ornaments on the cornices and upper mouldings of the pediment had been painted in *encaustic*, not carved.

The subject of the groups of statuary appears to be the contest for the body of Patroclus, one of the *Æacidæ* (or royal progeny of Ægina of old) as described by Horner.—*Cockerell on the Ægina Marbles. Brand's Journal.*

This magnificent structure undoubtedly belongs to the brilliant period of Æginetan power, when its navy and its commerce were the pride of Greece, and carried its citizens to the remotest shores of the Mediterranean and the Euxine. Money was struck at Ægina long before it was fabricated even at Athens. The victory of Salamis was mainly owing to the 30 ships of Ægina, and the voice of grateful Greece assigned to her warriors on that eventful day the prize of valour. Yet not long after, the rivalry of Athens began to cloud the prosperity of the haughty islanders, whose fleet she had before defeated; and Ægina at length sunk under the enmity of a relentless commercial rival, that banished her citizens, and supplied their place with Attic colonists. (T. S. T.)

ÆGINETA, PAULUS, a celebrated surgeon of the island of Ægina, from whence he derived his name. According to M. le Clerc's calculation, he lived in the fourth century; but Abulfaragius the Arabian, who is allowed to give the best account of those times, places him with more probability in the seventh. His knowledge in surgery was very great, and his works are deservedly famous. Fabricius ab Aquapendente has thought fit to transcribe him in a great variety of places. Indeed, the doctrine of Paulus Ægineta, together with that of Celsus and Albucasis, make up the whole text of this author. He is the first writer who takes notice of the cathartic quality of rhubarb; and, according to Dr Milward, is the first in all antiquity who deserves the title of accoucheur.

ÆGINETARUM FERIÆ, a festival in honour of Neptune, originally instituted at Ægina after the Trojan war, when those families whose friends returned in safety dismissed their attendants, and held their rejoicings in private, out of respect to such as mourned.—Plutarch, *Quæst. Græc.* 44.

ÆGINHARD, the celebrated secretary and supposed son-in-law of Charlemagne. He is said to have been carried through the snow on the shoulders of Imma, to prevent his being traced from her apartments by the emperor her father; a story which the elegant pen of Addison has copied and embellished in the third volume of the Spectator. There is a letter of Æginhard's still extant, lamenting the death of his wife, written in the tenderest strain of connubial affection: but it does not say that this lamented lady was the princess; and indeed some critics have supposed that Imma was not the daughter of Charlemagne. He was a native of Germany, and educated by the munificence of his imperial master, of which he has left the most grateful testimony in his preface to the life of that monarch. Æginhard, after the loss of his wife, is supposed to have passed the remainder of his days in religious retirement, and to have died soon after the year 840. His life of Charlemagne, his annals from 741 to 889, and his letters, are all inserted in the 2d volume of Duchesne's *Scriptores Francorum.* An improved edition of this valuable historian, with the annotations of Hermann Schmincke, in 4to, was published in 1711.

ÆGIPHILA, in *Botany*, GOAT-FRIEND.

ÆGIS, in *Ancient Mythology*, a name given to the shield or buckler of Jupiter and Pallas. The goat Amalthæa, which had suckled Jove, being dead, that god is said to have covered his buckler with the skin; whence the appellation *ægis*, from αιξ, αιγος, *she-goat.* Jupiter afterwards restored the animal to life, covered it with a new skin, and placed it among the stars. He made a present of his buckler to Minerva; whence that goddess's buckler is also called *ægis.* Perseus, having killed Medusa, Minerva nailed her head in the middle of the ægis, which thenceforth had the faculty of converting into stone all those who looked upon it; as Medusa herself had during her life. Others suppose the ægis not to have been a buckler, but a cuirass or breastplate; and it is certain that the ægis of Pallas, described by Virgil, *Æn.* lib. viii. v. 435, must have been a cuirass, since that poet says expressly that Medusa's head was on the breast of the goddess. But the ægis of Jupiter, mentioned a little higher, v. 354, seems to have been a buckler. The words—

> ......Cum sæpe nigrantem
> *Ægida* concuteret dextra,

are descriptive of a buckler, but not at all of a cuirass or breastplate. Servius makes the same distinction on the two passages of Virgil; for on verse 354 he takes the ægis for the buckler of Jupiter, made, as above mentioned, of the skin of the goat Amalthæa; and on verse 435 he describes the ægis as the armour which covers the breast, and which in speaking of men is called *cuirass*, and *ægis* in speaking of the gods. Many authors have overlooked these distinctions for want of going to the sources.

ÆGISTHUS, in *Ancient History*, was the son of Thyestes by his own daughter Pelopea, who, to conceal her shame, exposed him in the woods. Some say he was taken up by a shepherd, and suckled by a goat; whence he was called *Ægisthus.* He seduced Clytemnestra, the wife of Agamemnon, and lived with her during the siege of Troy. Afterwards, with her assistance, he slew her husband, and reigned seven years in Mycenæ. He was slain, together with Clytemnestra, by Orestes. Pompey used to call Julius Cæsar *Ægisthus*, on account of his having seduced his wife Mutia, whom he afterwards put away, though he had three children by her.

ÆGIUM, in *Ancient Geography*, a town of Achaia Propria, five miles from the place where Helice stood, and famous for the council of the Achæans, which usually met there, on account probably of the commodious situation of the place.

ÆGOBOLIUM, in *Antiquity*, the sacrifice of a goat offered to Cybele. The ægobolium was an expiatory sacrifice, which bore a near resemblance to the taurobolium and criobolium, and seems to have been sometimes joined with them.

ÆGOPODIUM, in *Botany*, SMALL WILD ANGELICA, GOATWORT, GOATSFOOT.

ÆGOSPOTAMOS, in *Ancient Geography*, a river in the Thracian Chersonesus, falling with a south-east course into the Hellespont, to the north of Sestos; with a town, and a station or road for ships, at its mouth. Here the Athenians under Conon, through the fault of his colleague Philocles, received a signal overthrow from the Lacedemonians under Lysander (B.C. 405), which was followed by the taking of Athens, and put an end to the Peloponnesian war.

ÆGYPTUS, in *Fabulous History*, was the son of Belus, and brother of Danaus.

AEINAUTÆ, in *Antiquity*, αειναυται, *always mariners*, a denomination given to the senators of Miletus, because they held their deliberations on board a ship, and never returned to land till matters had been agreed on.

ÆLFRIC, an eminent ecclesiastic of the tenth century, was the son of an earl of Kent, and a monk of the Benedictine order in the monastery of Abingdon. In 993 he was settled in the cathedral of Winchester, under Athelwold the bishop, and undertook the instruction of the youth of the diocese; for which purpose he compiled a Latin-Saxon vocabulary, and some Latin colloquies. He also translated from the Latin into Saxon many of the historical books of the Old Testament. While he resided at Winchester he drew up Canons, which are a kind of charge to be delivered by the bishops to their clergy. He was afterwards abbot of St Albans, then bishop of Wilton, and finally, in 1022, was translated to the see of York. Here he had a hard struggle for some years in bravely defending his diocese against the incursions of the Danes. Ælfric is held up as one of the most distinguished prelates of the Saxon church. His learning for the times, was considerable, his morals pure, and his religious sentiments untainted with many of the corruptions of his age. Besides the works already mentioned, he translated two volumes of Homilies from the Latin Fathers. He was born in 964, and died in 1050.—*Allan's York.*

ÆLIA CAPITOLINA, a name given to the city built by the emperor Hadrian, A.D. 134, near the spot where the ancient Jerusalem stood, which he found in ruins when he visited the eastern parts of the Roman empire. A Roman colony was settled here, and a temple, in place of that of Jerusalem, was dedicated to Jupiter Capitolinus. Hence the name, to which he prefixed that of his own family.

ÆLIANUS, CLAUDIUS, born at Præneste, in Italy. He taught rhetoric at Rome, according to Perizonius, under the Emperor Alexander Severus. He was surnamed Μελιγλωσσος, *Honey-tongued*, on account of the sweetness of his style in his discourses and writings. He was likewise honoured with the title of *Sophist*, an appellation in his days given only to men of learning and wisdom. He loved retirement, and devoted himself to study. He greatly admired and studied Plato, Aristotle, Isocrates, Plutarch, Homer, Anacreon, Archilochus, &c. and, though a Roman, gives the preference to the writers of the Greek nation. His curious and entertaining work entitled *Variæ Historiæ* has been frequently republished, as well as his treatise *De Natura Animalium.* A very useful edition of the latter was published by Schneider, at Leipsic, in 1784, in 8vo; another at Jena, in 1832, by Fr. Jacobs. The collated edition of his works, by Gesner, 1556, fol., contains his *Epistolæ Rusticæ.*

ÆLIANUS, *Tacticus*, a Greek writer on military tactics, in the reign of the Emperor Hadrian.

AELTERE, a town with 6383 inhabitants, in the arrondissement of Ghent, and province of East Flanders.

ÆLURUS, the Latinised Greek name of the cat deity of Egypt; represented sometimes like a cat, and sometimes as a human body with a cat's head. The Egyptians had so superstitious a regard for this animal, that the killing of it, whether by accident or design, was punished with death; and Diodorus relates, that, in a time of famine, they chose rather to eat one another than touch these sacred animals. The cat was sacred to the goddess Pasht or Bubastis.

ÆMILIUS L. PAULLUS, son of that L. Paullus Æmilius who was killed at the battle of Cannæ. He was twice consul. In his first consulate he triumphed over the Ligurians, and in the second subdued Perseus, king of Macedonia, and reduced that country to a Roman province, for which he obtained the surname of Macedonicus. He died B.C. 160, at the age of seventy.

ÆMILIUS, *Paulus*, or *Paolo Emilio*, a celebrated historian, born at Verona, who obtained such reputation in Italy, that he was invited into France by the cardinal of Bourbon, in the reign of Louis XII., in order to write the history of the kings of France in Latin, and was presented to a canonry in the cathedral of Paris. He died at Paris on the 5th of May 1529. His work entitled *De Rebus gestis Francorum* was translated into French by Renard in 1581, and has also been translated into Italian and German.

ÆMOBOLIUM, in *Antiquity*, the blood of a bull or ram offered in the sacrifices, called *taurobolia* and *criobolia;* in which sense the word occurs in ancient inscriptions.

ÆNEAS, in *Fabulous History*, a Trojan prince, the son of Venus and Anchises. He plays a conspicuous part in the Iliad, and is represented, along with Hector, as the chief bulwark of the Trojans. Virgil has chosen him as the hero of his great epic, and the story of the Æneid, though not only at variance with other traditions, but inconsistent with itself, can never lose its place as a biography of the mythical founder of the Latin power. Æneas is described in the Æneid as escaping from the destruction of Troy, bearing his aged father on his shoulders, carrying in one hand his household gods, while with the other he leads his little son Ascanius or Iülus. His wife Crëusa is separated from them and lost in the tumult. After a perilous voyage he lands in Africa, and is kindly received by Dido, queen of Carthage; who, on his forsaking her to seek a new home, destroys herself. Again escaping the dangers of the sea, he arrives in Italy, where he forms an alliance with Latinus, a prince of the country, marries his daughter Lavinia, and founds a city which he calls after her, Lavinium. Turnus, king of the Rutuli, a rejected suitor of Lavinia, makes war on Latinus, and both are slain in battle. Æneas assumes the sovereignty of Latium, and the Trojan and Latin powers are united in one nation. After a reign of three years, Æneas falls in a battle with the Rutuli, assisted by Mezentius, king of Etruria, and is carried up into heaven.



ÆNEAS SYLVIUS, *Pope.* See PIUS II.

ÆNEID, the name of Virgil's epic poem, in celebration of the settlement of Æneas in Italy. See VIRGIL.

ÆNIGMA denotes any dark saying, wherein some well-known thing is concealed under obscure language. The word is Greek, Αινιγμα, from αινιττεσθαι, *obscure innuere*, to hint a thing darkly (αινος, a tale, saying, or proverb). The popular name is *riddle;* from the Belgic *raeden*, or the Saxon *araethan*, to interpret.

*Painted ÆNIGMAS* are representations of the works of nature or art, concealed under human figures, drawn from history or fable.

*A Verbal ÆNIGMA* is a witty, artful, and abstruse description of any thing. In a general sense, every dark saying, every difficult question, every parable, may pass for an ænigma. Hence obscure laws are called *ænigmata juris.* The alchemists are great dealers in the ænigmatic language, their processes for the philosopher's stone being generally wrapt up in riddles: *e. g. Fac ex mare et fœmina circulum, inde quadrangulum, hinc triangulum, fac circulum, et habebis lapidem philosophorum.*

ÆNITHOLOGIUS, in *Poetry*, a verse of two dactyls and three trochæi; as *Prælia dira placent truci juventæ.*

ÆOLIÆ INSULÆ, now *Isole di Lipari*, in *Ancient Geography*, seven islands situate between Sicily and Italy; so called from Æolus, the god of the winds, who was supposed to have ruled there. The Greeks call them *Hephæstiades;* and the Romans *Vulcaniæ*, from their fiery eruptions. They are also called *Liparæorum Insulæ*, from their principal island Lipari. Dionysius Periegetes calls them Πλωται, because circumnavigable.

ÆOLIAN HARP, a musical instrument consisting of catgut strings stretched over a wooden sound-box. When exposed to a current of air, the strings produce a variety of pleasing harmonic sounds in wild succession and combination. See MUSIC.

ÆOLIC, in a general sense, denotes something belonging to Æolis.

ÆOLIC, or ÆOLIAN, in *Grammar*, denotes one of the five dialects of the Greek tongue. It was first used in Bœotia, whence it passed into Æolia, and was that in which Sappho and Alcæus wrote. The Æolic dialect generally throws out the aspirate or sharp spirit, and agrees in so many things with the DORIC dialect, that the two are usually confounded.

The *Æolic digamma* is a name given to the letter F, which the Æolians used to prefix to words beginning with vowels, as Fοινος for οινος; also to insert between vowels, as οFις for οις.

*ÆOLIC Verse*, in *Prosody*, a verse consisting of an iambus or spondee; then of two anapæsts, separated by a long syllable; and, lastly, of another syllable: such as, *O stelliferi conditor orbis.* It is also called *eulogic* verse; and, from the chief poets who used it, *Archilochian* and *Pindaric.*

ÆOLIPILE, in *Hydraulics*, is a hollow ball of metal, generally used in courses of experimental philosophy, in order to demonstrate the possibility of converting water into an elastic steam or vapour by heat. The instrument, therefore, consists of a slender neck or pipe, having a narrow orifice inserted into the ball by means of a shouldered screw. This pipe being taken out, the ball is filled almost full of water and the pipe being again screwed in, the ball is placed on a pan of kindled charcoal, where it is well heated, and there issues from the orifice a vapour, with prodigious violence and great noise, which continues till all the included water is discharged. The stronger the fire is, the more elastic and violent will be the steam; but care must be taken that the small orifice of the pipe be not by any accident stopped up, because the instrument would in that case infallibly burst in pieces, with dangerous violence. Another way of introducing the water is to heat the ball red-hot when empty, which will drive out almost all the air; and then, by suddenly immersing it in water, the pressure of the atmosphere will force in the fluid, till it is nearly full. Descartes and others have used this instrument to account for the natural cause and generation of the wind: and hence it was called *Œolipila:* q. d. *pila Æoli*, the ball of Æolus.

ÆOLIS, or ÆOLIA, in *Ancient Geography*, a country of Asia Minor, settled by colonies of Æolian Greeks. Taken widely, it comprehends all Troas and the coast of the Hellespont to the Propontis, because in those parts there were several Æolian colonies. In a more limited sense it is applied to the district between Troas to the N. and Ionia to the S.

ÆOLUS, in *Heathen Mythology*, the god of the winds, was said to be the son of Jupiter by Acasta or Sigesia, the daughter of Hippotas; or, according to others, the son of Hippotas by Meneclea, daughter of Hyllus, king of Lipara. He dwelt in the island now called Stromboli, one of the Æolian islands. Others place his residence at Rhegium, in Italy; and others, again, in the island Lipara. He is represented as having authority over the winds, which he held enchained in a vast cavern. Strabo, and some other writers, consider him to have had a real existence; and derive the fable of his power over the winds, from his skill in meteorology and the management of ships.

> Hîc vasto rex Æolus antro,
> Luctantis ventos tempestatesque sonoras
> Imperio premit, ac vinclis et carcere frenat.
> Illi indignantes magno cum murmure montis
> Circum claustra fremunt; celsâ sedet Æolus arce
> Sceptra tenens, mollitque animos, et temperat iras:
> Ni faciat, maria ac terras cœlumque profundum
> Quippe ferant rapidi secum, verrantque per auras.
>
> ÆNEID, *Lib.* i. 52.

ÆON, a Greek word, properly signifying the age or duration of any thing.

ÆON, among the followers of Plato, was used to signify any virtue, attribute, or perfection: hence they represented the deity as an assemblage of all possible æons, and called him *pleroma*, a Greek term signifying *fulness.* The Valentinians, who, in the first ages of the church, blended the conceits of the Jewish cabalists, the Platonists, and the Chaldean philosophers, with the simplicity of the Christian doctrine, invented a kind of Theogony, or Genealogy of Gods (not unlike that of Hesiod), whom they called by several glorious names, and all by the general appellation of ÆONS: among which they reckoned Ζωη, *life;* Λογος, *word;* Μονογονης, *only-begotten;* Πληρωμα, *fulness;* and many other divine powers and emanations, amounting in number to thirty; which they fancied to be successively derived from one another, and all from one self-originated deity, named *Bythus*, i. e. *profound* or *unfathomable;* whom they called likewise, *the most high and ineffable father.*



ÆORA, among ancient writers on medicine, is used for gestation; which sort of exercise was often prescribed by the physicians of those days. Other exercises consisted principally in the motion of the body; but in the *æora* the limbs were at rest, while the body was carried about and moved from place to place, in such a manner as the physician prescribed. It had therefore the advantage of exercise, without the fatigue of it. This exercise was promoted several ways; sometimes the patient was laid in a sort of hammock, supported by ropes, and moved backward and forward; sometimes his bed ran nimbly on its feet; and sometimes he was carried in a litter, in a boat or ship, or on even ground in a chariot. Asclepiades was the first who brought gestation into practice, which was used as a means to recover strength after a fever, &c.

ÆPINUS, FRANCIS ULRICH THEODORE, eminent in the mathematics, and in natural philosophy, was born at Rostock in Lower Saxony in 1724, and died at Dorpt in Livonia in 1802. We regret that our means of information do not enable us to communicate any particulars in regard to his personal history; but we shall give some account of his contributions to science; and these, after all, form the most interesting memorials of a philosopher's life.

The work by which he is best known is entitled *Tentamen Theoriæ Electricitatis et Magnetismi*, published at Petersburg in 1759. It appeared under the sanction of the Imperial Academy, to which the theory had been in part communicated; and it is said on the title-page to be *Instar Supplementi Comment. Acad. Petropolitanæ.* The work indeed merited this distinction, as being the first systematic and successful attempt to apply mathematical reasoning to the subjects of electricity and magnetism. Already the theory of Franklin with regard to the former was very generally received, and was supposed to afford a satisfactory explanation of the phenomena. But though it seemed sufficient for this purpose in the common and somewhat loose manner in which the matter had hitherto been treated, it was not certain that the same would hold when the conclusions were accurately and mathematically deduced. To apply this test was what Æpinus undertook, and what he has executed in a manner very satisfactory and complete. He has treated very fully, and perhaps has nearly exhausted, what may be called the *statics* of electricity and magnetism, or the equilibrium of their forces. A great field yet remains, where the motion of the electric fluid is to be considered, and its distribution over the surfaces of bodies of a given figure; where greater difficulties are to be encountered, and where the latest improvements of the integral calculus in the hands of Laplace and Poisson have begun to be applied. The investigations of Æpinus in their own department led to very satisfactory results, and the exact agreement between them and the phenomena actually exhibited was extensively observed. Notwithstanding this agreement, we cannot consider the theory of positive and negative electricity as being yet sufficiently established. Though the assumption on which it is founded appear very simple at first, it is found more complex on a nearer inspection. The assumption is, that a fluid resides in the surfaces of all the bodies termed electrics, which is highly elastic, and strongly attracted, at the same time, by the particles of the body; and that while this fluid remains equally diffused over the surface of the body, no phenomenon whatever gives any information of its existence. By certain mechanical opera-

Æpinus.

tions, however, the equilibrium of this fluid may be destroyed; the fluid may be accumulated at one end, or on one side of a body, and entirely withdrawn from the opposite. It is when an electric is brought into this state that it exhibits the phenomena of electricity, between which and the calculus instituted on the suppositions just laid down, Æpinus has everywhere remarked the most exact agreement. One great difficulty, however, still remains: the negative ends of two electrified bodies repel one another just as much as the ends which are reckoned positive. But such an effect cannot result from the mere absence of a substance: when the electric fluid is withdrawn, if repulsion still continue, it must arise from the mutual action of the particles of the body itself. Thus it would appear, that, in the absence of the electric fluid, the tendency of the particles of matter is to repel one another. This is an essential part of the theory; and it is not accurate to say, that the doctrine of Franklin or Æpinus supposes no more than the existence of an elastic fluid diffused over the surfaces, and strongly attracted by the particles, of bodies. It supposes, besides, that those particles, in the absence of this fluid, mutually repel one another. This not only takes away from the simplicity of the hypothesis, but it is obviously a very unnatural, not to say a contradictory supposition; because, when the electric matter is removed, how comes it to pass that the particles of the body, notwithstanding their mutual repulsion, still cohere together as firmly as before? This difficulty is acknowledged by Æpinus himself; but it would seem that the theory had taken a strong hold of his mind before he was aware of this consequence from it, so that he became by degrees reconciled to a supposition which appeared to him at first not a little incongruous. This must not surprise us: it is not always that, even among philosophers, we meet with the candour, or perhaps we should say the courage, with which Newton suspended his belief in his own great discovery, the principle of universal gravity, as long as the erroneous opinion then existing about the magnitude of the earth made the moon's motion in her orbit appear inconsistent with the descent of falling bodies.

Another remark, made by Æpinus himself, involves in it a difficulty which should have induced him to view his theory with considerable diffidence. Though he considers the difference of the two electricities to be the same as between excess and defect, or to consist in this, that the fluid which is deficient in the one part is in excess in the other, he admits that no phenomenon points out on which side the excess, or on which the defect lies. This is a strong indication that the difference is not of the kind supposed. We are not left at a loss to tell whether cold is the absence of a substance which we call heat, or heat the absence of a substance which we call cold. If there were just as much reason for asserting the one of these propositions as the other, one would certainly be inclined to reject both. The same should be done with respect to electricity and magnetism.

The investigations of Æpinus, however, are by no means rendered useless, even if the theory of positive and negative electricity, or of positive and negative magnetism, be exchanged for that of two elastic fluids, each attracting the other, and both attracted by the particles of bodies. Most of his investigations may be easily accommodated to this supposition, and, therefore, they are, fortunately for themselves and for their author, of a more permanent nature than the principles from which they were deduced.

It is to be added to this, that Æpinus was the first who saw the affinity between electricity and magnetism in its full extent, and perceived the light that these two mutually cast on one another. He instituted a regular series of experiments on the nature of the tourmaline, on which he wrote a small treatise, published in 1762. He is to be regarded also as the inventor of the condenser of electricity, and of the electrophorus, of which he gave the complete theory.

Æpinus.

A very excellent view of the theory of Æpinus was published at Paris by M. Haüy in 1787, in 8vo. The same author has, however, adopted the theory of the two fluids in his own treatise, *Leçons de Physique.* There is a remarkable coincidence between Æpinus's work on electricity and magnetism, and that of Mr Cavendish, given in the *Philosophical Transactions* for 1771, p. 584. The principles from which they set out, and the conclusions at which they arrive, are in a great measure the same. It appears, however, quite certain, that Mr Cavendish knew nothing of the work of the Russian philosopher till his own was completed. His mode of proceeding is more geometrical, and in some parts he has gone farther.

The researches of Æpinus were not confined to the subjects now mentioned, but extended to most of the branches of natural philosophy. Beside the treatise on the tourmaline, he published, in 1762, a work, in 4to, *On the distribution of heat at the surface of the earth;* a work which, though translated into French, has hardly, we believe, made its way into this country, and of which we are therefore unable to speak from our own knowledge. He is also the author of many valuable memoirs on different subjects in pure mathematics, in astronomy, mechanics, optics, meteorology, contained in the 7th, 8th, 9th, 10th, and 12th volumes of the *Novi Commentarii Petropolitanæ*, and in the volumes of the *Berlin Memoirs* for 1755, 1756. In a memoir contained in the last of these, is the first account of his experiments on the tourmaline, which were conducted with great accuracy and judgment, and do honour to the author as a man of a sound and philosophical understanding, well instructed in the true principles of inductive investigation. Indeed, notwithstanding the objections we have made to his theories of electricity and magnetism, we must acknowledge that this is the general impression produced by the perusal of his works. He appears to have been well acquainted with practical astronomy, and sometimes to have had the charge of the imperial observatory. He made improvements on the micrometer and the reticulum, and wrote a memoir on the effects of parallax in the transit of a planet over the sun; a difficult subject, and one rendered at that time (1764) peculiarly interesting, on account of the transit of Venus which was just past, and that which was soon expected. (*Novi Com. Pet.* tom. x. p. 433.) In the same volume he has a memoir on the subject of *accidental colours*, which at that time had hardly been treated of by any author but Buffon; and another on the affinity between electricity and magnetism. In the 12th volume he notices, we believe for the first time, the electric property of the Brazilian emerald. He was not aware that this emerald is in reality the green tourmaline (*Brogniart*, tom. i. p. 418.); a variety of that mineral on which he had already exercised his ingenuity with so much success.

It is rare, in an advanced state of science, to have the satisfaction of making a new discovery with regard to a subject quite elementary, and one that has been long a subject of attention. This, however, happened to Æpinus with respect to the *lever*, and to the simplest kind of lever—that which has equal arms; of which he has demonstrated a new property, in the 8th volume of the *Commentaries* above referred to. It is this:—If a lever with equal arms be acted on at its opposite ends by forces in a given ratio to one another, and having their directions parallel to straight lines given in position; and if these forces be resolved each into two, one at right angles to the lever, and the other in the direction of it; in the case of equilibrium, the sum of the two forces, having the same direction with the lever, will be the *greatest possible.* This theorem, remarkable for its simplicity, and for illustrating the connection between the equilibrium of bodies, and certain problems concerning the maxima or minima of variable quantities, occurred when he was pursuing some of his inquiries concerning magnetism. He seems not to have been very fortunate, however, in his investigation, which is more complex than is necessary, as the proposition admits of a geometrical demonstration remarkable for its simplicity. (J. P.)

ÆQUI, a brave ancient people of Italy, inhabiting the upper valley of the Anio, who, in confederacy with the Volsci carried on a long series of hostilities with the early Romans; but were finally subdued in the year B.C. 302.

ÆQUIMELIUM, in *Antiquity*, a place in Rome where stood the house of Spurius Mælius, who, by largesses corrupting the people, affected the supreme power. Refusing to appear before the dictator Cincinnatus, he was slain by Servilius Ahala, master of the horse; his house was razed to the ground, and the spot on which it stood was called *Area Æquimelii.—Livy*, iv. 13-16.

ÆRA, in *Chronology*, a fixed point of time from whence any number of years is begun to be counted. It is sometimes also written in ancient authors *Era*. The origin of the term is contested, though it is generally allowed to have had its rise in Spain. Sepulveda supposes it formed from A. ER. A. the notæ or abbreviatures of the words *annus erat Augusti*, occasioned by the Spaniards beginning their computation from the time their country came under the dominion of Augustus, or that of receiving the Roman calendar. This opinion, however ingenious, is rejected by Scaliger, not only on account that in the ancient abbreviatures *A* never stood for *annus*, unless when preceded by *V* for *vixit;* but that it seems improbable they should put ER for *erat*, and the letter A, without any discrimination, both for *annus* and *Augustus.* Vossius nevertheless favours the conjecture, and judges it at least as probable as either that of Isidore, who derives *æra* from *æs*, the tribute-money wherewith Augustus taxed the world; or that of Scaliger himself, who deduces it likewise from *æs*, though in a different manner. *Æs*, he observes, was used among the ancients for an *article* or *item* in an account; and hence it came also to stand for a sum or number itself. From the plural *æra*, came the corruption *æra, æ, æram*, in the singular; much as *Ostia, æ, Ostiam*, the name of a place, from *Ostia*, the mouths of the Tiber.

The difference between the terms *æra* and *epoch* is, that the æras are certain points fixed by some people or nation, and the epochs are points fixed by chronologists and historians. The idea of an æra comprehends also a certain succession of years proceeding from a fixed point of time, and the epoch is that point itself. Thus the Christian æra began at the epoch of the birth of Jesus Christ. See CHRONOLOGY.

ÆRARIUM, the treasury or place where the public money was deposited amongst the Romans.

*Ærarium Ilithyæ*, or *Junonis Lucinæ*, was where the moneys were deposited which parents paid for the birth of each child.

*Ærarium Privatum* was the emperor's privy purse, or the place where the money arising from his private patrimony was deposited.

*Ærarium Sanctius* contained the moneys arising from the twentieth part of all legacies: this was kept for the extreme necessities of the state.



*Ærarium Vicesimarum*, the place where the money arising from the taxes levied from foreign countries was laid up; so called because it most commonly consisted of a twentieth part of the produce.

There are several other treasuries mentioned in history, as the *Ærarium Juventutis, Veneris*, &c. The temple of Saturn was the public treasury of Rome, either because Saturn first taught the Italians to coin money, or, which is most likely, because this temple was the strongest and most secure, and therefore the fittest place for that purpose.

*Ærarium* differs from *Fiscus*, as the first contained the public money, the second that of the prince. The two are, however, sometimes indiscriminately used for each other.

ÆRARIUS, a name given by the Romans to a degraded citizen, who had been struck off the list of his century. Such persons were so called, because they were still liable to all the taxes (*æra*), though deprived of the privileges of citizens.

The *ærarii* were incapable of making a will, of inheriting, of voting in assemblies, or of enjoying any post of honour or profit; in effect, they were only subject to the burdens, without the benefits of society; yet they retained their freedom, and were not reduced to the condition of slaves. To be made an *ærarius* was a punishment inflicted for some offence, and reputed one degree more severe than to be expelled a tribe, *tribu moveri.*

ÆRARIUS was likewise an officer instituted by Alexander Severus, for the distribution of the money given in largesses to the soldiery or people.

ÆRARIUS was also used for a person employed in coining or working brass. These are sometimes called *ærarii fusores.* At other times, *ærarius* is distinguished from *fusor;* the former answering to what we now call coppersmiths, the latter to founders.

ÆRARIUS was also applied to a soldier who receives pay.

AERIA, or EERIA, in *Ancient Geography*, the ancient name of Egypt. The scholiast on Apollonius Rhodius says, that not only Thessaly, but Egypt, was called Ηερια by the Greeks, which Eusebius also confirms; and hence Apollinarius, in his translation of the 114th Psalm, uses it for Egypt. Hesychius applies this name to Ethiopia.

AERIE. See AIRY.

AERNEN, a market town near the river Rhone, in the canton of Wallis or Valais, in Switzerland, in the district of Gambs. It has a state-house and other good buildings, and is the seat of justice for the district.

AERODYNAMICS. See DYNAMICS.

AEROLITE, a term recently, but perhaps improperly, applied to those singular substances commonly called METEORIC STONES. See METEOROLITE.

AEROMANCY, a species of divination performed by means of air, wind, &c.

AEROMETRY, the science of measuring the air. It comprehends not only the doctrine of the air itself, considered as a fluid body, but also its pressure, elasticity, rarefaction, and condensation. But the term is at present not much in use, this branch of natural philosophy being more frequently called Pneumatics.

AERONAUTICA, from αηρ, and ναυτικος, derived from ναυς, *ship;* the art of sailing in a vessel or machine through the atmosphere, sustained as a ship in the sea. See AERONAUTICS.

# AERONAUTICS.

Aëronautics.

Gradual discovery of navigation.

IN every stage of society men have eagerly sought, by the combination of superior skill and ingenuity, to attain those distinct advantages which nature has conferred on the different tribes of animals, by endowing them with a peculiar structure and a peculiar force of organs. The rudest savage learns from his very infancy to imitate the swimming of a fish, and plays on the surface of the water with an agility and a perseverance which seem to decline with the advancement of civilisation. But an art so confined in its exercise, and requiring such a degree of bodily exertion, could not be considered of much avail. It was soon perceived, that the fatigue of impulsion through the water could be greatly diminished, by the support and floating of some light substance. The trunk of a tree would bear its rude proprietor along the stream; or, hollowed out into a canoe, and furnished with paddles, it might enable him even to traverse a river. From this simple fabric, the step was not great to the construction of a boat or barge, impelled by the force of oars. But it was a mighty stride to fix masts and apply sails to the vessel, and thus substitute the power of wind for that of human labour. The adventurous sailor, instead of plying on the narrow seas, or creeping timidly along the shore, could now launch with confidence into the wide ocean. Navigation, in its most cultivated form, may be fairly regarded as the consummation of art, and the sublimest triumph of human genius, industry, courage, and perseverance.

Vain attempts to fly through the air.

Having by his skill achieved the conquest of the waters that encompass the habitable globe, it was natural for man to desire likewise the mastery of the air in which we breathe. In all ages, accordingly, has ingenuity been tortured in vain efforts at flying. The story of Icarus testifies how fatal such daring attempts had generally proved to their projectors. Trials made with automatons, though less liable to risk and danger, were yet equally fallacious. Archytas, a most eminent Greek geometer and astronomer, who perished by shipwreck on the coast of Calabria, was believed by his admiring contemporaries to have constructed an artificial dove, which, by the action of a system of internal springs, wafted itself through the air. If such a piece of mechanism was ever made, we may be sure that its flight was really produced, as in the scenes of the opera, by means of invisible strings or wires.

Flying ascribed to demons,

So thoroughly were the ancients convinced of the impossibility of men being able to fly, that they ascribed the absolute rule of the sky to divinities of the first order. The supreme Jupiter alone reposed on his empyreal throne, far above the heights of Olympus; and to him was it given, from the region of the clouds, to point the winged lightning, and to hurl the flaming thunderbolt. On special missions he dispatched Mercury, as his messenger, through the wide range of atmosphere. The oriental nations, from whom we have borrowed the greater part of our vulgar mythology, likewise committed such journeys to certain genii or ministering spirits. But the glowing visions of the East received a darker tinge from the character and climate of our Gothic ancestors. The arch-fiend himself was, at no very distant period, firmly believed to have the especial control of the air, and to career in the whirlwind and impel the howling tempest. Those wretched creatures whom the unfeeling credulity of our ancestors, particularly during the prevalence of religious fanaticism, stigmatized and murdered under the denomination of witches, were supposed to work all their enchantments, to change their shapes at will, and to transport themselves through the air with the swiftness of thought, by a power immediately derived from their infernal master. At a period somewhat earlier, every person in possession of superior talents and acquirements was believed to deal in magic, and to perform his feats of skill chiefly through the secret aid granted him by the prince of darkness. In spite of the incurable perverseness of his conduct, it must be confessed that the devil has always had the credit of retaining some little inclination to assist the efforts of genius.

Aëronautics.

and to magicians.

During the darkness of the middle ages, every one at all distinguished by his knowledge in physics was generally reputed to have attained the power of flying in the air. Our famous countryman Friar Bacon, among other dreams engendered in his fervid brain, has not scrupled to claim the invention of that envied and transcendent art. To these pretensions the credulity and indulgent admiration of some authors have lent more credit than they really deserved. Any person who will take the trouble to examine the passages of Bacon's obscure though ponderous works, must soon be convinced, that the propositions advanced by him are very seldom founded on reality, but ought rather to be considered as the sportive illusions of a lively and teeming fancy. Albertus Magnus, who lived about the same period, and was esteemed in Germany as a perfect prodigy, pretended also to the art of flying. More than a century afterwards, John Müller of Königsberg, and thence styled *Regiomontanus*, one of the chief restorers of genuine mathematical learning in Europe, was reported by some writers of note to have, like Archytas, fashioned an artificial dove, which displayed its wings, and flew before the emperor Charles V. at his public entrance into Nüremburg. But, unfortunately for the veracity of the story, Regiomontanus died in early life, full sixty years before that visit took place.

Dark features of that art.

While the belief in necromancy prevailed, such tales assumed colours of the most lurid hue. Fiery dragons, created by infernal machination, were imagined to rush impetuous through the sky, vomiting flames, and widely scattering the seeds of pestilence. Grave writers, in those benighted ages, even ventured to describe the method of imitating the composition of such terrific monsters. A mass of large hollow reeds were to be disposed and bound together, then sheathed completely in skin, and smeared over with pitch and other inflammable matters: this light and bulky engine, partially set on fire, and launched in the thickest darkness into the air, might be sufficient, when borne along by the force of the wind, to strike the ignorant populace with affright and horror. But such spectacles would come to lose their terrors by repeated failure and the insensible progress of knowledge. So late as the year 1750, a small Catholic town in Swabia was almost entirely burnt to ashes by an unsuccessful experiment of that sort, instigated, and probably directed, no doubt for the edification of their flock, by the lowest order of priests. It was attempted to represent the effigy of Martin Luther, whom the monks firmly believe to be the very imp of Satan, under the form of a winged serpent, furnished with all the requisite appendages of a forked tail and hideous claws. Unluckily for the skill of the machinist, this phantom directly fell against the chimney of a house, to which it set fire; and the flames spreading furiously in every direction, the people had soon cause to lament bitterly their intemperate zeal.

Later attempts at flying.

The scheme of flying in the air, which men of the first genius had once entertained, appears to have gradually descended to a lower class of projectors. Those who afterwards occupied themselves with such hopeless attempts, had commonly a smattering of mechanics, with some little share of ingenuity, but wrought up by excessive conceit.

In the beginning of the sixteenth century, an Italian adventurer visited Scotland, during the reign of James IV.; and being a man of some address, and at the same time a pretender to alchemy, he contrived to insinuate himself into the favour of that gay and needy prince, by holding out hopes of augmenting his scanty treasury by the acquisition of the philosopher's stone. He was collated by royal favour to the abbacy of Tungland in Galloway; but not having succeeded in creating artificial riches, he resolved, in the height of his enthusiasm, at once to gratify and astonish the courtiers, by the display of a feat still more extraordinary. Having constructed a set of ample wings, composed of various plumage, he undertook, from the walls of Stirling Castle, to fly through the air to France. This experiment he had actually the folly or hardihood to try; but he soon came to the ground, and broke his thigh-bone by the violence of the fall. For his unlucky failure, however, the abbot had the dexterity to draw a very plausible excuse from the wretched sophistry, termed science in that age. "My wings," said the artful Italian, "were composed of various feathers; among them were the feathers of dunghill fowls, and they, by a certain sympathy, were attracted to the dunghill; whereas, had my wings been composed of the feathers of eagles alone, the same sympathy would have attracted them to the region of the air." This anecdote has furnished to Dunbar, the Scotish poet, the subject of one of his rude Satires.

A century afterwards, Fleyder, rector of the grammar-school at Tübingen, entertained, in 1617, the worshipful magistrates of that city with a lecture on the art of flying, which he published at the lapse of eleven years, yet prudently contented himself with barely explaining his theory. A poor monk, however, ambitious to reduce this theory into practice, having provided himself with spacious wings, took his flight from the top of a high tower; but encountering a cross wind, his machinery misgave, and falling precipitously to the ground, he broke both his legs, and perished miserably. An accident of a similar kind is related to have happened not long since near Vienna.

Impossibility of flying first demonstrated by Borelli.

The impossibility of rising, or even remaining suspended in the air, by the action of any machinery impelled by human force, was first demonstrated by Borelli, a most eminent Italian mathematician and philosopher, who lived in the fertile age of discovery, and was thoroughly acquainted with the true principles of mechanics and pneumatics. In his celebrated and excellent work *De Motu Animalium*, published in 1670, he showed, by accurate calculation, the prodigious force which the pectoral muscles of birds must exert and maintain. The same principles, applied to the structure of the human frame, proved how very disproportionate was the strength of the corresponding muscles in man. It is not, therefore, the mere difficulty of contriving and combining machinery which should perform the peculiar motions of wings, that has rendered all attempts of the kind futile, but the utter want of adequate force in the human body to give such impulsion to those extended vanes as would be necessary for supporting so great a weight in the thin medium of the atmosphere.

Having found by experience the impossibility, from any application of inherent strength, of ascending into the atmosphere, it was natural for men of ardent minds, who still pursued that dazzling project, to look for some extraneous aid among the varied powers of the elements.

Cosmological notions of the ancients.

The notions entertained by the ancients respecting the composition of the world might have suggested important hints for realizing the scheme of aërial navigation. The four elements—earth, water, air, and fire or ether, arranged according to their several qualities and tendencies, were supposed to constitute this universal frame. Earth, being heavy and inert, occupies the centre of the system, and above it flowed the waters; air, from its lightness, rose upwards, and invested the globe with an atmosphere; while the diffuse ethereal substance soared, by its extreme buoyancy, to the celestial regions, and filled with splendour their pure expanse. Every portion of these distinct elements, if transported from its place, was conceived as having a natural and constant appetency to return to its original situation. Earth and water sink downwards by their gravity, while air and fire, endued with an opposite principle, as invariably rise to the higher spaces. A portion of fire, joined to water or to air, communicates, in a corresponding degree, its levity, or disposition to ascend. Thus, warm air always rises; water, subdued by excessive heat, flies upwards in the form of vapour; and the volatile parts of inflamed bodies are borne to the sky in smoke.

Idea of sailing through the air first given by Albert of Saxony,

The first person that seems to have formed a just idea of the principle on which a balloon could be constructed was Albert of Saxony, a monk of the respectable order of St Augustin, who lived in the fourteenth century, and wrote a learned commentary on the physical works of Aristotle. Since fire is more attenuated than air, and floats above the region of our atmosphere, this ingenious person conceived that a portion of such ethereal substance, inclosed in a light hollow globe, would raise it to a certain height, and keep it suspended in the sky. But the same philosopher rightly subjoined, that a greater mixture of air introduced into the balloon, by rendering this heavier than before, would cause it to descend proportionally, in the same way precisely as water admitted through the seams of a ship makes the vessel to sink in the ocean. It is evident that nothing was wanted for completing Montgolfier's discovery, but to carry those fine views into execution.

and adopted by Mendoza

The ideas of Albert of Saxony were long afterwards zealously embraced by Francis Mendoza, a Portuguese Jesuit, who died at Lyons in the course of a tour through France in 1626, at the age of 46. He maintained that the combustible nature of fire was no real obstacle to its application in balloons, since its extreme levity, and the exclusion of the air, would hinder it from supporting inflammation. Casper Schott, a Jesuit likewise, pursued more soberly the same speculation in Germany. He stated that no air of these lower regions is ever light enough to produce an ascent, and that the lucid ethereal matter which swims above our atmosphere is alone fitted for aërial navigation. Were any superhuman power, therefore, to bring down a store of that buoyant substance, to be inclosed in a hollow ball of wood or thin lead, the vessel, being furnished with a rudder and sails, might then, he conceived, boldly navigate the sky.

and Casper Schott.

Blended with alchemical notions.

Similar notions have been renewed at different times. They were likewise often blended with the alchemical tenets so generally received in the course of the fifteenth, sixteenth, and part of the seventeenth centuries. Conceiving with the ancients that the dew which falls during the night is of celestial origin, and shed by the stars, speculative men still imagined this pure humidity to be drawn up again to the heavens by the sun's rays in the heat of the day. Many persons, imbued with the wretched learning of that age, had the simplicity to believe that an egg-shell filled with the morning dew, and placed at the foot of a ladder leaning against the roof of a house, would, as the day advanced, spontaneously rise along the bars, and mount to the chimney-tops.

**Whimsical projects of Father Laurus.**

This whimsical fancy is confidently related as an observed fact by Father Lauretus Laurus. "Take," says he, very gravely, "a goose egg, and, having filled it with dew gathered fresh in the morning, expose it to the sun during the hottest part of the day, and it will ascend, and rest suspended for a few moments." To perform the experiment on a greater scale, however, he proposed to employ the largest swan's egg, or a bag artificially prepared from the thinnest and lightest skin, into which, instead of dew, he would introduce the three alchemical elements, nitre, sulphur, and mercury; and he imagined that these active bodies, expanded and sublimed by the mere heat of the sun, must spring powerfully upwards. In this way he thought the dove of Archytas might be constructed. But the visionary priest had yet another scheme to advance for effecting the ascent of the automaton: he proposed to cram the cavity of the dove with highly condensed air; and was so grossly ignorant of the principles of motion as to suppose that this imprisoned fluid would impel the machine in the same manner as wind does a sail. Should such a force be found not sufficiently efficacious, he finally recommended the application of fire; not, however, on account of its buoyant property, but because of the propulsive power which it exerts. To prevent the fire from consuming the wooden machine, he recommends lining the inside with cloth of asbestos or other incombustible materials; and to feed and support steadily this fire, he suggested a compound of butter, salts, and orpiment, lodged in metallic tubes, which he imagined would at the same time heighten the whole effect, by emitting a variety of musical tones like an organ.

**Proposals of Cardan and Fabry.**

Influenced by the same views, other authors, and particularly the famous Cardan, have proposed, for aërial ascents, to apply fire acting as in a rocket. Still later, but in the same country, Honoratus Fabry, penitentiary of the pope, and teacher in the gymnasium at Rome, who died about the end of the seventeenth century, described a huge apparatus, consisting of very long tin pipes, in which air was compressed by the vehement action of fire below. In a boat suspended from the machine, a man was to sit and direct the whole, by the opening or shutting of valves.

**Philosophical romance of Cyrano de Bergerac.**

The projects and vagaries of learned men about the misty period of the restoration of science were finely ridiculed by Cyrano de Bergerac, a very witty and eloquent French writer, in a philosophical romance, entitled *The Comical History of the States and Kingdoms in the Sun and Moon.* This eccentric genius, born at Perigord in 1620, was noted for his impetuous temper and boiling courage. He spent his youth in dissipation and feats of arms; but afterwards, in riper life, he quitted the military profession, and betook himself to the study of poetry and philosophy, which he prosecuted with great ardour and success till he died, at the early age of 35. In his romance, from which perhaps Swift borrowed the idea of Gulliver's voyage to Laputa, Bergerac introduced a good deal of the Cartesian philosophy, then just coming into vogue; but lashed severely the pedantry and ignorance of various pretenders to science. To equip himself for performing the journey to the moon, the French traveller fastens round his body a multitude of very thin flasks filled with the morning's dew. The heat of the sun, by its attractive power exerted on the dew, raised him up to the middle region of the atmosphere; where some of his flasks happening unluckily to break, the adventurer sunk again to the ground, and alighted in Canada. There he constructed a new machine, acting by a train of wheels, with which he mounted to some height; but falling down, he had the misfortune to break his leg. He crept aside, in search of ox-marrow to compose a salve, with which he instantly healed his bruises; and returning again, he found his engine in the possession of some soldiers, who had fixed to it a number of sky-rockets. Replacing himself now in the car, he applied fire to the rockets, and darted upwards with inconceivable swiftness: the earth retired gradually from view, while the orb of the moon appeared proportionally to expand, till, approaching the sphere of her activity, he was borne softly along, and descended on the lunar surface into a most delicious and luxuriant grove. Here, of course, he met with angelic personages, endowed with every perfection of body and mind, and far exalted above the mean vices and the rancorous passions which poison and inflame the inhabitants of this blood-stained globe. In the conversations which Bergerac held with those supernal beings, he was informed that a native of our planet, utterly disgusted at the crimes which pollute its "sin-worn mould," had once on a time provided himself with a pair of very large and thin metallic vessels, which he filled with smoke, and sealed in the light; and having attached himself below them, the buoyant power of the confined smoke carried him to the highest region of our atmosphere, where the attraction of the moon at length prevailing, drew him to her surface, while the great extent of the machinery, by opposing resistance, served to break the force of his fall. The moment, however, those slender capacious vessels were liberated from his weight, they rose again by the action of the smoke, till they reached a medium of the same density, and finally took their station in the bright fields of ether, where they form the constellation now called the *Balance.*

In further discourse with his sublime instructor, our romantic voyager was shown how to obtain the power of ascension from the loadstone. He was directed to take two magnets, each about a foot square, to roast them in the fire, to separate their impurities by solution, and thus concentrate their attractive virtue in a mere calx, which could be formed into a ball. Aided by such counsels, he now resolved to visit the sun. With much labour and perseverance he constructed a chest of very thin steel, six feet high and three feet wide; an icosahedron of crystal, the highest of all the regular solids, being fitted into the top, and the bottom having a small valve which opened outwards. Into this chest he shut himself, while the sun's rays, concentrated and multiplied by reflection from the numerous facets of the crystal, heated the air intensely, and drove a great part of it out below; and he ascended rapidly towards the glorious luminary, breathing ecstaticly in divine light, which gleamed with the richest tints of enamelled gold and purple. But it would be foreign to our purpose to follow the rest of the narrative, which, though disguised and mingled with fantastic visions, evidently contains the true principles of aëronautics.

**Lana's scheme for navigating the air.**

The most noted and elaborate scheme for navigating the atmosphere was proposed by the Jesuit Francis Lana, in a book written in the Italian language, and printed at Brescia in 1670, with the aspiring title of *Prodromo dell' Arte Maestra.* His project was to procure four copper balls of very large dimensions, yet so extremely thin, that, after the air had been extracted, they should become, in a considerable degree, specifically lighter than the surrounding medium. He entered into some calculations to prove that the buoyant power thus obtained would be

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fully adequate to produce the desired effect. Yet he seems to have had only a slender knowledge of geometry, and but little acquaintance with the progress of physical science. For instance, he founds his computations entirely on the pneumatical discoveries of Galileo and Toricelli, without making any reference to those important facts which the invention of the air-pump by Otto Guericke had successively detected in the course of near 30 years. He assumes that air is 640 times lighter than water; that a cubic foot of water weighs 80 pounds, and consequently that the weight of the same bulk of air is an ounce and a half. If we rectify the estimate of Lana, and reduce it to English measures, each of his copper balls had about 25 feet in diameter, with the thickness of only the 225th part of an inch, the metal weighing 365 pounds avoirdupois, while the weight of the air which it contained must amount to 670 pounds, leaving, after a vacuum had been formed, an excess of 305 pounds, for the power of ascension. Those four balls would therefore rise together into the atmosphere with a combined force of 1220 pounds, which was thought sufficient by the projector to transport a boat completely furnished with masts, sails, oars, and rudders, and carrying several passengers. To extract the air from their cavities, the method proposed was, to procure a Toricellian vacuum, by connecting each globe, fitted with a stop-cock, to a tube of at least thirty-five feet long; the whole being filled with pure water, and raised gently into a vertical position, the mass of liquid, exceeding the pressure of the atmosphere, would flow out, and subside to some point below the cock, which could then be shut.

His calculations.

His attempts to answer objections.

Lana enumerates the different objections which might be urged against his scheme, and endeavours to answer them. He thinks that the spherical and perfectly arched form of the shell of copper would, notwithstanding its extreme thinness, enable it, after the exhaustion was effected, to sustain the enormous pressure of the external air, which, acting equally on every point of the surface, would rather tend to consolidate than to crush or tear the metal. As the atmosphere becomes always lighter in the upper regions, the machinery could only rise to a certain limit; and if this were found too high for easy breathing, the ascent could be regulated by opening occasionally the cocks to admit some air into the cavity of the balls, and thus increase their specific gravity. There seemed to him no very great difficulty in directing and impelling the aërial bark, by means of rudders, oars, and sails; but the objection was more serious on account of the hazards of tremendous shipwreck, from the violence of winds and tempests. Yet what most alarmed the insinuating Jesuit, and which he earnestly prays God to avert, was the danger that would result, from the successful practice of the art of aëronautics, to the existence of civil government, and of all human institutions. No walls or fortifications could then protect cities, which might be completely subdued or destroyed, without having the power to make any sort of resistance, by a mere handful of daring assailants, who should rain down fire and conflagration from the region of the clouds.

So sanguine was Lana, as to conceive that the very moderate sum of a hundred ducats would be sufficient to defray the expense of all this huge and delicate apparatus. But his poverty, fortunately, no doubt, for his credit as a man of learning, prevented him from proceeding further than mere speculation; and none of the foreign princes, who about that period often squandered, like gamesters, much of their wealth in the dark and chimerical search after the philosopher's stone, seemed any way disposed to engage in the magnificent scheme of aërial navigation.

The project of Lana appears to have in some degree excited the attention of the learned, though it was at the same time very generally condemned. Hooke, Borelli, Leibnitz, and Sturmius, examined it, and severely exposed its defects. Indeed, any person at all acquainted with actual experiment must see that it was absolutely impracticable. Passing over other circumstances, the attenuated shell of copper, from its size and excessive thinness, could not have strength enough to support even its own weight, far less the slightest pressure of the atmosphere. The plate, however, that Lana has given of his whole combined apparatus appears very striking; and after Montgolfier's discovery, it could not fail to attract a greater share of notice than it was otherwise entitled to claim.

Project of Galien.

So late as the year 1755, and not very long before the final invention of balloons, a very fanciful scheme, yet on the grandest scale, for navigating the atmosphere, was published with most circumstantial detail, in a small pamphlet, by Joseph Galien, a Dominican friar, and professor of philosophy and theology in the papal university of Avignon. This visionary proposed to collect the fine diffuse air of the higher regions, where hail is formed, above the summit of the loftiest mountains, and to inclose it in a bag of a cubical shape, and of the most enormous dimensions, extending more than a mile every way, and composed of the thickest and strongest sail-cloth. With such a vast machine, far outrivalling in boldness and magnitude the ark of Noah, it would be possible, he thought, to transport a whole army, and all their ammunitions of war. But we need not stop one moment to consider a project so perfectly chimerical, which involves, besides, the erroneous supposition that the air of the upper regions is, independently of its diminished compression, essentially thinner and more elastic than the air below.

It cannot fail to strike the reader, that the persons who have occupied themselves the most with attempts at aërial navigation, were all of them Catholic priests;—whether this pursuit is to be explained from their habits of seclusion and their ignorance of the affairs of real life, or from their familiar acquaintance with the relations of miracles and other legendary tales, which might lead them to see nothing very extraordinary in the art of flying through the air. The various schemes of that kind, produced at different times, contain a few just principles, generally mixed up, however, with a large portion of absurdity. But very wide is the distance from such speculations to the real exhibition of the experiment itself.

Confused ideas of Lord Bacon on aëronautics.

Some writers have stated that Lord Bacon first published the true principles of aëronautics. This round assertion we cannot help noticing, because it has really no foundation, except in the propensity, fostered by indolence, which would gladly refer all the discoveries ever made to a few great names. They mistake, indeed, the character of Bacon, who seek to represent him as an inventor. His claim to immortality rests chiefly on the profound and comprehensive views which he took of the bearings of the different parts of human knowledge; for it would be difficult to point out a single fact or observation with which he enriched the store of physical science. On the contrary, being very deficient in mathematical learning, he disregarded or rejected some of the noblest discoveries made in his own time.

We can find only two passages in Lord Bacon's works which can be considered as referring to aëronautics, and they both occur in that collection of loose facts and inconclusive reasonings which he has entitled *Natural History*. The *first* is styled *Experiment Solitary, touching Flying in the Air*, and runs thus: "Certainly many birds of good wing (as kites and the like) would bear up a good weight as they fly; and spreading feathers thin and close, and in great breadth, will likewise bear up a great weight, being even laid, without tilting up on the sides. *The further extension of this experiment might be thought upon.*" This hint is not in fairness obnoxious to stricture, since the ingenious Bishop Wilkins, twenty years afterwards, still believed that men could acquire the art of flying. Nor was there any reason to despair, till Borelli at length demonstrated its absolute impossibility.—The second passage is more diffuse, but less intelligible: it is styled *Experiment Solitary, touching the Flying of unequal Bodies in the Air.* "Let there be a body of unequal weight (as of wool and lead, or bone and lead); if you throw it from you with the light end forward, it will turn, and the weightier end will recover to be forwards, unless the body be over long. The cause is, for that the more dense body hath a more violent pressure of the parts from the first impulsion; which is the cause (though heretofore not found out, as hath been often said) of all violent motions: and when the hinder part moveth swifter (for that it less endureth pressure of parts) than the forward part can make way for it, it must needs be that the body turn over; for (turned) it can more easily draw forward the lighter part." The fact here alluded to is the resistance that bodies experience in moving through the air, which depending on the quantity of surface merely, must exert a proportionally greater effect on rare substances. The passage itself, however, after making every allowance for the period in which it was written, must be deemed confused, obscure, and unphilosophical.

True theory of balloons.

That a body must remain suspended in a fluid denser than itself, was first established by Archimedes, whose propositions in hydrostatics were further extended in modern times by Stevinus and other early mathematicians. But the principles on which a balloon could be made to rise in the atmosphere were scarcely understood till very long afterwards, when chemistry, near the latter part of the last century, had succeeded in ascertaining the properties of the different kinds of aëriform substances. The Greeks of the lower empire knew that air is greatly dilated by warmth; and Sanctorio, the ingenious medical professor at Padua, by applying this expansion, about the year 1590, to the construction of the thermometer, had happily placed it in a strong light. His countryman Borelli remarked, almost a century afterwards, that a heated iron or a burning taper brought near one of the scales of a well-poised balance, by exciting a vertical current, will cause it to mount up with force,—a fact which affords the only true explication of the numerous experiments of Buffon with the weighing of red-hot balls, whose regular and constant results appeared to that eloquent philosopher to exhibit a conclusive demonstration of the actual ponderability of heat. Yet warm air, alone and unassisted, has still no very great power of ascension. The buoyancy communicated to that fluid by the distensible vapour of water and other more volatile liquids is in some cases considerable, especially when combined at the same time with heat. But those aëriform substances which are more elastic than common air display the most steady and powerful tendency to rise in the atmosphere. Such, in a remarkable degree, is the hydrogen gas, owing probably to the expansive force communicated by the very large share of heat which is embodied with it. The late most ingenious and accurate Mr Cavendish, in 1766, found, by a nice observation, this fluid to be at least seven times lighter than atmospheric air. It therefore occurred to Dr Black of Edinburgh, that a very thin bag filled with hydrogen gas would rise to the cieling of a room

Lightness of hydrogen gas found by Cavendish.

He provided, accordingly, the allantois of a calf, with the view of showing, at a public lecture, such a curious experiment before his numerous auditors; but, owing to some unforeseen accident or imperfection, it chanced to fail, and that celebrated professor, whose infirm state of health and cold or indolent temper more than once allowed the finest discoveries, when almost within reach, to escape his penetration, did not attempt to repeat the exhibition, or seek to pursue the project any farther. Several years afterwards, a similar idea occurred to Mr Cavallo, who found, however, that bladders, though carefully scraped, are too heavy, and that China paper is permeable to the gas. It is rather singular that he did not think of gold-beater's skin, which had for like purposes been recommended two centuries before by the grammarian Joseph Scaliger and some other writers. But in 1782 this ingenious person succeeded with the pretty experiment of elevating soap-bubbles, by inflating them with hydrogen gas.

Power of ascension.

To construct an aëronautic machine, it is only required, therefore, to provide a thin bag, of sufficient capacity, and to fill it with hydrogen gas, or with air which is kept in a rarefied state. The form and strength of the material are not so essential as in Lana's project, since it here suffers an equal pressure on both its outer and its inner side. Nor is it an absolute condition that the substance of the bag should be quite impervious to the gas or confined air; though such a defect, by allowing the partial escape of the buoyant fluid, must inevitably diminish the vigour and abridge the duration of the power of the balloon's ascent. This power is evidently the excess of the weight of an equal bulk of atmospheric air above the aggregate weight of the included gas, joined to that of the bag, and of all its appendages: in other words, the final power of ascent is the difference between the weight of the included gas and of that of an equal volume of external air, further diminished by the weight of the whole apparatus. But supposing the form of the balloon to remain the same, this counteracting load, as it depends on the quantity of surface contained in the bag, must be proportioned to the *square* of the diameter; whereas the difference between the internal and external volume of fluid, which constitutes the whole of the buoyant force, increases in a faster ratio, being proportioned to the capacity of the bag, or the *cube* of its diameter. It hence follows, that however small the excess may be of the specific gravity of the external air above that of the collected fluid, there must always exist some corresponding dimension which would enable a balloon to mount in the atmosphere.

The theory of aëronautics, considered in its detail, includes three distinct things: *first,* the power of a balloon to rise through the air; *second,* the velocity of its ascent; and, *third,* the stability of its suspension at any given height in the atmosphere. These points we shall examine separately.

Buoyancy of balloons

I. *The buoyant force of balloons.* Since balloons in their shape generally approach to the spherical form, it will be more convenient to ground our calculations on that figure. A globe of common air at the level of the sea, and of the mean density and temperature, is found to weigh about the 25th part of a pound avoirdupois. Consequently, if a perfect vacuum could be procured, a balloon of ten feet diameter must rise with a force of 40 pounds; one of twenty feet diameter, with that of 320 pounds; and a balloon of thirty feet in diameter would mount in the atmosphere with the power of 1080 pounds:—thus augmenting always in the ratio of the cube of the diameters. But air expands by heat about the 450th part

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from humidity; The dilatation which the presence of humidity communicates to air will, during fine weather in this climate, amount generally to one eighteenth part, though it may sometimes reach to more than the double of this quantity. But, in the tropical regions, such dilatation will commonly exceed the twentieth part of the volume of fluid. Hence moist air thrown into a bag, likewise wetted, and sufficiently large, would cause it to rise in the atmosphere. To succeed, however, in this way, the balloon constructed of coarse linen would require enormous dimensions; not less than three hundred feet in diameter.

from heat joined to moisture. But it is the union of heat and moisture that gives to air the greatest expansion. The white smoke with which the balloons are filled on Montgolfier's plan, was found, by computation, to be at least one-third specifically lighter than the external air. This purer sort of smoke is scarcely any thing but air itself charged with vapour, being produced by the burning of chopped straw or vine twigs in a brasier, under the orifice of the bag. It would have required no fewer than 150 degrees of heat alone to cause the same extent of rarefaction.

Smoke balloons. We have therefore sufficient data for calculating the buoyant force of the common fire, or rather smoke balloons. This force, being estimated about $12\frac{1}{2}$ pounds avoirdupois when the diameter of the bag is ten feet, would amount to $1562\frac{1}{2}$ pounds if the diameter were fifty feet, and to 12,500 pounds if it were a hundred feet. The weight of the linen case may be reckoned at two-fifths of a pound for a sphere of one foot in diameter. Consequently, a balloon of ten feet diameter would, without its appendages, weigh 40 pounds; one of fifty feet diameter, 1000 pounds; and one of a hundred feet diameter, 4000 pounds. Such a balloon of ten feet diameter would need $27\frac{1}{2}$ pounds to make it rise, but one of fifty feet diameter would ascend with a force of $562\frac{1}{2}$ pounds, and one of a hundred feet diameter would exert an ascending power of not less than 8500 pounds. There is besides to be deducted the weight of the cordage, the car, the ballast, and the passengers. It would require, on these estimates, a diameter of $33\frac{1}{3}$ feet, to procure merely an equilibrium between the weight of the canvass and the buoyant force of the rarefied air.

The hydrogen gas obtained from the action of dilute sulphuric acid upon iron filings is only six times lighter than atmospheric air; but the gas evolved during the solution of zinc in that acid is not less than twelve times lighter than the standard fluid. The ordinary way of examining the specific gravity of the different gases requires a very delicate operation of weighing with the most exquisite balance; a serious difficulty, which long retarded our knowledge of their comparative densities. In one of the notes to his *Treatise on Heat*, Professor Leslie has pointed out a very simple method, founded on the principles of pneumatics, for discovering the relative specific gravities of the aëriform fluids. This consists in observing the time that a given portion of the gas, under a determinate pressure, takes to escape through a very small aperture. The density of the gaseous fluid must be inversely as the square of the interval elapsed. Thus, the hydrogen gas procured from zinc, but without any depuration, was found, under a pressure of the same column of water, to flow thrice as fast as atmospheric air. This experiment is very striking, and requires no more apparatus than a cylindrical glass jar, open below, and surmounted by a cap terminating in a fine tubular orifice.

Balloons with hydrogen gas On a very moderate supposition, therefore, and after making every allowance for imperfect operation, we may consider the hydrogen gas which fills a balloon as six times lighter than the like bulk of common air. Consequently, such a balloon must exert five-sixths of the whole buoyant force corresponding to its capacity, or will have a tendency to mount in the atmosphere, that is equal to the thirtieth part of a pound avoirdupois for a globe of one foot diameter. A spherical balloon of fifteen feet diameter would hence have a buoyancy of $112\frac{1}{2}$ pounds; one of thirty feet, 900 pounds; and one of sixty feet no less than 7200 pounds. But thin silk, varnished with caoutchouc or elastic gum, to render it impervious to air, is found to weigh only the twentieth part of a pound when formed into a globe of one foot diameter. A silk balloon of fifteen feet diameter would hence weigh $11\frac{1}{4}$ pounds; one of thirty feet, 45 pounds; and one of sixty feet diameter, 180 pounds. Wherefore, the power of ascension exerted by such balloons would, in pounds avoirdupois, be respectively $101\frac{1}{4}$, 855, and 7020. It follows, also, that a balloon of a foot and a half in diameter would barely float in the atmosphere, the weight of its varnished silk being then exactly balanced by the buoyant effort of the body of hydrogen gas.

But the calculations now given would in strictness require a small modification. The weight of the bag and of all the appendages must evidently compress the included gas, and thereby render it in some degree denser. To compute this minute effect, we have only to consider, that the pressure of a column of atmosphere, at the mean temperature, and near the level of the sea, is 1632 pounds, on a circle of a foot diameter. Thus, in the large balloon of sixty feet diameter, if we suppose the whole load to have been 6000 pounds, the compression of the bag would only amount to five-thirds of a pound for each circle of a foot diameter in the horizontal section, or correspond to the 979th part of the entire pressure of the atmosphere. But the weight of the confined gas being 1200 pounds, its buoyancy must have suffered a diminution of somewhat more than a pound, or $\frac{1}{11}$ from the encumbrance opposed to it. This correction is therefore a mere theoretical nicety, which may be totally disregarded in practice.

Celerity of the ascent of balloons. II. The next circumstance to be considered in aëronautics is, *the celerity with which balloons make their ascent.* It is obvious that the efficient power of ascension, or the excess of the whole buoyant force above the absolute weight of the apparatus, would, by acting constantly, produce always an accelerated motion. But this acceleration is very soon checked, and a uniform progress maintained, by the increasing resistance which the huge mass must experience in its passage through the air. The velocity which a balloon would gain from unobstructed acceleration must, from the theory of dynamics, be to that which a falling body acquires in the same time, as the efficient buoyancy is to the aggregate weight of the apparatus and of the contained fluid. Thus, if the balloon were to rise with a force equal to the eighth part of its compound weight, the celerity resulting from a constant acceleration would be expressed by multiplying four feet into the number of seconds elapsed since it was launched into the air. Its accelerating advance, however, being opposed,

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Terminal velocity.

the balloon may to all appearance attain, though still affected with partial oscillations, the final velocity in perhaps little more than double the time required without such obstruction.

This final velocity, or the velocity at which the ascent becomes uniform, the resistance from the air being then equal to the efficient buoyancy of the balloon, is easily calculated. The resistance a circle encounters in moving through any fluid in the direction perpendicular to its plane, is measured by the weight of a column of that fluid, having the circle for its base, and an altitude equal to the height from which a heavy body in falling would acquire the given celerity. But near the level of the sea, and at the mean temperature, a column of atmospheric air 17 feet high, and incumbent on a circle of one foot diameter, weighs a pound avoirdupois; which is therefore the resistance that such a circle would suffer if carried forwards with the celerity of 33 feet each second. According to the same theory, however, which we owe to the sagacity of Newton, the resistance of a sphere is just the half of that of its generating circle, and consequently a velocity of $46\frac{2}{3}$ feet in a second through the air would, in ordinary cases, create a resistance of one pound to a ball of one foot diameter. In other circumstances, the quantity of resistance must be proportional to the squares of the velocities and of the diameters. Whence, if the buoyant force were always the same, the velocity of the ascent of a balloon would be inversely as its diameter.

Example. General formula.

Suppose a balloon to have thirty feet in diameter, and an ascensional power of 100 pounds. This effort is evidently the same as the ninth part of a pound for a globe of a foot diameter, and would therefore be countervailed by the resistance corresponding to a velocity of $46\frac{2}{3}$ divided by 3, the square root of 9, or $15\frac{5}{9}$ feet each second. The balloon would therefore reach the altitude of a mile in about six minutes. Its accelerating force being only the sixteenth part of its total weight, it might have acquired the uniform motion of ascent in twenty seconds, or before it had attained the height of 200 feet. This example differs very little from reality, and the method of computation will easily be transferred to other cases.

But the resistance of the air assigned by theory is, from the circumstances omitted in the simplification of the problem, generally somewhat less than the results of observation. In low velocities this difference amounts seldom to the fifth part of the whole effect; but in the high velocities it increases considerably, exceeding even the third part in certain extreme cases. From the numerous and accurate experiments of Dr Charles Hutton, we may, however, deduce a simple formula for expressing the terminal velocity of balloons, or the celerity of their uniform ascent. Let $a$ denote the diameter of the balloon in English feet, and $f$ its ascensional power, measured in pounds avoirdupois; then $\frac{40}{a}\sqrt{f}$ will very nearly represent in feet the velocity each second of its regular ascent, or that velocity which would cause a resistance from the air precisely equal to the buoyant force. Or, to express the rule in words: As the diameter of the balloon in feet is to the constant number 40, so is the square root of the ascensional power in pounds to the terminal or uniform velocity of ascent each second. To illustrate the application of the formula by an easy example; suppose the balloon to have a diameter of 60 feet, with an accelerating power of 144 pounds; the corresponding rate of uniform ascent becomes $\frac{40}{60}\sqrt{144}$, or $\frac{2}{3}\times 12$, that is, 8 feet each second, or about a mile in eleven minutes.

Stability of suspension.

III. The last point which demands attention in aëronautics is, *the stability of the suspension of a balloon at any given height in the atmosphere.* The circumstances which might regulate or determine that stability, requiring some little exercise of thought, have been commonly neglected, and very seldom examined with due care. It will be proper to consider, *first,* the fire or smoke balloons, and, *secondly,* the balloons filled with hydrogen gas.

Smoke balloons.

1. The warm humified air of the balloon constructed after Montgolfier's plan suffering less external compression as it approaches the upper strata of the atmosphere, must at the same time necessarily expand, and partly escape by the orifice above the brasier. The weight of the included fluid, and that of the part expelled, constituting its buoyant force, will hence be reduced, in proportion to the diminished density of the medium in which it floats. The balloon will continue to ascend till its enfeebled buoyancy is no longer able to support the incumbent load. At the height of a mile above the surface, the power of ascension would be diminished rather more than one fifth part; but at an altitude of three miles and a half it would be reduced to one-half. At the ordinary temperature, this buoyancy would suffer a reduction of the hundredth part for each ascent of 278 feet. Resuming the data formerly stated, and supposing the balloon to have a spherical shape, its actual power of ascension, estimated in pounds avoirdupois, will be denoted by $\frac{a^3}{80}$, where $a$ signifies the diameter in feet, or the cube of the diameter divided by the constant number 80. If $m : n$ express the ratio of atmospheric density at the surface and at any given height, then will $\frac{n}{m}\cdot\frac{a^3}{80}$ denote the diminished buoyant force at that altitude.

We shall select, for example, a balloon of 100 feet diameter, which is one of the largest dimensions ever actually constructed. Near the level of the sea, and at the ordinary temperature, its power of ascension would be 12,500 pounds; but at the height of 8000 feet, or somewhat more than a mile and a half, when the density is diminished one-fourth, or $\frac{n}{m}=\frac{3}{4}$, that power becomes reduced to $\frac{3}{4}\times 12{,}500$, or 9375 pounds, being a deficiency of 3125 pounds. On the supposition that the balloon was at first so much loaded as to rest just suspended at the ground, a ballast of 3125 pounds must have been thrown out, to make it rise to the altitude of a mile and a half. Hence also the rejection of 125 pounds would have been sufficient to give the balloon an elevation of 278 feet. For the same reason, 10 pounds of ballast heaved out would raise it 22 feet at the surface, 29 feet at the height of a mile and a half, and 44 feet at that of three miles and a half.

Balloons charged with hydrogen gas

2. The stability of the suspension of balloons filled with hydrogen gas must depend on principles which are very different and less marked. In these aëronautic machines, after the gas has been once introduced, it is closely shut up; and therefore, having constantly the same absolute weight, it should likewise, in all situations, exert the same buoyant force. Hence, if the balloon were capable of indefinite extension, it would still continue its ascent through unbounded space. The determinate capacity of the bag alone can oppose limits to its rise in the atmosphere. The upper strata being rarer than those below, will have less power to keep any given bulk suspended; and the actual buoyancy being diminished from that cause, the balloon will find its station at a corresponding height in the diffuse medium. But this diminution of the buoyant force,

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and the consequent increase in the density of the hydrogen gas, must necessarily be confined within very moderate limits, otherwise the thin silk case would be torn to shreds by the expansive efforts of the imprisoned fluid. A safety-valve is accordingly placed at the top of the balloon, calculated to give vent to the gas before the distension has become such as to endanger the bursting of the case.

should not be completely filled;

A balloon should not at first be filled completely with hydrogen gas, but allowed to begin its ascent in a flaccid state. As it mounts into the rarer atmosphere, it will gradually swell, till it has attained its full distension, when the safety valve may come to act. But such dissipation of the gas ought, by a previous arrangement, to be as much as possible avoided. If the balloon were intended to rise to the height of four miles, it would not be requisite to fill more than half its capacity with the elastic fluid. To push the charge any farther in this case, would only occasion a superfluous waste of materials. By throwing out part of his ballast, the aëronaut may raise himself higher; and by opening the valve to permit some of the imprisoned gas to escape, he may descend again: but both those expedients are attended by a wasteful expenditure of power.

unstable when flaccid.

It is evident that a balloon can have no stability of equipoise, so long as it remains in a loose or flaccid state. The slightest action would then be sufficient to make it rise or fall, since, under such circumstances, any change of its station could not in the smallest degree affect the measure of its buoyant force. The general elevation to which the balloon will ascend must be determined by its quantity of ballast, conjoined with the regulation of the safety-valve; but the strain of the silk case itself would be sufficient to confine the ascent within certain limits, and to procure the stability of the floating mass. Thus, if a balloon fully distended had yet a slight disposition to rise, the imprisoned gas, suffering more and more compression as it gradually ascends, would become proportionally denser, and therefore lose a corresponding part of its previous buoyancy. An equilibrium would hence soon obtain, which must arrest the floating machine at a determinate height in the atmosphere.

Mode of adjusting balloons.

Suppose a balloon to be capable, without any danger of bursting, of sustaining an expansion equal to the hundredth part of the elasticity of the included fluid; the whole buoyancy would, by such an alteration, be diminished one five hundredth part, or this floating machine would subside 55 feet near the surface, and sink proportionally more in the upper regions. To produce the effect, it would only be requisite to throw common air into the bag, without suffering any portion of the hydrogen gas to escape. On this principle Meusnier, an ingenious French chemist, very soon after the first discovery of balloons, proposed to regulate with nicety their ascent and position of equilibrium in the atmosphere. The mode which he suggested was, to place within the principal balloon a much smaller one, to be filled occasionally with common air by help of bellows, or emptied again by opening an exterior valve. The aëronaut would thus have it in his power, without expending the charge of hydrogen gas, either to sink gently through a short space, or to rise again at will, by inflating the inner balloon, or allowing it to collapse. The adjustment of the height of a balloon could hence be managed with great precision.

The command possessed by the aëronaut of raising or depressing his machine at pleasure, might afford him the means of influencing the direction of its course. From the various motions of the several ranges of clouds, we may infer that different currents exist at the same time in the atmosphere. The aëronaut has, therefore, in his ascent, only to seek the current best suited to his purpose, and, taking his station in that stratum, to commit his flimsy vessel to the guidance of the stream.

Futility of applying sails or rudders.

Any other attempts to direct or control the flight of a balloon are altogether fallacious. Since it is carried along with the swiftness of the wind, no rudders or sails can have any action whatever. The aëronaut might fancy himself to float in a perfect calm, unless he chances to encounter irregular currents. The application of oars may turn a balloon, but can have no sensible effect in diverting or impelling its course. How vastly disproportionate is the force of the human arm to the overwhelming pressure of the wind against so huge a machine! To adapt machinery under these circumstances would be preposterous, and to look for help from such a quarter is visionary in the extreme. It must be admitted, however, that after a balloon has once gained its station of equilibrium, or passively floats in the air, the vigorous action of broad vanes, downwards or upwards, might serve to raise or depress the machine through a small space. Thus, a vertical force, exerted equal to nine pounds, would lift a balloon of thirty feet in diameter 278 feet higher. The application of ballast is hence infinitely preferable to any such bulky and unmanageable apparatus.

The Montgolfiers actually discover the balloon.

At the period where we left our narrative, the principles on which a balloon could be constructed were therefore pretty generally known to men of science. But to reduce these principles to complete effect, was still an enterprise of the most dazzling kind. This experiment seemed unfit for a cabinet or a laboratory, and it could succeed only on a large scale, exposed to the gaze of the multitude. Without the toil of investigation, or indeed any exercise of thought, all the world might witness the result, and admire the magnificent spectacle which it would present. This triumph over matter was at length achieved by the skill and perseverance of Stephen and Joseph Montgolfier, sons of the proprietor of an extensive and very celebrated paper manufactory established at Annonay, on the banks of a rivulet which flows into the Rhone, near forty miles below Lyons. These remarkable persons, though bred in a remote provincial town, possessed in a high degree ingenuity and the spirit of observation. Without having the benefit of a liberal education, their active curiosity had led them to acquire a more extensive and accurate stock of knowledge than is usually found in the same condition of life. Stephen was more attached to mathematics, but Joseph directed his studies chiefly to chemistry and natural philosophy. They were associated in business with their father, who passed his quiet days, like a patriarch, amidst a large family, and a numerous body of workmen, and reached the very advanced age of 93. Of the younger brother, who survived the other, and lived to make the very valuable yet much neglected discovery of the hydraulic ram, we may venture to speak from personal acquaintance. He was a man of great modesty and simplicity of character, yet firm and undaunted, of a calm and sedate aspect, tall and athletic in his person, and of a swarthy complexion, not unlike the celebrated Mr Watt, whom he resembled in some other particulars of his fortune. He was too speculative, perhaps, to succeed in the details of business; for, after trying various schemes of improvement, he quitted his paper manufactory and repaired to the capital, where he obtained a situation of trust under the late imperial government, at the chamber of models, as inspector of patents and internal improvements. In 1809 he had a stroke of palsy, which induced him to resort to the waters of Bourbonne; but receiving no benefit from them, he gladly preferred those of Balaruc,

Aëronautics.

near his old friends, where he died on the 26th of June in the following year, at the age of 60.

Their successive experiments.

The two brothers, who were accustomed to form their plans in concert, had long contemplated the floating and ascent of clouds in the atmosphere. It seemed to them, that a sort of factitious cloud, formed of very thin vapour, inclosed in a light bag of immense size, would mount to the higher regions. In pursuit of this idea, they selected a fluid specifically lighter than atmospheric air; and, accordingly, introduced hydrogen gas into large bags of paper and of thin silk, which rose up, as had been expected, to the cieling, but fell down in a few seconds, owing to the rapid escape of the gas through the cracks and pores of the case. This great facility with which hydrogen gas makes its way through any substance of a loose and incompact texture, is partly due to its extreme fluidity, but is chiefly occasioned by its strong and obstinate attraction for common air. The mode of preventing, or at least checking that escape, by the application of a proper varnish, was yet unknown. The prospect of overcoming the difficulty was so discouraging, that our experimenters had recourse to another scheme, more analogous to their original ideas, and it rewarded their continued efforts with the most complete success. In the month of November 1782, Joseph Montgolfier, happening, in the course of his frequent excursions, to be then at Avignon, procured a small silk bag, of the form of a parallelopipedon, open below, like a lady's hoop, and having a capacity of about forty-five cubic feet; under its orifice he burnt some paper, and saw, with inexpressible transport, the bag quickly swell, and mount rapidly to the height of seventy-five feet, where it remained till by cooling it lost its buoyancy. Returning to Annonay, he communicated the happy result to his brother, and it was resolved by them to prosecute the experiment on a large scale. Having provided a large quantity of coarse linen, they formed it into the shape of a globe, about thirty feet in diameter, which they lined with paper. On lighting a fire within its cavity, to warm and expand the air, they had the delightful satisfaction of seeing the bag ascend with a force equivalent to 500 pounds.

It was very natural that the brothers should now desire an occasion for exhibiting this grand experiment in their native town. They invited the members of the provincial meeting of the states of the Vivarais, then assembled at Annonay, to witness the first public aërial ascent.

First public ascent of a balloon.

On the 5th June 1783, amidst a very large concourse of spectators, the spherical bag or balloon, consisting of different pieces of linen, merely buttoned together, was suspended from cross poles; two men kindled a fire under it, and kept feeding the flames with small bundles of chopped straw; the loose bag gradually swelled, assuming a graceful form, and in the space of five minutes it was completely distended, and made such an effort to escape, that eight men were required to hold it down. On a signal being given, the stays were slipped, and the balloon instantly rose with an accelerating motion, till it reached some height, when its velocity continued uniform, and carried it to an elevation of more than a mile. All was admiration and transport. Amidst the shouts of unbounded acclamation, the progress of the artificial cloud retiring from sight arrested every eye. It was hurried along by the wind; but, its buoyant force being soon spent, it remained suspended only ten minutes, and fell gently in a vineyard, at the distance of about a mile and a half from the place of its ascension. So memorable a feat lighted up the glow of national vanity, and the two Montgolfiers were hailed and exalted by the spontaneous impulse of their fellow-citizens.

Of this splendid experiment a very hasty and imperfect account was transmitted to Paris, and quickly circulated over Europe. In those halcyon days, during the transient calm of political turmoils, and the happy absence of all military events, the prospect of navigating the atmosphere excited a very general ferment, and engrossed the conversation of all ranks. Yet the tale appeared so extraordinary as to leave some doubts of its veracity. In many places, and especially in this country, the more ignorant class of men, and those who affected superior wisdom, both agreed in considering the relation of Montgolfier's discovery as nothing but an imposition practised on the public credulity. To dispel the suspicions which infected the subject, it was necessary to repeat the experiment in every large capital.

The impression made by it in Europe.

When the intelligence of the first ascent of a balloon reached St Petersburg, it found the venerable Euler in a state of great debility, worn out with years and unremitting intellectual toil. Having lost, in the middle of his career, the sight of an eye, he had been for several years visited with total blindness. But in this afflicting situation his mind was still entire, and found delightful exercise in his former habits of calculation. It was in training a domestic to act as his amanuensis, that this great genius now condescended to dictate, in the German language, to his humble pupil, a work of the highest merit, *The Elements of Algebra*. During his last illness, Euler made an expiring effort, and applied his favourite analysis to determine the ascending motion of a balloon. He dictated the preliminary steps of the problem to one of his grandchildren: but the hand of death was already stretched over the patriarch;—no farther could he proceed with his investigation;—and composing himself for nobler scenes, he calmly expected the moment of dissolution.

Imitated at Paris.

The virtuosi at Paris were eager to repeat the experiment of the ascension of a balloon. M. Faujas de St Fond, an active and zealous naturalist, set on foot a subscription for defraying the expense, which was soon filled up. The construction of the machine was intrusted to the skill of two brothers of the name of Robert, under the superintendence of M. Charles, an ingenious lecturer in natural philosophy. It had at first been proposed merely to copy the process of Montgolfier, but Charles preferred the application of hydrogen gas; a resolution which afterwards occasioned much difficulty and delay. The balloon consisted of thin silk or tiffany, varnished with a solution of elastic gum, disposed into a globular shape, of about thirteen feet in diameter. The hydrogen gas was procured from the action of dilute sulphuric acid upon iron-filings, and was introduced through leaden pipes. But this gas, being rapidly formed, without having been made to pass through a body of cold water, entered the cavity of the balloon excessively hot, and charged with acid fumes, which afterwards condensed against the inside of the bag, injuring its texture, and loading it with superfluous humidity. Not fewer than 500 pounds of sulphuric acid were used, and twice this weight of iron-filings; yet several days were spent in abortive attempts to fill the balloon completely. At last it rose, and was kept suspended at the height of 100 feet above the ground. In this state it was conveyed with acclamations to the Place des Victoires, where it rested, and underwent some repair. About midnight it was thence transported in silent procession, preceded by torch-lights, and guarded by a detachment of horse and foot soldiers, to the Champ de Mars, at the distance of near two miles. The few passengers found at that still hour on the streets gazed with astonishment at the floating mass; and the very coachmen, filled with a sort of awe, respectfully saluted it as they passed.

Next day, being the 27th of August 1783, an immense

Balloon of Charles and Robert.

concourse of people covered the Champ de Mars, and innumerable spectators had planted themselves along the banks of the Seine and the amphitheatre of Passy. By three o'clock every avenue was filled with carriages, and all the beauty and fashion of Paris flocked towards the Ecole Militaire. The preparations being finished, a cannon was discharged as the signal of ascent. The balloon, liberated from its stays, shot upwards with such rapidity as in two minutes to reach, according to calculation, the height of 3000 feet, where it seemed lost in a dark cloud. It re-appeared at a greater elevation, but was soon obscured again amidst other clouds; and after performing a flight of about fifteen miles in the space of three quarters of an hour, it sunk to the ground in a field near Ecouen, where the peasants secured it, having noticed a rent in the upper part of the bag, to which its fall might be imputed. The success of the experiment was complete. The incredulous were sadly mortified; but every minor reflection was drowned in the tumult of excessive joy and exultation. It began to rain immediately after the balloon was launched, yet this unlucky circumstance had no effect to abate the curiosity of the spectators. Regardless of the torrents that fell, they were wholly absorbed in following with eager gaze the progress of the machine through the air. Even elegant ladies, dressed in their finest attire, stood exposed, looking intently the whole time, and were drenched to the skin. This small balloon weighed only thirty pounds, and had at first a buoyant force of forty pounds avoirdupois. If we employ the formula before given, the terminal velocity would be $\frac{40}{13}\sqrt{40} = 19\frac{6}{13}$ feet in a second, or 1168 feet each minute; which appears to correspond very well with fact.

Joseph Montgolfier constructs one of his balloons at Paris.

About this time Joseph Montgolfier visited Paris, and was invited by the Royal Academy of Sciences to repeat his experiment of Annonay on a larger scale. He constructed, with coarse linen and a paper lining, a balloon of a pear shape, and about 43 feet wide and 75 feet high. The smoke of fifty pounds of dry straw, in small bundles, joined to that of twelve pounds of wool, was found sufficient to fill it in the space of ten minutes. The bag duly swelled, and made an effort to rise equivalent to the weight of 500 pounds; but being reserved for exhibition the next day, it was totally destroyed, by its exposure during the night to incessant and violent rain. It became necessary, therefore, to prepare another balloon; and such was the expedition of the artist, that in five days he got the whole completed. Early on the morning of the 19th of September, it was placed upon an octagon scaffold, in front of the palace of Versailles. It had a very showy appearance, being painted with ornaments in oil colours. By ten o'clock the road from Paris was crowded with carriages of all descriptions. Every person of any note or fashion hurried from the metropolis to view the experiment; ladies of distinguished rank filled the windows; and the spacious courts and walks, and even the tops of the houses, were covered with impatient spectators. The royal family and their attendants came forth, and examined the details of the apparatus. About one o'clock the discharge of a mortar gave notice that the filling of the balloon was to commence. In eleven minutes another discharge announced that it was completely inflated; and on the third discharge of the mortar, the cords were cut, and the balloon instantly liberated. After balancing at first in a moment of anxious expectation to the spectators, it rose majestically, in an oblique direction, under the impulse of the wind, till it reached the height of 1500 feet, where it appeared for a while suspended; but in the space of eight minutes it dropped to the ground, at the distance of two miles from the point of its ascent. A sheep, a cock, and a duck, which had been put into the basket, the first animals ever carried up into the air, were found perfectly safe and unhurt by the journey, and the sheep even feeding at perfect ease. See Plate II. for a view of this balloon and the following ones.

This successful experiment encouraged Montgolfier to prepare, on a more solid construction, another balloon, of a spheroidal form, 45 feet wide and 75 feet high. While it was filling with smoke, Pilatre de Rozier, a young naturalist of great promise, and full of ardour and courage, leaped into the car, and was borne up to the height of 300 feet, where he continued some minutes suspended, the balloon being held down by long cords till it gently descended. The dangers of navigating the balloon being thus brought to a more correct estimate, it was resolved speedily to attempt the daring but sublime experiment. The badness of the weather, however, at this late season of the year, made the project be deferred several days. At last, on the 21st of November, every thing was ready for the ascent in the spacious gardens of the chateau of Muette, belonging to the court of the Dauphin. The sky had a lowering aspect, being loaded with heavy clouds, driven about by irregular winds. But the adventurers were not to be easily discouraged. After a first trial, which had nearly proved fatal to them, the balloon was again filled; and Rozier, with the marquis d'Arlandes, a major of infantry, who had volunteered to accompany him, took their seats in the car, having a store of ballast, and a provision of straw to supply the fire. About two o'clock the machine was launched, and it mounted with a steady and majestic pace. Wonder, mingled with anxiety, was depicted in every countenance; but when, from their lofty station in the sky, the navigators calmly waved their hats, and saluted the spectators below, a general shout of acclamation burst forth on all sides. As they rose much higher, however, they were no longer discernible by the naked eye.

Makes the first aërial voyage.

> .................. in the surging smoke
> Uplifted spurn the ground; thence many a league,
> As in a cloudy chair ascending, ride
> Audacious.

This balloon soared to an elevation of more than 3000 feet, and traversed, by a circuitous and irregular course, the whole extent of Paris, whose gay inhabitants were all absorbed in admiration and amazement. A curious circumstance occurred during the passage of the floating mass: to the gazers planted on the towers of the metropolitan church of Notre Dame, it chanced to intercept the body of the sun, and thus gave them, for a few seconds, the spectacle of a total eclipse. It has been alleged, that when the balloon had reached so high that the objects on earth were no longer distinguishable, the marquis d'Arlandes began to think that his curiosity and ambition were sufficiently gratified. He was therefore anxious to descend, and murmured against his companion, who still kept feeding the fire. At last, on hearing some cracks from the top of the balloon, and observing holes burning in the sides, the major became outrageously alarmed at his imminent danger, and applying wet sponges to stop the progress of combustion, he compelled the *savant* to desist from his officious operations. As they now descended too fast, however, M. d'Arlandes was not less anxious and diligent in throwing fresh straw upon the fire, in order to gain such an elevation as would clear the different obstacles. The navigators dexterously avoided the lofty buildings of Paris, by supplying fuel as occasion required; and, after a journey of 20 or 25 minutes, they safely alighted beyond the Boulevards, having described a track of six miles.

Such was the prosperous issue of the first aërial navigation ever achieved by mortals. It was a conquest of science which all the world could understand; and it flattered extremely the vanity of that ingenious people, who hailed its splendid progress, and enjoyed the honour of their triumph. The Montgolfiers had the annual prize of six hundred livres adjudged to them by the Academy of Sciences; the elder brother was invited to court, decorated with the badge of St Michael, and received a patent of nobility; and on Joseph a pension was bestowed, with the further sum of forty thousand livres, to enable him to prosecute his experiments with balloons.

The facility and success, however, of the smoke or fire balloons appeared to throw into the shade the attempts made by the application of hydrogen gas. M. Charles, the promoter of this plan, was keenly reproached by M. Faujas de St Fond, for departing from the method practised by the original inventor; and he was, moreover, with his associates the Roberts, held up to public derision in the smaller theatres of Paris. To silence the cavils and insinuations of his antagonists, he resolved, therefore, on making some new efforts. A subscription was opened to defray the expense of a globe twenty-eight feet in diameter, and formed of tiffany, with elastic varnish. After repeated accidents and delays, this balloon was planted, on the 1st of December 1783, at the entrance of the great alley of the Tuilleries; and the diffuse fluid was this time introduced into it from a sort of gasometer. The dilute sulphuric acid and the iron-filings being put into wooden casks, disposed round a large cistern, the gas was conveyed in long leaden pipes, and made to pass through the water under a glass bell plunged in it. The whole apparatus cost about L.400 sterling, one-half of which was expended on the production of the gas alone. An immense concourse of spectators had collected from all parts. The discharge of a cannon at intervals announced the progress in filling the balloon. To amuse the populace, and quiet their impatience, M. Montgolfier was desired to let off a small fire-balloon, as a mark of his precedence. At last, the globe being sufficiently inflated, and a quantity of ballast, consisting of small sand bags, lodged in the car, leaving only $22\frac{1}{2}$ pounds for the measure of the buoyant force, MM. Charles and Robert placed themselves in the appended boat or car, and the machine was immediately disengaged from its stays. It mounted with a slow and solemn motion. According to the formula given, the terminal velocity of ascension must have been only about 400 feet each minute, or at the rate of somewhat less than five miles in the hour. "The car, ascending amidst profound silence and admiration," to borrow the warm and exaggerated language of the reporter, "allowed, in its soft and measured ascent, the bystanders to follow with their eyes and their hearts two interesting men, who like demigods soared to the abode of the immortals, to receive the reward of intellectual progress, and carry the imperishable name of Montgolfier. After the globe had reached the height of 2000 feet, it was no longer possible to distinguish the aërial navigators; but the coloured pennants which they waved in the air testified their safety and their tranquil feelings. All fears were now dissipated; enthusiasm succeeded to astonishment; and every demonstration was given of joy and applause." The balloon, describing a tortuous course, and rising or sinking according to the fancy of its conductors, was, after a flight of an hour and three quarters, made to alight on the meadow of Nesle, about twenty-five miles from Paris. For the space of an hour, the buoyancy of the machine had been sensibly augmented by the sun's rays striking against the surface of the bag, and heating up the contained gas to the temperature of 55 degrees by Fahrenheit's scale.

New balloon of Charles and the Roberts.

Their ascent.

After this prosperous descent, the globe, though become rather flaccid and loose by its expenditure, yet still retained a great buoyant force when relieved from the weight of the travellers. The sun had just set, and the night was beginning to close; but M. Charles formed the resolution of making alone another aërial excursion. His courage was rewarded by the spectacle of one of the most novel and enchanting appearances in nature. He shot upwards with such celerity as to reach the height of near two miles in ten minutes. The sun rose again to him in full orb; and, from his lofty station in the heavens, he contemplated the fading luminary, and watched its parting beams, till it once more sunk below the remote horizon. The vapours rising from the ground collected into clouds, and covered the earth from his sight. The moon began to shine, and her pale rays scattered gleams of various hues over the fantastic and changing forms of those accumulated masses. This scene had all the impressive solemnity of the true sublime. No wonder that the first mortal eye that ever contemplated such awful grandeur could not refrain from shedding tears of joy and admiration. The region in which M. Charles hovered was now excessively cold; and as he opened the valve occasionally during his ascent, to prevent the violent distension of the balloon, the hydrogen gas, not having time to acquire the temperature of the exterior air, rushed out like misty vapour, with a whistling noise. But prudence forbade the voyager to remain long at such an elevation, while darkness was gathering below. He therefore descended slowly to the earth, and, after the lapse of 35 minutes, alighted near the wood of Tour du Lay, having, in that short interval, travelled about nine miles.

Ascent of Charles alone.

This balloon, with its passengers and ballast, weighed at first 680 pounds; but, notwithstanding the care taken in filling it, the hydrogen gas must have been mixed with a large proportion of common air, since it was only $5\frac{1}{4}$ times lighter than this fluid. The barometer, which stood at 29·24 English inches at the surface of the ground, subsided to 20·05 at the greatest elevation to which M. Charles had reached. This gives by calculation an altitude of 9770 feet. The thermometer, which was at 41° by Fahrenheit's scale at the first ascent, fell to 21° at the highest flight; giving a difference of one degree for every $488\frac{1}{2}$ feet of ascent.

The next voyage through the air was performed in the largest balloon ever yet constructed. The elder Montgolfier had been persuaded to open a subscription at Lyons for the sum of L.180 sterling, to construct an aëronautic machine capable of upholding a great weight, and of carrying a horse or other quadruped. It had an elongated shape, 109 feet wide and 134 feet high, and was formed of two folds of linen, having three layers of paper laid between them, and quilted over with ribands. It showed at first enormous buoyant power. A truss of straw, moistened with spirit of wine, was found, when set on fire, to yield humid smoke sufficient to inflate the balloon, and the burning of five pounds weight of alder faggots kept it in full action. Though loaded with a ballast of eighteen tons, it yet lifted up six persons from the ground. Unfortunately, it was very much damaged one night, in consequence of being exposed to rain, frost, and snow. However, on the 19th of January 1784, the balloon was charged in seventeen minutes, by the combustion of 550 pounds of alder. Joseph Montgolfier, accompanied by the ardent Pilatre de Rozier, and four other persons of note, with the proper ballast, took their seats in a wicker gallery, and were launched into the atmosphere. They

Ascent of Montgolfier at Lyons.

manœuvred over the city of Lyons, and near the course of the Rhine, for the space of forty minutes; but a large rent having been observed in the upper part of the balloon, they were compelled to descend abruptly, though without any further accident.

The difficulties and dangers of aërial navigation being at length surmounted, the ascents of balloons were now multiplied in all quarters. It will therefore be sufficient henceforth to notice very succinctly some of the more distinguished attempts of that kind.

Andreani.

The Chevalier Paul Andreani of Milan had a spherical balloon, of 70 feet in diameter, formed after Montgolfier's plan, at his own charge, in which, accompanied by two companions, he ascended from that capital on the 25th of February 1784. The machine rose to the height of 1300 feet; but after having described, in twenty minutes, a very circuitous track, it settled upon a large tree, from which however the voyagers, by applying fresh fuel, extricated themselves, and alighted on clear ground, without receiving any hurt.

Blanchard.

On the 2d of March Blanchard, who had been for some years before occupied with the chimerical project of flying in the air, and who fancied that the same principles and contrivances might be applied to direct the motion of balloons, mounted alone, and with great intrepidity, at Paris, in a silk balloon 40 feet in diameter, constructed by subscription, and filled with hydrogen gas. He darted rapidly to the height of above a mile, and after being driven about by cross winds for an hour and three quarters, he descended in the plain of Billancourt.

On the 28th of June in the same year, an ascent was made at Lyons before the King of Sweden, who then travelled under the name of Count Haga, with a fire-balloon, having somewhat of a pear shape, and 75 feet in height.

Fleurant and Thiblé.

Two passengers, M. Fleurant and a young lady, Madame Thiblé, the first female that ever adventured on such a daring voyage, entered the car, and ascended with great velocity. In four minutes the noise of the multitude was no longer audible, and in two more the eye could not distinguish them. It was inferred, from a trigonometrical calculation, that they had reached the altitude of 13,500 feet. Their flag, with its staff of 14 pounds weight, being thrown down, took seven minutes to fall to the ground. The thermometer had dropt to 43° on Fahrenheit's scale; and to the sensation of cold which they felt was joined that of a ringing in the ears. Different currents were found to occupy distinct strata of the atmosphere; and in passing from one stratum to another, the balloon was affected by a sensible undulation. The travellers continued to feed their fire with the loppings of vines, till this provision being nearly spent, they safely alighted in a corn-field, having traversed about six miles in three quarters of an hour.

Rozier and Proust.

About a fortnight afterwards, the same prince was gratified by a more splendid ascent, commanded for his entertainment by the French monarch. A large fire-balloon, carrying the naturalists Rozier and Proust, was launched from the outer court of Versailles. It soared to the height of 12,520 feet, and might appear to float in a vast congregation of extended and towering white clouds. The thermometer stood at 21° of Fahrenheit, and the flakes of snow fell copiously on the voyagers, while it only rained below. Descending again from that chaotic abyss, they were charmed with the lively aspect of a rich and populous district. They alighted at the entrance of the forest of Chantilly, about thirty-six miles from Versailles, after a flight of an hour and five minutes.

We omit the relation of a prosperous ascent performed at Rhodés on the 6th of August, by the Abbé Carnus and his companion, with a fire-balloon, of a globular shape, and 57 feet in diameter.—The longest aërial journey yet made was accomplished at Paris, on the 19th of September. The duke de Chartres, afterwards Orleans, and the noted Egalité, employed Robert to construct for him a silk balloon, which should be filled with hydrogen gas. It had 56 feet in height and 36 feet diameter, being composed of a cylinder terminated by two hemispheres; a construction which was rightly supposed to give much additional solidity to the machine. A small bag, on Meusnier's plan, had been introduced within it, and the boat was, besides, furnished with a helm and four oars. This balloon, bearing the duke himself, the two artists, and another companion, and having 500 pounds of ballast, was allowed to rise very slowly, with a buoyancy of only 27 pounds. At the height of 1400 feet, the voyagers perceived, not without uneasiness, thick dark clouds gathering along the horizon, and threatening the approach of a thunder-storm. They heard the distant claps, and experienced something like the agitation of a whirlwind, although they had not felt the slightest concussion in the air from the discharge of cannon. The thermometer suddenly dropped from 77° Fahrenheit to 61°; and the influence of this cold caused the balloon to descend within 200 feet of the tops of the trees near Beauvais. To extricate themselves, they now threw out more than forty pounds of ballast, and rose to an elevation of 6000 feet, where it was found that the confined gas had so obstinately retained its heat, as to be no less than 42° warmer than the external air. The duke became alarmed, and betrayed such impatience to return again to the earth, that he is said to have pierced the lower part of the silk bag in holes with his sword. After narrowly escaping the dangers from wind and thunder, the balloon at last descended in safety near Bethune, having performed a course of 135 miles in the space of five hours.

Duke of Orleans.

Guyton-Morveau.

On the 25th of April in the same year, the celebrated chemist Guyton-Morveau, with the Abbé Bertrand, ascended from Dijon in a balloon, nearly of a globular shape, 29 feet in diameter, composed of the finest varnished tiffany, and filled with hydrogen gas. They did not start till five o'clock in the evening, the barometer being at 29·3 inches, and the thermometer at 57° on Fahrenheit's scale; and, after surmounting some accidents, they rose to an altitude of 10,465 feet, or very nearly two English miles, where the barometer had sunk to 19·8 inches, and the thermometer to 25°. They felt no inconvenience, however, except from the pinching of their ears with cold. They saw an ocean of clouds below them, and in this situation they witnessed, as the day declined, the beautiful phenomenon of a parhelion, or mock sun. The real luminary was only ten degrees above the horizon, when, all at once, another sun appeared to plant itself within six degrees of the former. It consisted of numerous prismatic rings, delicately tinted, on a ground of dazzling whiteness. At half-past six o'clock, after a voyage of an hour and a half, they safely alighted near Magny, about fifteen miles distant from Dijon.

His second ascent.

With the same balloon, M. Guyton-Morveau made a second ascent on the 12th of June, accompanied by the President De Virly. It was launched at seven o'clock in the morning, the barometer being then at 29·5 inches, the thermometer at 66°, and Saussure's hygrometer at $81\frac{1}{2}$°. It swelled very fast, however, owing to the effect of the sun's increasing heat; and the upper valve being at intervals opened, to give vent to excess of the gas, this escaped with a noise like the rushing of water. As the voyagers did not mount to any very great elevation, they enjoyed an agreeable temperature, and could easily, by observing

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the situation of the different villages scattered below them, trace out their tortuous route on the surface of the map. By nine o'clock they had reached the height of 6030 feet, the barometer now standing at 24·7 inches, the thermometer at 70°, and the hygrometer at $65\frac{1}{2}$. Three quarters of an hour afterwards they descended at the village of Etevaux, only twelve miles from Dijon, having described at least double this distance in the air. The heat had increased so much since the morning, that, notwithstanding the loss of elastic fluid, the balloon seemed yet nearly inflated on touching the ground.

Remarkable voyage of Testu.

An aërial voyage, most remarkable for its duration and its adventures, was performed on the 18th of June 1786, from Paris, by M. Testu, with a balloon 29 feet in diameter, constructed by himself, of glazed tiffany, furnished with auxiliary wings, and filled, as usual, with hydrogen gas. It had been much injured by wind and rain during the night before its ascension; but having undergone a slight repair, it was finally launched, with its conductor, at four o'clock in the afternoon. The barometer then stood at 29·68 inches, and the thermometer as high as 84°, though the day was cloudy and threatened rain. The balloon had at first been filled only five-sixths, but it gradually swelled as it became drier and warmer, and acquired its utmost distension at the height of 2800 feet. But, to avoid the waste of gas or the rupture of the silk, the navigator endeavoured to descend by the re-action of his wings. Though this force had little efficacy, yet at half-past five o'clock he softly alighted on a corn-field in the plain of Montmorency. Without leaving the car, he began to collect a few stones for ballast; when he was surrounded by the proprietor of the field and a troop of peasants, who insisted on being indemnified for the damage occasioned by his idle and curious visitors. Anxious now to disengage himself, he persuaded them that, his wings being broken, he was wholly at their mercy. They seized the stay of the balloon, which floated at some height, and dragged their prisoner through the air in a sort of triumph towards the village. But M. Testu, finding that the loss of his wings, his cloak, and some other articles, had considerably lightened the machine, suddenly cut the cord, and took an abrupt leave of the clamorous and mortified peasants. He rose to the region of the clouds, where he observed small frozen particles floating in the atmosphere. He heard thunder rolling beneath his feet, and, as the coolness of the evening advanced, the buoyant force diminished, and, at three quarters after six o'clock, he approached the ground near the abbey of Royaumont. There he threw out some ballast, and in the space of twelve minutes rose to a height of 2400 feet, where the thermometer was only 66 degrees. He now heard the blast of a horn, and descried huntsmen below in full chace. Curious to witness the sport, he pulled the valve, and descended, at eight o'clock, between Etouen and Varville, when, rejecting his oars, he set himself to gather some ballast. While he was thus occupied, the hunters galloped up to him. He mounted a third time, and passed through a dense body of clouds, in which thunder followed lightning in quick succession.

> With fresh alacrity and force renew'd,
> Springs upward, like a pyramid of fire,
> Into the wild expanse, and through the shock
> Of fighting elements, on all sides round
> Environ'd wins his way.

The thermometer fell to 21°, but afterwards regained its former point of 66°, when the balloon had reached the altitude of 3000 feet. In this region the voyager sailed till half-past nine o'clock, at which time he observed from his "watch-tower in the sky" the final setting of the sun. He was now quickly involved in darkness, and enveloped in the thickest mass of thunder-clouds. The lightnings flashed on all sides, and the loud claps were incessant. The thermometer, seen by the help of a phosphoric light which he struck, pointed at 21°, and snow and sleet fell copiously around him. In this most tremendous situation the intrepid adventurer remained the space of three hours, the time during which the storm lasted. The balloon was affected by a sort of undulating motion upwards and downwards, owing, he thought, to the electrical action of the clouds. The lightning appeared excessively vivid, but the thunder was sharp and loud, preceded by a sort of crackling noise. A calm at last succeeding, he had the pleasure to see the stars, and embraced this opportunity to take some necessary refreshment. At half-past two o'clock the day broke in; but his ballast being nearly gone, and the balloon again dry and much elevated, he resolved to descend to the earth, and ascertain to what point he had been carried. At a quarter before four o'clock, having already seen the sun rise, he safely alighted near the village of Campremi, about 63 miles from Paris.

Balloons in England.

At this period, ascents with balloons had been multiplied, not only through France, but all over Europe. They were very seldom, however, directed to any other object than amusement, and had soon degenerated into mere exhibitions for gain. The first balloon seen in England was constructed by an ingenious Italian, the Count Zambeccari. It consisted of oiled silk, in a globular shape, about ten feet in diameter, and weighed only eleven pounds. It was entirely gilt, which not only gave it a beautiful appearance, but rendered it less permeable to the gas. On the 25th of November 1783 it was filled about three-fourths, and launched at one o'clock from the artillery ground, and in the presence of a vast concourse of spectators. At half-past three in the afternoon it was taken up at Petworth, in Sussex, about the distance of 48 miles. It was not till the following year, on the 21st of September, that a countryman of his, named Lunardi, first mounted in a balloon at London. He afterwards repeated the experiment in different parts of England, and during the following year in Scotland. This active person took an expeditious but careless method of filling his balloon with gas. He had two large casks, sunk into the ground for their better security, in which he deposited 2000 pounds of the borings of cannon, divided by layers of straw, to present a larger surface. An equal weight of sulphuric acid, or common oil of vitriol, diluted with six times as much water, was poured upon the iron, and the hydrogen gas now formed, without being cooled or washed, was immediately introduced into the balloon. To Lunardi succeeded Blanchard, who possessed just as little science, but had greater pretensions, and some share of dexterity and skill. This adventurer is said to have performed not fewer than thirty-six voyages through the air, and to have acquired a large sum of money by those bold and attractive exhibitions. His most remarkable journey was across the British Channel, in company with Dr Jeffries, an American physician. On the 7th of January 1785, in a clear frosty day, the balloon was launched from the cliff of Dover, and, after a perilous course of two hours and three quarters, it alighted in safety on the edge of the forest of Guicnnes, not far beyond Calais. By the magistrates of this town were the two aërial travellers treated with the utmost kindness and hospitality; and their wondrous arrival was welcomed as a happy omen, alas! how fallacious, of the lasting harmony to subsist between rival nations, now cemented by the conclusion of the famous Commercial Treaty.

Zambeccari. Lunardi. Blanchard.

The original smoke balloon of Montgolfier appears to

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have gradually fallen into disrepute, and the more elegant and expensive, but far more powerful construction, which employs varnished silk to contain hydrogen gas, came to be generally preferred. With due precaution and management, the sailing through the atmosphere is perhaps scarcely more dangerous now than the navigating of the ocean. Of some hundred ascents made at different times with balloons, not above two or three cases are recorded to have had a fatal termination. The first was rendered memorable by the shocking death of the accomplished and interesting Rozier, who perished a martyr to his ardent zeal for the promotion of science. Being anxious to return the visit which Blanchard and Jeffries had paid to the French coast, by crossing the channel again and descending in England, he transported his balloon, which was of a globular shape, and forty feet in diameter, to Boulogne; and after various delays, occasioned chiefly by adverse winds, he mounted on the 15th June 1785, with his companion M. Romain. From some vague idea of being better able to regulate the ascent of the balloon, he had most incautiously suspended below it a small smoke one of ten feet diameter; a combination to which may be imputed the disastrous issue. Scarcely a quarter of an hour had elapsed, when the whole apparatus, at the height of above three thousand feet, was observed to be on fire; and its scattered fragments, with the unfortunate voyagers, were precipitated to the ground. They fell near the sea-shore, about four miles from Boulogne, and were instantly killed by the tremendous crash, their bodies being found most dreadfully mangled. The next fatal accident with balloons happened in Italy, several years later, when a Venetian nobleman and his lady, after having performed successfully various ascents, fell from a vast height, and perished on the spot. A few years ago, the younger William Sadler, one of our most skilful aëronauts, who had successfully crossed the Irish channel from Dublin to Anglesey, was killed by collision with a tall chimney, in a descent at Liverpool.

Shocking fate of Rozier and Romain.

The Parachute.

To guard, in some degree, against the risks arising from the occurrence of such accidents, the *Parachute* was afterwards introduced; being intended to enable the voyager, in case of alarm, to desert his balloon in mid-air, and drop, without sustaining injury, to the ground. The French language, though not very copious, has yet supplied this convenient term, signifying *a guard for falling*, as it has likewise furnished the words of analogous composition, *parapluie, paravent*, and *parasol*, to denote *an umbrella, a door-screen*, and *a shade for the sun*. The *parachute* very much resembles the ordinary umbrella, but has a far greater extent. The umbrella itself, requiring such strength to bear it up against a moderate wind, might naturally have suggested the application of the same principle to break the force of a fall. Nothing was required but to present a surface having dimensions sufficient to experience from the air a resistance equal to the weight of descent, in moving through the fluid with a velocity not exceeding that of the shock which a person can sustain without any danger. Accordingly, in the East, where the umbrella, or rather the parasol, has been from the remotest ages in familiar use, this implement appears to be occasionally employed by vaulters, for enabling them to jump safely from great heights. Father Loubere, in his curious account of Siam, relates that a person, famous in that remote country for his dexterity, was accustomed to divert exceedingly the king and the royal court by the prodigious leaps which he took, having two umbrellas with long slender handles fastened to his girdle. He generally alighted on the ground, but was sometimes carried by the wind against trees or houses, and not unfrequently into the river. Not many years since, the umbrella was, at least on one occasion, employed in Europe with similar views, but directed to a very different purpose. In the early part of the campaign of 1793, the French general Bournonville, having been sent by the National Convention, with four more commissioners, to treat with the Prince of Saxe-Cobourg, was, contrary to the faith or courtesy heretofore preserved in the fiercest wars that have raged among civilized nations, detained a prisoner with his companions, and sent to the fortress of Olmutz, where he suffered a rigorous confinement. In this cruel situation he made a desperate attempt to regain his liberty. Having provided himself with an umbrella, he jumped from a window at the height of forty feet; but being a very large heavy man, this screen proved insufficient to check his precipitate descent. He struck against the opposite wall, fell into the ditch, and broke his leg, and was carried in this condition back again to his dungeon.

First used.

Blanchard was the first who constructed parachutes, and annexed them to balloons, for the object of effecting his escape in case of accident. During the excursion which he undertook from Lisle, about the end of August 1785, when this adventurous aëronaut traversed, without halting, a distance not less than 300 miles, he let down a dog from a vast height in the basket of a *parachute*, and the poor animal, falling gently through the air, reached the ground unhurt. Since that period the practice and management of the *parachute* have been carried much farther by other aërial travellers, and particularly by M. Garnerin, who has dared repeatedly to descend from the region of the clouds with that very slender machine.

Garnerin's descent.

This ingenious and spirited Frenchman visited London during the short peace of 1802, and made two fine ascents with his balloon, in the second of which he threw himself from an amazing elevation with a parachute. This consisted of thirty-two gores of white canvass formed into a hemispherical case of twenty-three feet diameter, at the top of which was a truck or round piece of wood ten inches broad, and having a hole in its centre, admitting short pieces of tape to fasten it to the several gores of the canvass. About four feet and a half below the top, a wooden hoop of eight feet in diameter was attached by a string from each seam; so that when the balloon rose, the parachute hung like a curtain from this hoop. Below it was suspended a cylindrical basket covered with canvass, about four feet high, and two and a quarter wide. In this basket the aëronaut, dressed in a close jacket and a pair of trousers, placed himself, and rose majestically from an inclosure near North Audley Street at six o'clock in the evening of the 2d of September. After hovering seven or eight minutes in the upper region of the atmosphere, he meditated a descent in his parachute. Well might he be supposed to linger there in dread suspense, and to

> ..................................... look a while
> Pondering his voyage; for no narrow frith
> He had to cross...............
> He views the breadth, and, without longer pause,
> Downright into the world's first region throws
> His flight precipitant, and winds with ease,
> Through the pure marble air, his oblique way.

He cut the cord by which his parachute was attached to the net of the balloon; it instantly expanded, and for some seconds it descended with an accelerating velocity, till it became tossed extremely, and took such wide oscillations that the basket or car was at times thrown almost into a horizontal position. Borne along likewise by the influence of the wind, the parachute passed over Mary-le-bone and Somers-town, and almost grazed the houses of St Pancras. At last it fortunately struck the ground in a neighbouring field; but so violent was the shock as to throw poor Garnerin on his face, by which accident he received some cuts, and bled considerably. He seemed to be much agitated, and trembled exceedingly at the moment he was released from the car. One of the stays of the parachute had chanced to give way; which untoward circumstance deranged the apparatus, disturbed its proper balance, and threatened the adventurer, during the whole of his descent, with immediate destruction. The feeling of such extreme peril was too much for human nature to bear.

Theory of the parachute.

From the principles before explained, we may easily determine the descent of a parachute. When, with its attached load, it is abandoned in the air, it must, from the continued action of gravity, proceed at first with an accelerated motion, till its increasing velocity comes to oppose a resistance equal to the force of attraction, or to the combined weight of the whole apparatus. After this counterpoise has taken place, there existing no longer any cause of acceleration, the parachute should descend uniformly with its acquired rapidity. This perfect equilibrium will not, however, be attained at once. The accumulation of swiftness produced by the unceasing operation of gravity, is not immediately restrained by the corresponding increased resistance of the atmosphere. The motion of a parachute must hence, for some short time, be subject to a sort of interior oscillation, alternately accelerating and retarding. It first shoots beyond the terminal velocity, and then, suffering greater resistance, it relaxes, and contracts within the just limits. This unequal and undulating progress which a parachute exhibits subsequently to the commencement of its fall, is calculated to excite disproportionate alarms of insecurity and danger.

Rate of its descent.

The terminal velocity of a parachute, or the uniform velocity to which its motion tends, would, according to theory, be equal, if its surface were flat, to the velocity that a heavy body must acquire in falling through the altitude of a column of air incumbent on that surface, and having, under the usual circumstances, the same weight as the whole apparatus. But we have already seen, that a cylinder of air, one foot in diameter and height, weighs only, in ordinary cases, the seventeenth part of a pound avoirdupois. Wherefore, if the square of the diameter of a parachute be divided by 17, the quotient will give the number of pounds equivalent to the weight of an atmospheric column of one foot; and the weight of the apparatus being again divided by this quotient, the result will express the entire altitude of an equiponderant column. Of this altitude, the square root multiplied by 8 will denote the final velocity, or that with which the parachute must strike the ground. Suppose, for example, that the diameter of the parachute were 25 feet: then $25 \times 25 = 625$; and this, divided by 17, gives $36\frac{13}{17}$. Consequently, if the parachute with its load weighed only $36\frac{13}{17}$ pounds, the shock received at the surface of the earth would be precisely the same as that which is felt in dropping from an elevation of one foot. Had the weight of the apparatus, therefore, been four times greater, or $147\frac{1}{17}$ pounds, the shock sustained would be the same as that from a fall of four feet; which is near the limit, perhaps, of what a person can bear without suffering injury from the violence of concussion. The velocity of descent, on this latter supposition, would be $8\sqrt{4}$, or sixteen feet each second.

Correct formula.

But the actual resistance of the air is rather greater than what theory would give; and it is besides augmented by the concavity of the opposing surface, which occasions an accumulation of the fluid. Let $a$ denote the diameter of a parachute, and $f$ the total weight of the apparatus abandoned to its gravity in the atmosphere; if we take Dr Hutton's valuable experiments for the basis of the calculation, the terminal velocity of descent may be expressed in round numbers, by $\frac{26}{a}\sqrt{f}$, in feet each second, and consequently the length of fall which would occasion the same shock, is $\left(\frac{13}{4a}\right)^2 . f$, or very nearly $\frac{10\frac{1}{2}}{a^2} . f$. Thus, if the parachute had thirty feet in diameter, and weighed, together with its appended load, 225 pounds; then $\frac{26}{30}\sqrt{225} = \frac{26}{30} \times 15 = \frac{13}{15} \times 15 = 13$ feet, or the velocity with which it would strike the ground; and $\left(\frac{13}{120}\right)^2 225 = 2\frac{3}{8}$ feet, being the height from which a person dropping freely would receive the same shock.

Celerity in the higher regions.

Since the resistance which air opposes to the passage of a body is diminished by rarefaction, it is evident, that the parachute disengaged from a balloon, in the more elevated regions of the atmosphere, will at first acquire a greater velocity than it can afterwards maintain as it approaches the ground. Resuming the notation employed before, the ratio of the density of the air at the surface, and at any given height, being expressed by $n : m$; then the velocity of counterpoise at that elevation would be $\frac{26}{a}\sqrt{\frac{m}{n} . f}$, or it would be equal to what is accumulated in falling freely a height of $\frac{10\frac{1}{2}}{a^2} . \frac{m}{n} . f$ feet. It is the final velocity, however, that must be chiefly considered in parachutes, being what determines the shock sustained in alighting. The violence of the rushing through the air will seldom be attended with any serious inconvenience. If we suppose the mean velocity with which a parachute descends to be twelve feet each second, this will correspond to the rate of a mile in $7\frac{1}{2}$ minutes; not more than that of a very gentle trot. We are not told from what height Garnerin dropped; but if he took four minutes in his descent, it was probably about half a mile.

The practice of aëronautics has not realized those expectations of benefit to mankind which sanguine projectors were at first disposed to entertain. It was soon found, that a balloon, launched into the atmosphere, is abandoned, without guidance or command, to the mercy of the winds. To undertake to direct or impel the floating machine by any exertion of human strength, was evidently a chimerical attempt. All the influence which the aëronaut really possesses consists in a very limited power of raising or depressing it, according to circumstances. He cannot hope to shape his course, unless by skilfully adapting his elevation to catch the prevailing currents.

Balloons used in war.

Almost the only purpose to which balloons have hitherto been applied with success, had for its object that of military *reconnoissance*. In the early part of the French revolutionary war, when ingenuity and science were so eagerly called into active service, a balloon, prepared under the direction of the *Aërostatic Institute* in the Polytechnic School, and intrusted to the command of two or three experienced officers, was distributed to each of the republican armies. The decisive victory which General Jourdan gained, in June 1794, over the Austrian forces in the plains of Fleurus, has been ascribed principally to the accurate information of the enemy's movements before and during the battle, communicated by telegraphical signals from a balloon which was sent up to a moderate height in the air. The aëronauts, at the head of whom was the cele-

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brated Guyton-Morveau, mounted twice in the course of that day, and continued, about four hours each time, hovering in the rear of the army at an altitude of 1300 feet. In the second ascent, the enterprise being discovered by the enemy, a battery was opened against them; but they soon gained an elevation above the reach of the cannon. Another balloon, constructed by the same skilful artist, M. Conté, was attached to the army sent on the memorable expedition to Egypt. What service it rendered the daring invader in the wide plains and sandy deserts of Africa, we are not informed; but, after the capitulation of Cairo, it was brought back, with the remains of the army, to France, and employed in the sequel, as we shall find, more innocently in philosophical research. These balloons, being calculated for duration, were of a more solid and perfect construction than usual. Originally they were filled with hydrogen gas, obtained from the decomposition of water on a large scale. For this purpose, six iron cylinders had been fixed by masonry in a simple kind of furnace, each of their ends projecting, and covered with an iron lid. Two sets of metal tubes were also inserted, the one for conveying hot water, and the other for carrying off the gas which was formed. The cylinders being charged with iron-turnings, and brought to a red heat, the humidity was instantly converted into steam, and decomposed, the oxygen uniting with the iron, while the hydrogen gas was discharged, and made to deposit any carbonic gas that might adhere to it, by passing through a reservoir filled with caustic lye before it entered the balloon. By this method there was procured, at a very moderate expense, and in the space of about four hours, a quantity of hydrogen gas sufficient to inflate a balloon of thirty feet in diameter.

Method of filling them.

The ascents with balloons should appear to furnish the readiest means of ascertaining important facts in meteorology and atmospheric electricity, departments of science which are still unfortunately in their infancy. Some aëronauts have asserted that the magnetic needle ceased to traverse at very great elevations in the atmosphere; a statement which received some countenance from the observations made by Saussure on the lofty summit of the Col du Geant, where that celebrated naturalist thought he had found the magnetic virtue to be diminished one fifth part. It has been pretended by others, that the air of the higher regions is not of the same composition as at the surface of the earth, and is, independently altogether of its rarity, less fitted for the purpose of respiration. To determine these, and other relative points, was, therefore, an object interesting to the progress of physical science. A few years since, two young and ardent French philosophers, MM. Biot and Gay-Lussac, proposed to undertake an aërial ascent, in order to examine the magnetic force at great elevations, and to explore the constitution of the higher atmosphere and its electrical properties. For such a philosophical enterprise they were eminently qualified, having been educated together at the Polytechnic School, and both of them deeply versed in mathematics; the former indulging in a wide range of study, and the latter concentrating his efforts more on chemistry and its application to the arts. Their offer to government was seconded by Berthollet and Laplace, and the celebrated chemist Chaptal, then minister of the interior, gave it his patronage and warm support. The balloon which had once visited Egypt was delivered to the custody of Biot and Gay-Lussac; and the same artist who constructed it was, at the public expense, ordered to refit and prepare it under their direction. Besides the usual provision of barometers, thermometers, hygrometers, and electrometers, they had two compasses, and a dipping-needle, with another fine needle, carefully magnetized, and suspended by a very delicate silk thread, for ascertaining by its vibrations the force of magnetic attraction. To examine the electricity of the different strata of the atmosphere, they carried several metallic wires, from sixty to three hundred feet in length, and a small electrophorus feebly charged. For galvanic experiments they had procured a few discs of zinc and copper, with some frogs; to which they added insects and birds. It was also intended to bring down a portion of air from the higher regions, to be subjected to a chemical analysis; and for this purpose a flask, carefully exhausted, and fitted with a stop-cock, had been prepared.

Scientific ascent of Biot and Gay-Lussac.

The balloon was placed in the garden of the *Conservatoire des Arts*, or Repository of Models, formerly the Convent of St Martin; and no pains were spared by Conté in providing whatever might contribute to the greater safety and convenience of the voyagers. Every thing being now ready for their ascent, these adventurous philosophers, in the presence of a few friends, embarked in the car at ten o'clock in the morning of the 23d of August 1804. The barometer was then at 30·13 inches, the thermometer at 61·7° on Fahrenheit's scale, and Saussure's hygrometer pointed at 80·8°, or very near the limit of absolute humidity. They rose with a slow and imposing motion. Their feelings were at first absorbed in the novelty and magnificence of the spectacle which opened before them; and their ears were saluted with the buzz of distant gratulations, sent up from the admiring spectators. In a few minutes they entered the region of the clouds, which seemed like a thin fog, and gave them a slight sensation of humidity. The balloon had become quite inflated, and they were obliged to let part of the gas escape, by opening the upper valve; at the same time, they threw out some ballast, to gain a greater elevation. They now shot through the range of clouds, and reached an altitude of about 6500 English feet. These clouds, viewed from above, had the ordinary whitish appearance; they all occupied the same height, only their upper surface seemed marked with gentle swells and undulations, exactly resembling the aspect of a wide plain covered with snow.

Their experimental operations.

MM. Biot and Gay-Lussac now began their experimental operations. The magnetic needle was attracted, as usual, by iron; but they found it impossible at this time to determine with accuracy its rate of oscillation, owing to a slow rotatory motion with which the balloon was affected. In the meanwhile, therefore, they made other observations. A Voltaic pile, consisting of twenty pairs of plates, exhibited all its ordinary effects,—gave the pungent taste, excited the nervous commotion, and occasioned the decomposition of water. By rejecting some more ballast, they had attained the altitude of 8940 feet, but afterwards settled to that of 8600 feet. At this great elevation, the animals which they carried with them appeared to suffer from the rarity of the air. They let off a violet bee, which flew away very swiftly, making a humming noise. The thermometer had fallen to 56·4° by Fahrenheit, yet they felt no cold, and were, on the contrary, scorched by the sun's rays, and obliged to lay aside their gloves. Both of them had their pulses much accelerated: that of Biot, which generally beat seventy-nine times in a minute, was raised to one hundred and eleven; while the pulse of his friend Gay-Lussac, a man of a less robust frame, was heightened from sixty to eighty beats in the minute. Notwithstanding their quickened pulsation, however, they experienced no sort of uneasiness, nor any difficulty in breathing.

Magnetical observations.

What perplexed them the most was the difficulty of observing the oscillations of a delicately suspended magnetic needle. But they soon remarked, on looking attentively down upon the surface of the conglomerated clouds, that the balloon slowly revolved, first in one direction, and then returned the contrary way. Between these opposite motions there intervened short pauses of rest, which it was necessary for them to seize. Watching, therefore, the moments of quiescence, they set the needle to vibrate, but were unable to count more than five, or very rarely ten oscillations. A number of trials, made between the altitudes of 9500 and 13,000 feet, gave 7″ for the mean length of an oscillation, while at the surface of the earth it required $7\frac{1}{20}$″ to perform each oscillation. A difference so very minute as the hundred and fortieth part could be imputed only to the imperfection of the experiment; and it was hence fairly concluded, that the force of magnetic attraction had in no degree diminished at the greatest elevation which they could reach. The direction of this force, too, seemed, from concurring circumstances, to have continued the same; though they could not depend on observations made in their vacillating car with so delicate an instrument as the dipping needle.

**Birds liberated at vast heights.**

At the altitude of 11,000 feet they liberated a green linnet, which flew away directly; but, soon feeling itself abandoned in the midst of an unknown ocean, it returned and settled on the stays of the balloon. Then mustering fresh courage, it took a second flight, and dashed downwards to the earth, describing a tortuous yet almost perpendicular track. A pigeon which they let off under similar circumstances afforded a more curious spectacle. Placed on the edge of the car, it rested a while, measuring as it were the breadth of that unexplored sea which it designed to traverse: now launching into the abyss, it fluttered irregularly, and seemed at first to try its wings in the thin element; till, after a few strokes, it gained more confidence, and, whirling in large circles or spirals, like the birds of prey, it precipitated itself towards the mass of extended clouds, where it was lost from sight.

It was difficult, in those lofty and rather humid regions, to make electrical observations; and the attention of the scientific navigators was besides occupied chiefly by their magnetical experiments. However, they let down from the car an insulated metallic wire of about 250 feet in length, and ascertained, by means of the electrophorus, that the upper end indicated resinous or negative electricity. This experiment was several times repeated; and it seemed to corroborate fully the previous observations of Saussure and Volta relative to the increase of electricity met with in ascending the atmosphere.

**Diminution of temperature.**

The diminution of temperature in the higher regions was found to be less than what is generally experienced at the same altitude on mountains. Thus, at the elevation of 12,800 feet, the thermometer was at 51° by Fahrenheit, while it stood as low as $63\frac{1}{2}$° at the observatory; being only a decrement of one degree for each 1000 feet of ascent. This fact corresponds with the observations made by former aëronauts, and must have been produced, we conceive, by the operation of two distinct causes. First, the rays from the sun, not being enfeebled by passing through the denser portion of the atmosphere, would act with greater energy on the balloon and its car, and consequently affect the thermometer placed in their vicinity. Next, the warm current of air, which during the day rises constantly from the heated surface of the ground, must augment the temperature of any body which is exposed to its influence. During the night, on the contrary, the upper strata of the atmosphere would be found colder, we presume, than the general standard, owing to the copious descent of chill portions of air from the highest regions.

**Hygrometric observations.**

The hygrometer, or rather hygroscope, of Saussure, advanced regularly towards dryness, in proportion to the altitude which they attained. At the elevation of 13,000 feet it had changed from 80·8° to 30°. But still the conclusion, that the air of the higher strata is drier than that of the lower, we are inclined to consider as fallacious. In fact, the indications of the hygroscope depend on the relative attraction for humidity possessed by the substance employed, and the medium in which it is immersed. But air has its disposition to retain moisture always augmented by rarefaction, and consequently such alteration alone must materially affect the hygroscope. The only accurate instrument for ascertaining the condition of air with respect to dryness is founded on a property of evaporation. But we shall afterwards have occasion to discuss this subject at due length.

**Their descent.**

The ballast now being almost quite expended, it was resolved to descend. The aëronauts therefore pulled the upper valve, and allowed part of the hydrogen gas to escape. They dropped gradually, and when they came to the height of 4000 feet, they met the stratum of clouds, extending horizontally, but with a surface heaved into gentle swells. When they reached the ground, no people were near them to stop the balloon, which dragged the car to some distance along the fields. From this awkward and even dangerous situation they could not extricate themselves without discharging the whole of their gas, and therefore giving up the plan of sending M. Gay-Lussac alone to explore the highest regions. It has been reported that his companion M. Biot, though a man of activity and not deficient in personal courage, was so much overpowered by the alarms of their descent, as to lose for the time the entire possession of himself. The place where they alighted, at half-past one o'clock, after three hours and a half spent in the midst of the atmosphere, was near the village of Meriville, in the department of the Loiret, and about fifty miles from Paris.

It was the desire of several philosophers at Paris, that M. Gay-Lussac should mount a second time, and repeat the different observations at the greatest elevation he could attain. Experience had instructed him to reduce his apparatus, and to adapt it better to the actual circumstances. As he could only count the vibrations of the magnetic needle during the very short intervals which occurred between the contrary rotations of the balloon, he preferred one of not more than six inches in length, which therefore oscillated quicker. The dipping needle was magnetized and adjusted by the ingenious M. Coulomb. To protect the thermometer from the direct action of the sun, it was inclosed within two concentric cylinders of pasteboard covered with gilt paper. The hygrometers, constructed on Richer's mode, with four hairs, were sheltered nearly in the same way. The two glass flasks intended to bring down air from the highest regions of the atmosphere had been exhausted till the mercurial gage stood at the 25th part of an inch, and their stop-cocks were so perfectly fitted, that, after the lapse of eight days, they still preserved the vacuum. These articles, with two barometers, were the principal instruments which M. Gay-Lussac took with him. The skill and intelligence of the artist had been exerted in further precautions for the safety of the balloon.

**Gay-Lussac ascends again alone.**

At forty minutes after nine o'clock on the morning of the 15th of September, the scientific voyager ascended, as before, from the garden of the Repository of Models. The barometer then stood at 30·66 English inches, the thermometer at 82° by Fahrenheit, and the hygrometer at $57\frac{1}{2}$°. The sky was unclouded, but misty. Scarcely had the observer reached the height of 3000 feet, when he observed spread below him, over the whole extent of the atmosphere, a thin vapour, which rendered the distant objects very indistinct. Having gained an altitude of 9950 feet, he set his needle to vibrate, and found it to perform twenty oscillations in 83″, though it had taken 84·33″ to make the same number at the surface of the earth. At the height of 12,680 feet he discovered the variation of the compass to be precisely the same as below; but with all the pains he could take, he was unable to determine with sufficient certainty the dip of the needle. M. Gay-Lussac continued to prosecute his other experiments with the same diligence, and with greater success. At the altitude of 14,480 feet he found that a key, held in the magnetic direction, repelled with its lower end, and attracted with its upper end, the north pole of the needle of a small compass. This observation was repeated, and with equal success, at the vast height of 20,150 feet; a clear proof that the magnetism of the earth exerts its influence at remote distances. He made not fewer than fifteen trials at different altitudes, with the oscillations of his finely suspended needle. It was generally allowed to vibrate twenty or thirty times. The mean result gives 4·22″ for each oscillation, while it was 4·216″ at the surface of the earth; an apparent difference so extremely small, as to be fairly neglected.

His observations in magnetism.

Successive decrements of temperature.

During the whole of his gradual ascent, he noticed, at short intervals, the state of the barometer, the thermometer, and the hygrometer. Of these observations, amounting in all to twenty-one, he has given a tabular view. We regret, however, that he has neglected to mark the times at which they were made, since the results appear to have been very considerably modified by the progress of the day. It would likewise have been desirable to have compared them with a register noted every half hour at the Observatory. From the surface of the earth to the height of 12,125 feet, the temperature of the atmosphere decreased regularly from 82° to 47·3° by Fahrenheit's scale. But afterwards it increased again, and reached to 53·6°, at the altitude of 14,000 feet; evidently owing to the influence of the warm currents of air which, as the day advanced, rose continually from the heated ground. From that point the temperature diminished, with only slight deviations from a perfect regularity. At the height of 18,636 feet the thermometer subsided to 32·9°, on the verge of congelation; but it sunk to 14·9° at the enormous altitude of 22,912 feet above Paris, or 23,040 feet above the level of the sea, the utmost limit of the balloon's ascent.

Comparison of these observations.

From these observations no conclusive inference, we think, can be drawn respecting the mean gradation of cold which is maintained in the higher regions of the atmosphere; for, as we have already remarked, the several strata are during the day kept considerably above their permanent temperature by the hot currents raised from the surface through the action of the sun's rays. If we adopt the formula given by Professor Leslie at the end of his Elements of Geometry, which was the result of some accurate and combined researches, the diminution of temperature corresponding to the first part of the ascent, or 12,125 feet, ought to be forty degrees of Fahrenheit. It was actually 34·7°, and would no doubt have approached to 40°, if the progressive heating of the surface, during the interval of time, were taken into the account. In the next portion of the voyage, from the altitude of 14,000 to that of 18,636 feet, or the breadth of 4636 feet, the decrement of temperature according to the formula should only have been 16¼°, instead of 20·7°, which was really marked; a proof that the diurnal heat from below had not yet produced its full effect at such a great height. In the last portion of the balloon's ascent, from 18,636 feet to 22,912. a range of 4276 feet, the decrease of heat ought to be 15½°, and it was actually 18°; owing most probably to the same cause, or the feebler influence which warm currents of air from the surface exert at those vast elevations. Taking the entire range of the ascent, or 22,912 feet, the diminution of temperature according to the same formula would be for the gradation of temperature in ascending the atmosphere 85·4°. The decrease actually observed would be 67·1°, which might be raised to 80°, if we admit the very probable supposition, that the surface of the earth had become heated from 82° to 94·9° during the interval between ten o'clock in the morning and near three in the afternoon, when the balloon floated at its greatest elevation.

Aëronautics.

After making the fair allowances, therefore, on account of the operation of deranging causes, the results obtained by M. Gay-Lussac, for the gradation of temperature in the atmosphere, appear, on the whole, to agree very nearly with those derived from the formula which theory, guided by delicate experiments, had before assigned. This gradation is evidently not uniform, as some philosophers have assumed; but proceeds with augmented rapidity in the more elevated regions. The same conclusion results from a careful inspection of the facts which have been stated by other observers.

Indications of the hygrometer.

The hygrometers, during the ascent of the balloon, held a progress not quite so regular, but tending obviously towards dryness. At the height of 9950 feet they had changed from 57·5° to 62°; from which point they continued afterwards to decline, till they came to mark 27·5°, at the altitude of 15,190 feet. From this inferior limit the hygrometers advanced again, yet with some fluctuations, to 35·1°, which they indicated at the height of 18,460 feet. Above this altitude the variation was slight, though rather inclining to humidity. There can exist no doubt, however, that, allowing for the influence of the prevailing cold, the higher strata of the atmosphere must be generally drier than the lower, or capable of retaining, at the same temperature, a larger share of moisture.

Prospect of the highest atmosphere.

At the altitude of 21,460 feet M. Gay-Lussac opened one of his exhausted flasks; and, at that of 21,790 feet, the other. The air rushed into them through the narrow aperture, with a whistling noise. He still rose a little higher, but, at eleven minutes past three o'clock, he had attained the utmost limit of his ascent, and was then 22,912 feet above Paris, or 23,040 feet, being more than four miles and a quarter, above the level of the sea. The air was now more than twice as thin as ordinary, the barometer having sunk to 12·95 inches. From that stupendous altitude, sixteen hundred feet above the summit of the Andes, more elevated than the loftiest pinnacle of our globe, and far above the heights to which any mortal had ever soared, the aërial navigator might have indulged the feelings of triumphant enthusiasm. But the philosopher, in perfect security, was more intent on calmly pursuing his observations. During his former ascent, he saw the fleecy clouds spread out below him, while the canopy of heaven seemed of the deepest azure, more intense than Prussian blue. This time, however, he perceived no clouds gathered near the surface, but remarked a range of them stretching, at a very considerable height, over his head; the atmosphere, too, wanted transparency, and had a dull, misty appearance. The different aspect of the sky was probably owing to the direction of the wind, which blew from the north-north-west in his first voyage, but in his second from the south-east.

Feelings of Gay-Lussac.

While occupied with experiments at this enormous elevation, he began, though warmly clad, to suffer from excessive cold, and his hands, by continual exposure, grew benumbed. He felt likewise a difficulty in breathing, and his pulse and respiration were much quickened. His throat became so parched from inhaling the dry attenuated air, that he could hardly swallow a morsel of bread; but he experienced no other direct inconvenience from his situation. He had indeed been affected, through the whole of the day, with a slight headache, brought on by the preceding fatigues and want of sleep; but though it continued without abatement, it was not increased by his ascent.

His descent.

The balloon was now completely distended, and not more than 33 pounds of ballast remained: it began to drop, and M. Gay-Lussac, therefore, only sought to regulate its descent. It subsided very gently, at the rate of about a mile in eight minutes; and after the lapse of thirty-four minutes, or at three quarters after three o'clock, the anchor touched the ground, and instantly secured the car. The voyager alighted with great ease near the hamlet of St Gourgon, about sixteen miles north-west from Rouen. The inhabitants flocked around him, offering him assistance, and eager to gratify their curiosity.

His analysis of the air brought down.

As soon as he reached Paris, he hastened to the laboratory of the Polytechnic School, with his flasks, containing air of the higher regions, and proceeded to analyze it in the presence of Thenard and Gresset. Opened under water, the liquid rushed into them, and apparently half filled their capacity. The transported air was found, by a very delicate analysis, to contain exactly the same proportions as that collected near the surface of the earth, every 1000 parts holding 215 of oxygen. From concurring observations, therefore, we may conclude that the atmosphere is essentially the same in all situations.

Remarks on these last ascents.

The ascents performed by MM. Biot and Gay-Lussac are memorable, for being the first ever undertaken solely for objects of science. It is impossible not to admire the intrepid coolness with which they conducted those experiments, operating, while they floated in the highest regions of the atmosphere, with the same composure and precision as if they had been quietly seated in their cabinets at Paris. Their observations on the force of terrestrial magnetism show most satisfactorily its deep source and wide extension. The identity of the constitution of the atmosphere to a vast altitude was likewise ascertained. The facts noted by Gay-Lussac, relative to the state of the thermometer at different heights, appear generally to confirm the law which theory assigns for the gradation of temperature in the atmosphere: but many interesting points were left untouched by this philosopher. We are sorry that he had not carried with him the *cyanometer*, which enabled Saussure to determine the colour of the sky on the summits of the Swiss mountains. Still more we regret that he was not provided with an hygrometer and a photometer, of Leslie's construction. These delicate instruments could not have failed, in his hands, to furnish important data for discovering the relative dryness and transparency of the different strata of air. It would have been extremely interesting, at such a tremendous height, to have measured with accuracy the feeble light reflected from the azure canopy of heaven, and the intense force of the sun's direct rays, and hence to have determined what portion of them is absorbed in their passage through the lower and denser atmosphere.

Since that time numerous ascents have been performed in different countries, generally by adventurers guided by no philosophical views, nor leading to any valuable results. It would therefore be superfluous to recount such repeated attempts.

Various projects with balloons.

Balloons have at different times been thought capable of useful application. It has been even proposed to employ their power of ascension as a mechanical force. This might be rendered sufficient, it was believed, to raise water from mines, or to transport obelisks, and place them on great elevations. We can easily imagine situations where a balloon could be used with advantage; such as to raise, without any scaffolding, a cross or a vane to the top of a high spire. But the power would then be purchased at a very disproportionate expense. It would require $4\frac{1}{2}$ pounds of iron, or 6 of zinc, with equal quantities of sulphuric acid, to yield hydrogen gas sufficient to raise up the weight of one pound.

The proposal of employing balloons in the defence and attack of fortified places appears truly chimerical. They have rendered important service, however, in reconnoitring the face of a country, and communicating military signals; and it is rather surprising that a system, which promised such obvious benefits, has not been carried much farther.

Their application proposed for the improvement of meteorology.

But to a skilful and judicious application of balloons, we may yet look for a most essential improvement of the infant science of meteorology. Confined to the surface of this globe, we have no direct intimation of what passes in the lofty regions of the atmosphere. All the changes of weather, which appear so capricious and perplexing, proceed, no doubt, from the combination of a very few simple causes. Were the philosopher to penetrate beyond the seat of the clouds, examine the circumstances of their formation, and mark the prevailing currents, he would probably remove in part the veil that conceals those mighty operations. It would be quite practicable, we conceive, to reach an elevation of seven miles, where the air would be four times more attenuated than ordinary. A silk balloon, of forty feet diameter, if properly constructed, might be sufficient for that enormous ascent, since its weight would only be 80 pounds, while its buoyant force, though not more than a quarter filled with hydrogen gas, would amount to $533\frac{1}{3}$, leaving $453\frac{1}{3}$ pounds for the passenger and the ballast. The balloon could be safely charged, indeed, to the third part of its capacity, on account of the contraction which the gas would afterwards suffer from the intense cold of the upper regions; and this gives it an additional buoyancy of $177\frac{8}{9}$ pounds. The voyager would not, we presume, suffer any serious inconvenience from breathing the very thin air. The animal frame adapts itself with wonderful facility to external circumstances. Perhaps the quickened pulse and short respiration, which some travellers have experienced on the summits of lofty mountains, should be attributed chiefly to the suddenness of their transition, and the severity of the cold. The people of Quito live comfortably 9560 feet above the level of the sea; and the shepherds of the hamlet of Antisana, the highest inhabited spot in the known world, who breathe, at an elevation of 13,500 feet, air that has only three-fifths of the usual density, are nowise deficient in health or vigour. But the intenseness of the cold is probably what the resolute observer would have most to dread, at the height of seven miles. This decrease of temperature, perhaps equal to 148 degrees, might extend below the point at which mercury freezes. Yet several circumstances tend to mitigate such extreme cold, and proper clothing might enable an experimenter for a short time to resist its effects.

Much could be done, however, without risk or material expense. Balloons from fifteen to thirty feet in diameter, and carrying register thermometers and barometers, might be capable of ascending alone to altitudes between eight and twelve miles. Dispatched from the centres of the great continents, they would not only determine the extreme gradation of cold, but indicate by their flight the direction of the regular and periodic winds which doubtless obtain in the highest regions of the atmosphere. But we will not enlarge. In some happier times, such experiments may be performed with the zealous concurrence of different governments;—when nations shall at last become satisfied with cultivating the arts of peace; instead of wasting their energies in sanguinary, destructive, and fruitless wars.

In Plate II. there is a view of the principal balloons. The figure in the centre represents the shape of the gores for forming the cloth into a globular shape. AE, the length of the gore, is equal to the half of the circumference of the globe; BC, the breadth, is the same proportional part of the circumference as the number of gores which it requires to form the sphere. The figures between CB and A denote the breadths of the half-gore, at equal distances from the centre; the breadth BD at the centre being taken equal to 1, and the others in decimals. In this manner it is easy to construct an exact pattern of the gores, all which, being united, will form a true sphere.



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AEROPHYLACEA, a term used by naturalists for caverns or reservoirs of air, supposed to exist in the bowels of the earth.

AEROPHYTES, a designation sometimes applied to parasite plants.

AERSCHOT, a once fortified city of Belgium, on the river Demer, 7 miles from Louvain, and 20 from Antwerp, containing 4053 inhabitants.

ÆRTSEN, PETER, a Dutch historical painter of great merit, both for drawing and colouring. His master-pieces are an altar-piece at Delft, representing the Nativity and the Wise Men's Offering, and one at Amsterdam of the Death of the Virgin. He died in 1575, aged 56.

ÆRUGINOUS, an epithet given to such things as resemble or partake of the nature of the rust of copper.

ÆRUGO, a Latin term which properly signifies the rust of copper, whether natural or artificial. The former is found about copper mines, and the latter, called *verdigris*, is made by corroding copper plates with acids.

ÆRUSCATORES, in *Antiquity*, a kind of strolling beggars, not unlike gypsies, who drew money from the credulous by fortune-telling, &c. It was also a denomination given to griping exactors, or collectors of the revenue. The Galli, or priests of Cybele, were called *æruscatores magnæ matris;* and μητραγυρται, from their begging in the streets; to which end they had little bells to draw people's attention, similar to some orders of mendicants abroad.

ÆS, commonly translated *brass:* but the æs of the Romans was a *bronze*, or alloy of copper and tin; and the cutting instruments of the ancient Greeks and Egyptians were also of bronze. The Romans borrowed their arms, as well as their money, from the Etruscans. Analysis of the bronzes of these nations shew that they contain from 8 to 12 per cent. of tin, which gave them hardness and the capability of receiving a good edge.

ÆS CIRCUMFORANEUM, money borrowed from the usurers around the Roman Forum. (*Cic. ad. Attic.* ii.)

ÆS EQUESTRE, ÆS HORDEARIUM, ÆS MILITARE, ancient terms for the pay of Roman soldiers, previous to the introduction of the regular *stipendium*, and furnished, it would appear, not from the public treasury, but by certain private persons as decreed by the state. The first, which amounted to 10,000 asses, was the purchase-money of the horse of an Eques; the second, amounting to 2000 asses, was the pay of an Eques, and was furnished by maidens, widows, and orphans, if possessed of a certain amount of property, in consideration that they enjoyed protection, and were not included in the census; and it seems probable that they were also charged with the payment of the *Æs Equestre:* the third, which Niebuhr reckons at 1000 asses a-year (the year then containing but 10 months), was the pay of a foot-soldier, and probably was provided by the *tribuni ærarii*, who would appear to have been private persons who received that title as collectors of the *tributum* for paying the army. —See Smith's *Dict. of Greek and Roman Antiquities*, 2d. edition.

ÆS UXORIUM, in *Antiquity*, a sum paid by bachelors, as a penalty for living single to old age. This tax for not marrying seems to have been first imposed in the year of Rome 350, under the censorship of M. Furius Camillus and M. Posthumus. At the census, or review of the people, each person was asked, *Et tu ex animi sententia uxorem habes liberorum quærendorum causa?* He who had no wife was hereupon fined after a certain rate, called *æs uxorium.*

*Per Æs et libram* was a formula in the Roman law, whereby purchases and sales were ratified. Originally the phrase seems to have been only used in speaking of things sold by weight, or by the scales; but it afterwards was used on other occasions. Hence even in adoptions, as there was a kind of imaginary purchase, the formula thereof expressed, that the person adopted was bought *per æs et libram.*

ÆSCHINES, an Athenian, a Socratic philosopher, the son of Charinus, a sausage-maker. He was continually with Socrates; which occasioned this philosopher to say, that the sausage-maker's son was the only person who knew how to pay a due regard to him. It is said that poverty obliged him to go to Sicily to Dionysius the tyrant; and that he met with great contempt from Plato, but was extremely well received by Aristippus, to whom he showed some of his dialogues, and received from him a handsome reward. He would not venture to profess philosophy at Athens, Plato and Aristippus being in such high esteem; but he opened a school, in which he taught philosophy to maintain himself. He afterwards wrote orations for the forum. Phrynicus, in Photius, ranks him amongst the best orators, and mentions his orations as the standard of the pure Attic style. Hermogenes has also spoken very highly of him. He wrote, besides, several Dialogues: 1. Concerning virtue, whether it can be taught. 2. Eryxias, or Erasistratus; concerning riches, whether they are good. 3. Axiochus; concerning death, whether it is to be feared,—but those extant on the several subjects, are not genuine remains. M. le Clerc has given a Latin translation of them, with notes and several dissertations, entitled *Silvæ Philologicæ.*

ÆSCHINES, a celebrated Grecian orator, was born in Attica 389 years before the Christian era. According to his own account, he was of distinguished birth; according to that of Demosthenes, he was the son of a courtesan, and a humble performer in a company of comedians. But whatever was the true history of his birth and early life, his talents, which were considerable, procured him great applause, and enabled him to be a formidable rival to Demosthenes himself. The two orators, inspired probably with mutual jealousy and animosity, became at last the strenuous leaders of opposing parties. Æschines was accused by Demosthenes of having received money as a bribe, when he was employed on an embassy to Philip of Macedon. He indirectly retaliated the charge by bringing an accusation against Ctesiphon, the friend of Demosthenes, for having moved a decree, contrary to the laws, to confer on Demosthenes a golden crown, as a mark of public approbation. A numerous as-

Æschylus. sembly of judges and citizens met to hear and decide the question. Each orator employed all his powers of eloquence; but Demosthenes, with superior talents, and with justice on his side, was victorious; and Æschines was sent into exile. The resentment of Demosthenes was now softened into generous kindness; for when Æschines was going into banishment, he requested him to accept of a sum of money; which made him exclaim, "How do I regret leaving a country where I have found an enemy so generous, that I must despair of ever meeting with a friend who shall be like him!"

Æschines opened a school of eloquence at Rhodes, which was the place of his exile; and he commenced his lectures by reading to his audience the two orations which had been the cause of his banishment. His own oration received great praise, but that of Demosthenes was heard with boundless applause. In so trying a moment, when vanity must be supposed to have been deeply wounded, with a noble generosity of sentiment, he said, "What would you have thought if you had heard him thunder out the words himself!"—Æschines afterwards removed to Samos, where he died in the 75th year of his age. Three only of his orations are extant. His eloquence is not without energy, but it is diffuse and ornamented, and more calculated to please than to move the passions.

ÆSCHYLUS, the father of the Greek tragic drama, was born in the year 525 B.C., in the Attic demos of Eleusis. The period of his youth and manhood coincides, therefore, with that great uprising of the national spirit of the Greeks, caused by the successive attempts of Darius, king of Persia, and his son Xerxes, to enslave their European neighbours on the north and west shores of the Ægean; and it was no doubt as much for the advantage of his poetical faculty as for the development of his manhood, that he took an active part in those famous military achievements by which the march of the insolent Asiatic hosts was repelled. The father of Attic tragedy helped, in the year 490, to drive the captains of Darius into the marshes of Marathon, and, ten years later, encompassed with ruin the multitudinous armament of Xerxes, within the narrow strait of Salamis. The glories of this naval achievement, the bard who had helped to win it with his sword afterwards lived to celebrate with the lyre, and left to the world the play of *The Persians*, as a great national record of combined poetry and patriotism almost unique in history. Of his subsequent career at Athens, only a few scanty notices remain, and those chiefly connected with the representation of his plays. We know that he composed 70 plays, and that he gained the prize for dramatic excellence 13 times; further, that the Athenians esteemed his works so highly as to allow some of them to be represented after his death,—a privilege, in their dramatic practice, altogether anomalous. We know, also, that in the course of his life he paid one or two visits to Sicily, to which country he was attracted, no doubt, by the same literary influence in the person of its ruler Hiero, that drew thither Bacchylides, Simonides, and other notable men of that rich epoch. There can, at the same time, be little doubt that one cause of his visits to that island may have been a want of sympathy as to political matters between him and the Athenian public; for while the Athenians, from the time of Cleisthenes (A.C. 510), had been advancing by rapid and decided steps to the full expansion of the democratic principle, it is evident, from some passages in his plays, especially from the whole tone and tendency of the *Eumenides*, that the political leanings of the poet of the *Prometheus* were towards aristocracy, and that, in the days of Pericles, he foresaw, with a sorrowful fear, the ripeness of those democratic evils which within so short a period led Xenophon to seek a new fatherland in Sparta, and opened to the Macedonian a plain path to the sovereignty of Greece. But whatever may have been his motives for retiring from the scene of so many literary triumphs (and the gossipers of ancient times have of course transmitted to us their pleasant inventions on this point), it is certain that, in the year A.C. 456, two years after the representation of his great trilogy, *The Orestiad*, he died at Gela, in Sicily, in the 69th year of his age; and the people of Gela, rejoicing in his bones, as Ravenna does in those of the banished Dante, inscribed the following memorial on his tomb:—

> "Here Æschylus lies, from his Athenian home
> Remote, 'neath Gela's wheat-producing loam;
> How brave in battle was Euphorion's son,
> The long-haired Mede can tell who fell at Marathon."

And thus he lives among posterity, celebrated more as a patriot than as a poet; as if to witness to all times, that the great world of books, with all its power, is but a small thing unless it be the reflection of a greater world of action.

Of the seventy plays which an old biographer reports him to have composed, only seven remain, with a few fragments of little significance, save to the keen eye of the professed philologist. These fragments, however, are sufficient to justify the high esteem in which he was held by the Athenian public, and by that greatest of all the great wits of a witty age and a witty people, Aristophanes. In the grand trilogy which exhibits, in three consecutive tragedies, the story of the murder of Agamemnon, and its moral sequences, we have a perfect specimen of what the Greek tragedy was to the Greeks, as at once a complex artistic machinery for the exhibition of national legend, and a grave pulpit for the preaching of important moral truths; nor could a more worthy founder than Æschylus of such a "Sacred Opera" be imagined. His imagination dwells habitually in the loftiest region of the stern old religious mythology of primeval Greece; his moral tone is pure—his character earnest and manly—and his strictly dramatic power (notwithstanding the very imperfect form of the drama in his day), as exhibited more especially in the *Agamemnon*, in the *Eumenides*, and in some parts of the *Prometheus*, is such as none of his famous successors, least of all Euripides, could surpass. Of his other plays, the *Seven against Thebes* is a drama, as Aristophanes expressed it, "full of war," and breathes in every line the spirit of the age and of the people that saved Europe from the grasp of Oriental despotism; *The Persians*, though weak in some parts, contains some fine choral poetry, and a description of the battle of Salamis, that will belong to the poetry of the world so long as the world lasts; while *The Suppliants* presents much in a tasteful translation, that makes us lament the loss of the missing pieces of the trilogy to which it belonged, no less than the blundering of the thoughtless copyists of the middle ages, by whose pen it has been so egregiously defaced. For in ancient times the flowing rhetorical Euripides was found a more useful model for the schools of eloquence, than the lofty, stern, and sometimes harsh, and occasionally it may be obscure, Æschylus: therefore, the text of the latter has been comparatively neglected, and much work was left for the tasteful philologist, before many parts of his noblest choruses could be rendered legible. Of the editions of Æschylus, the most notable in the earlier times of modern scholarship is that of Stanley; in more recent times, that of Schütz, who undertook the work of restoration with much learning and great boldness. The impulse given by this scholar was moderated by Wellauer, who, in his edition, along with some happy emendations, principally endeavoured to vindicate the authority of the manuscript readings from the large license of conjectural critics; and now from the remains of the great Hermann, has been published a text that should present the just medium between the timidity of Wellauer, and the rashness of mere conjectural criticism. Of English poetical translations there are only two; the old one by Potter, and a recent one by Blackie. There is also a translation in literal prose by Buckley. (J. S. B.)

ÆSCULAPIUS, in the *Heathen Mythology*, the god of physic, was the son of Apollo and the nymph Coronis. He was educated by the centaur Chiron, who taught him physic, by which means Æsculapius cured the most desperate diseases. But Jupiter, enraged at his restoring to life Hippolytus, who had been torn in pieces by his own horses, killed him with a thunderbolt. According to Cicero, there were three deities of this name; the first, the son of Apollo, worshipped in Arcadia, who invented the probe and bandages for wounds; the second, the brother of Mercury killed by lightning; and the third, the son of Arsippus and Arsinoe, who first taught the art of tooth-drawing and purging. At Epidaurus, Æsculapius's statue was of gold and ivory, with a long beard, his head surrounded with rays, holding in one hand a knotty stick, and the other entwined with a serpent: he was seated on a throne of the same materials as his statue, and had a dog lying at his feet. The Romans crowned him with laurel, to represent his descent from Apollo; and the Phliasians represented him as beardless. The cock, the raven, and the goat, were sacred to this deity. His chief temples were at Pergamus, Smyrna, Tricca, a city in Thessaly, and the isle of Coos; in all which votive tablets were hung up, showing the diseases cured by his assistance. But his most famous shrine was at Epidaurus, where, every five years, games were instituted to him, nine days after the Isthmian games at Corinth.

ÆSOP, the fabulist, was born about the year 620 B.C., but the place of his birth is uncertain, that honour being claimed alike by Samos, Sardis, Mesembria in Thrace, and Cotiœum in Phrygia. He was brought, while young, to Athens as a slave, and having served several masters, was eventually enfranchised by Iadmon the Samian. He thereupon visited Crœsus king of Lydia, at whose court he is represented by Plutarch as reproving Solon for his discourteous manner towards the king. During the usurpation of Pisistratus, he is said to have visited Athens, and composed the fable of *Jupiter and the Frogs* for the instruction of the citizens (Phædrus, i. 2). As the ambassador of Crœsus at Delphi, he was charged with the distribution of the large sum of four minæ to each of the citizens; but, in consequence of some dispute, he returned the money to Crœsus. The Delphians, incensed at his conduct, accused him of sacrilege, and threw him headlong from a precipice, about 564 B.C. A pestilence which ensued being attributed to this crime, the people declared their willingness to make compensation for his death; which in default of a nearer connection was claimed and received by Iadmon, the grandson of his old master. (*Plut. de sera Num. Vind.*, p. 556. *Herodot.* ii. 134.) None of Æsop's works are extant. The popular stories regarding him are derived from a life prefixed to a book of fables purporting to be his, collected by Maximus Planudes, a monk of the fourteenth century, in which he is represented as a monster of ugliness and deformity, a notion utterly without foundation, and doubtless intended to heighten his wit by the contrast. That this life, however, was in existence a century before Planudes's time, appears by a manuscript of it found at Florence, and published in 1809. In Plutarch's *Convivium*, where Æsop is a guest, though there are many jests on his original servile condition, there are none on his appearance; and it would seem that the ancients were not usually restrained by delicacy in this point, since the personal defects of Socrates, and his resemblance to old Silenus, afford ample matter for merriment and raillery in the *Symposium* of Plato. We are told, besides, that the Athenians erected, in honour of Æsop, a noble statue by the famous sculptor Lysippus, a circumstance which alone were sufficient to confute the absurd fiction of his deformity: but more to the point is the statement of Pliny (xxxvi. 12.), that he was the *Contubernalis* of Rhodope, his fellow-slave, whose extraordinary beauty passed into a proverb:

Ἅπανθ' ὅμοια, καὶ Ῥοδῶπις ἡ καλή.

The obscurity in which the history of Æsop is involved, has induced some to deny his existence altogether; and Giambattista Vico, in his *Scienza Nuova*, chooses rather to consider him as an abstraction,—an excess of scepticism which is quite unreasonable. Whether Æsop left any written fables, has been more justly disputed, and Bentley inclines to the negative. Thus Aristophanes (*In Vespis*, v. 1259) represents the old man as learning his fables in conversation, and not from a book; and Socrates essayed to versify such as he remembered (Plat., *Phæd.* p. 61). Others again are of opinion, that a collection had been made of them before the time of Socrates. (*Mus. Crit.* i. 408.) It is, however, certain that fables bearing Æsop's name were popular at Athens during the most brilliant period of its literary history; though the discrepancies of authors in quoting the same fables seem in favour of Bentley's hypothesis. (Compare Aristot. *De Part. Anim.* iii. 2.; and Lucian. *Nigr.* 32.) The original fables were in prose, and were turned into verse by several writers; the first, after the example of Socrates, being Demetrius Phalereus. Next appeared an edition in elegiac verse, often cited by Suidas, but the author's name is unknown; then Babrius, an excellent Greek poet, turned them into choliambics; but of ten books, a few fables only are preserved entire. Of the Latin writers of Æsopean fables, Phædrus is the most celebrated.

> " Æsopus auctor quam materiam reperit,
> Hanc ego polivi versibus senariis."
> PHÆD.

The fables now extant in prose under Æsop's name are entirely spurious, as proved by Bentley in his *Dissertation on the Fables of Æsop*, and have been assigned an oriental origin. The identification of Æsop with the Arabian philosopher and fabulist Lokman (who is made by some traditions the contemporary of the psalmist David), has frequently been attempted; and the Persian accounts of Lokman, which among other things describe him as an ugly black slave, appear to have been blended by the author of the *Life* published by Planudes, with the classical stories respecting Æsop. The similarity of the fables ascribed to each renders it probable that they were derived from the same Indo-Persian source, or from the Chinese, who appear to have possessed such fables in very remote antiquity. A complete collection of the Æsopean Fables, 231 in number, was published at Breslau, by J. G. Schneider, in 1810.

ÆSOP, a Greek historian, whose life of Alexander the Great is preserved in a Latin translation by Julius Valerius. It is a work of no credit, abounding in errors.

ÆSOP, *Clodius*, a celebrated actor, who flourished about the 670th year of Rome. He and Roscius were contemporaries, and the best performers who ever appeared upon the Roman stage; the former excelling in tragedy, the latter in comedy. Cicero put himself under their direction, to perfect his action. Æsop lived in a most expensive manner, and at one entertainment is said to have had a dish which cost above L.800. This dish, we are told, was filled with singing and speaking birds, some of which cost near L.50. The delight which Æsop took in this sort of birds proceeded, as M. Bayle observes, from the expense. He did not make a dish of them because they could speak, (according to the refinement of Pliny upon this circumstance,) this motive being only accidental, but because of their extraordinary price.

Æsthetics || Æsymnium.

If there had been any birds that could not speak, and yet more scarce and dear than these, he would have procured such for his table. When he was upon the stage, he entered into his part to such a degree as sometimes to be seized with a perfect ecstasy. Plutarch mentions it as reported of him, that whilst he was representing Atreus deliberating how he should revenge himself on Thyestes, he was so transported beyond himself in the heat of action, that with his truncheon he smote one of the servants crossing the stage, and laid him dead on the spot. Æsop's son was no less luxurious than his father, for he dissolved pearls for his guests to swallow. Some speak of this as a common practice of his; but others mention his falling into this excess only on a particular day, when he was treating his friends. Horace[1] speaks only of one pearl of great value, which he dissolved in vinegar and drank.

[1] *Sat.* iii. lib. ii. 239.

ÆSTHETICS, a term derived from ʼαισθητικος, "belonging to sensation," employed by the followers of the German metaphysicians to designate philosophical investigations into the theory of *The Beautiful*, or *Philosophy of the Fine Arts*, which they are disposed to regard as a distinct science. It was first used in this sense by Wolf, about the middle of last century; and Winckelmann, in his work on painting and sculpture, maintains that *beauty* is a special property of bodies. Similar views are maintained by Baumgarten and Schelling, who apply their general principles to poetry, painting, sculpture, architecture, and music. Æsthetical speculations do not appear to have contributed any thing to the improvement of the fine arts, or to our real knowledge of mental phenomena.

ÆSTIMATIO CAPITIS, a term met with in old law-books for a fine anciently ordained to be paid for offences committed against persons of quality, according to their several degrees.

ÆSTIVAL, in a general sense, denotes something connected with, or belonging to summer. Hence æstival sign, æstival solstice, &c.

ÆSTUARY, in *Geography*, denotes an arm of the sea, which runs a good way within land. Such is the Bristol channel, and many of the firths of Scotland.

ÆSTUARY, in ancient baths, a secret passage from the hypocaustum into the chambers.

ÆSTUARY, among *Physicians*, a vapour bath, or any other instrument for conveying heat to the body.

ÆSTUI, a people that dwelt on the sea-coast in the N.E. of Germany, whose manners are minutely described by Tacitus. In appearance and manners, says that author, they resemble the Suevi; their language, that of Britain. They worshipped the mother of the gods, in whose honour they wore images of the boar, as amulets in war; fighting chiefly with clubs, as they had little iron. They engaged in husbandry, and gathered amber for the Roman market. This substance they called *glessum*. Their name is still preserved in the modern Esthen, the German name of the Esthonians. See Latham's *Germania of Tacitus*, p. 166. *Ukert*, vol. iii., pt. i., p. 420.

ÆSYMNETES, ʼΑισυμνητης, among the Greeks, was, like the Roman dictator, a person invested by the people with absolute power for a limited period in great emergencies of the State. Such was Pittacus at Mytilene, or Dracon and Solon at Athens.—Arist. *Polit.* iii. iv.

ÆSYMNIUM, in *Antiquity*, a monument erected to the memory of the heroes by Æsymnus the Megarean. On consulting the oracle in what manner the Megareans might be most happily governed, he was answered, *By holding consultation with the more numerous.* Taking this to signify the dead, he built the said monument, and a senate-house that embraced it within its compass, imagining that thus the dead would assist at their consultations.—*Pausanias.*

Aeth || Æther.

AETH. See ATH.

ÆTHALIA, or ILUA, in *Ancient Geography*, now *Elba*, an island on the coast of Etruria, in compass a hundred miles, abounding in iron. It was so called from αιθαλη, *smoke*, which issued from the shops of Vulcan.

ÆTHELING, or ÆDELING, the Anglo-Saxon title given to the children of kings and nobles. It is compounded of *æthel*, æðel, *illustrious*, and *ling*, lınȝ, which, when affixed to persons, indicates *diminution* or *adolescence*.

ÆTHELSTAN. See ATHELSTAN.

ÆTHER is usually understood of a thin, subtile matter or medium, much finer and rarer than air, which, commencing from the limits of our atmosphere, possesses the whole heavenly space. The word is Greek, αιθηρ, supposed to be formed from the verb αιθειν, *to burn, to flame;* some of the ancients, particularly Anaxagoras, supposing it to be of the nature of fire.

The philosophers cannot conceive that the largest part of the creation should be perfectly void; and therefore they fill it with a species of matter under the denomination of *æther*. But they vary extremely as to the nature and character of this æther. Some conceive it as a body *sui generis*, appointed only to fill up the vacuities between the heavenly bodies, and therefore confined to the regions above our atmosphere. Others suppose it of so subtile and penetrating a nature as to pervade the air and other bodies, and to possess the pores and intervals thereof. Others deny the existence of any such specific matter, and think the air itself, by that immense tenuity and expansion it is found capable of, may diffuse itself through the interstellar spaces, and be the only matter found therein.

In effect, æther being no object of our sense, but the mere work of imagination, brought only upon the stage for the sake of hypothesis, or to solve some phenomenon real or imaginary, authors take the liberty of modifying it as they please. Some suppose it of an elementary nature, like other bodies, and only distinguished by its tenuity, and the other affections consequent thereon; which is the philosophical æther. Others will have it of another species, and not elementary, but rather a sort of fifth element, of a purer, more refined, and spiritous nature, than the substances about our earth, and void of the common affections thereof, as gravity, &c. The heavenly spaces being the supposed region or residence of a more exalted class of beings, the medium must be more exalted in proportion. Such is the ancient and popular idea of æther, or æthereal matter.

The term *æther* being thus embarrassed with a variety of ideas, and arbitrarily applied to so many different things, the later and severer philosophers choose to set it aside, and in lieu thereof substitute other more determinate ones. Thus, the Cartesians use the term *materia subtilis*, which is their æther: and Sir Isaac Newton, sometimes a *subtile spirit*, as in the close of his *Principia;* and sometimes a *subtile* or *æthereal medium*, as in his *Optics*.

Heat, Sir Isaac Newton observes, is communicated through a vacuum almost as readily as through air; but such communication cannot be without some interjacent body, to act as a medium. And such body may be subtile enough to penetrate the pores of glass, and may permeate those of all other bodies, and consequently be diffused through all the parts of space.

The existence of such an æthereal medium being settled, that author proceeds to its properties; inferring it to be not only rarer and more fluid than air, but exceedingly more elastic and active; in virtue of which properties he shows, that a great part of the phenomena of nature may be produced by it. To the weight, *e. g.* of this medium, he attributes gravitation, or the weight of all other bodies; and to its elasticity, the elastic force of the air and of nervous fibres, and the

Æther || Ætites.

emission, refraction, reflection, and other phenomena of light; as also sensation, muscular motion, &c. In fine, this same matter seems the *primum mobile*, the first source or spring of physical action in the modern system.

The Cartesian æther is supposed not only to prevade, but adequately to fill, all the vacuities of bodies; and thus to make an absolute plenum in the universe.

But Sir Isaac Newton shows that the celestial spaces are void of all sensible resistance; and hence it follows, that the matter contained therein must be immensely rare, in regard the resistance of bodies is chiefly as their density; so that if the heavens were thus adequately filled with a medium or matter, how subtile soever, they would resist the motion of the planets and comets much more than quicksilver or gold. But it has been supposed that what Newton has said of æther is to be considered only as a conjecture, and especially as no new proofs of its existence have been adduced since his time.

Æther, a term applied to several particular fluids. See Chemistry.

ÆTHEREAL, (*æthereus*) something that belongs to, or partakes of, the nature of Æther. Thus we say, *the æthereal space, æthereal regions*, &c. Some of the ancients divided the universe, with respect to the matter contained therein, into elementary and æthereal. Under the æthereal world was included all that space above the uppermost element, viz. fire. This they supposed to be perfectly homogeneous, incorruptible, unchangeable, &c. The Chaldees placed an æthereal world between the empyreum and the region of the fixed stars. Besides which, they sometimes also speak of a second æthereal world, meaning by it the starry orb; and a third æthereal world, by which is meant the planetary region.

ÆTHIOPIA. See Ethiopia.

AETIANS, in *Church History*, a branch of Arians, who maintained that the Son and Holy Ghost are in all things dissimilar to the Father. See Aetius.

ÆTIOLOGY is that part of pathology which is employed in exploring the causes of diseases.

AETION, a celebrated painter, who left an excellent picture of Roxana and Alexander, which he exhibited at the Olympic games. It represented a magnificent chamber, where Roxana is sitting on a bed of a most splendid appearance, which is rendered still more brilliant by her beauty. She looks downwards in a kind of confusion, being struck with the presence of Alexander standing before her. A number of little Cupids flutter about, some holding up the curtain, as if to show Roxana to the prince, whilst others are busied in undressing the lady; some pull Alexander by the cloak, who appears like a young bashful bridegroom, and present him to his mistress. He lays his crown at her feet, being accompanied by Hephæstion who holds a torch in his hand, and leans upon a youth, who represents Hymen. Several other little Cupids are represented playing with his arms: some carry his lance, stooping under so heavy a weight; others bear along his buckler, upon which one of them is seated, whom the rest carry in triumph; another lies in ambush in his armour, waiting to frighten the rest as they pass by. This picture gained Aetion so much reputation, that the president of the games gave him his daughter in marriage.—*Lucian.*

ÆTITES, or Eagle-stone, in *Natural History*, a flinty or crustated stone, hollow inside, and containing a *nucleus*, which, on shaking, rattles within. It was formerly in repute for several extraordinary magical as well as medical powers; such as preventing abortion, discovering thieves, and other ridiculous properties. The word is formed from αετος, eagle, the popular tradition being, that it is found in the eagle's nest, whither it is supposed to be carried while the female sits, to prevent her eggs from becoming rotten. It is found in various places. Near Trevoux, in France, one can scarcely dig a few feet without finding considerable strata or beds of the coarser or ferruginous kind. They are originally soft, and of the colour of yellow ochre. But the finest and most valued of all the eagle-stones are accidental states of one or other of our common pebbles.

Aetius || Ætna.

AETIUS, one of the most zealous defenders of Arianism, was born at Antioch in Cœle-Syria, and flourished about the year 336. Being left fatherless, and in poverty, he became a slave, and was afterwards a goldsmith, and also practised physic. After being servant to a grammarian, of whom he learned grammar and logic, he was ordained deacon at Antioch, and at length bishop, by Eudoxius, patriarch of Constantinople. Aetius was banished into Pisidia on account of his religious opinions; but was recalled from exile on the accession of Julian, and was much esteemed by that emperor. He died, it is supposed, at Constantinople, about the year 366. St Epiphanius has noticed 70 of his propositions against the Trinity. His followers were called Aetians.

Aetius, a famous physician, born at Amida in Mesopotamia, and the author of a work entitled *Tetrabiblos*, which is a collection from the writings of those physicians who went before him. He lived, according to Dr Freind, in the end of the fifth or the beginning of the sixth century.

Aetius, governor of Gallia Narbonensis in the reign of Valentinian III., forced the Franks who were passing into Gaul to repass the Rhine. He defeated the Goths, and routed Attila, king of the Huns, who invaded Gaul with an army of 700,000 men. But the emperor, jealous of the merit of this great man, killed him in 454, with his own hand, under the pretence that he had permitted the invasion of the Huns, after Attila's defeat.

ÆTNA, (in the Itineraries *Æthana*, supposed from αιθω, *to burn;* according to Bochart, from *athuna*, a furnace, or *ætuna*, darkness), now *Monte Gibello;* a volcano or burning mountain of Sicily, situated in Long. 15. E. Lat. 38. N.

This mountain, famous from the remotest antiquity, both for its bulk and terrible eruptions, stands in the eastern part of the island, in a very extensive plain, called *Val di Demona*, from the notion of its being inhabited by devils, who torment the spirits of the damned in the bowels of this volcano.

Magnitude and height of the mountain.

The base of Ætna is well defined by the sea, and by the rivers Giaretta and Alcantara; and is about eighty-seven miles in circumference, with its greatest diameter extending from east to west. The following measurements, taken by Captain Smyth, we have adopted as the most accurate hitherto published:

| | |
|---|---|
| The Summit | 10874 feet. |
| Foot of the Cone | 9760 |
| The English House | 9592 |
| Philosopher's Tower | 9467 |
| Bishop's Snow Stoves | 7410 |
| Highest part of the Woody Region | 6279 |
| The Goats' Cavern | 5362 |
| Angelo the Herdsman's Cottage | 4205 |
| Nicolosi Convent | 2449 |
| Lingua-Grossa | 1725 |
| Caltabiano Station | 371 |
| Catania Station | 47 |

General appearance.

The products and general appearance of this volcano have been described by many travellers. The journey from Catania to its summit has been described by M. D'Orville, Mr Brydone, Sir William Hamilton, M. Houel, the abbé Spallanzani, Smyth, &c. They all agree that

Ætna.

this single mountain affords an epitome of the different climates throughout the whole world. Towards the foot it is extremely hot; farther up, more temperate; and grows gradually more and more cold the higher we ascend. At the very top it is perpetually covered with snow: from thence the whole island is supplied with that article, so necessary in a hot climate, and without which, the natives say, Sicily could not be inhabited. So great is the demand for this commodity, that the bishop's revenues, which are considerable, arise from the sale of Mount Ætna's snow; and he is said to draw L.1000 a year from one small portion lying on the north side of the mountain. Great quantities of snow and ice are likewise exported to Malta and Italy, making a considerable branch of commerce. The snow of Ætna, says Captain Smyth, is not only consumed in vast quantities all over the island, but forms an extensive article of commerce with Malta and Italy, to which places it is sent in such profusion as to be sold from a penny to threepence the pound, a rate which renders it accessible to the lower orders.

Crater described.

In the middle of the snowy region stands the great *crater*, or mouth of Ætna. Sir William Hamilton describes the crater as a little mountain, about a quarter of a mile perpendicular, and very steep, situated in the middle of a gently inclining plain, of about nine miles in circumference. It is entirely formed of stones and ashes; and, as he was informed by several people of Catania, had been thrown up about 25 or 30 years before the time (1769) he visited Mount Ætna. Before this mountain was thrown up, there was only a prodigiously large chasm or gulf in the middle of the above-mentioned plain; and it has been remarked, that about once in 100 years the top of Ætna falls in; which undoubtedly must be the case at certain periods, otherwise the mountain would continually increase in height. As this little mountain, though emitting smoke from every pore, appeared solid and firm, Sir William Hamilton and his companions went up to the very top. In the middle is a hollow, about two miles and a half in circumference, according to Sir William Hamilton; three miles and a half, according to Mr Brydone; and three or four, according to M. D'Orville. The inside is crusted over with salts and sulphur of different colours. It goes shelving down from the top, like an inverted cone; the depth, in Sir William Hamilton's opinion, nearly corresponding to the height of the little mountain. From many places of this space issue volumes of sulphurous smoke, which being much heavier than the circumambient air, instead of ascending in it, roll down the side of the mountain, till, coming to a more dense atmosphere, it shoots off horizontally, and forms a large track in the air, according to the direction of the wind; which, happily for our travellers, carried it exactly to the side opposite to that on which they stood. In the middle of this funnel is the tremendous and unfathomable gulf, so much celebrated in all ages, both as the terror of this life and the place of punishment in the next. From this gulf continually issue terrible and confused noises, which in eruptions are increased to such a degree as to be heard at a prodigious distance. Its diameter is probably very different at different times; for Sir William Hamilton observed, by the wind clearing away the smoke from time to time, that the inverted hollow cone was contracted almost to a point; while M. D'Orville and Mr Brydone found the opening very large. Both Mr Brydone and Sir William Hamilton found the crater too hot to descend into it; but M. D'Orville was bolder; and accordingly, he and his fellow-traveller, fastened to ropes which two or three men held at a distance for fear of accidents, descended as near as possible to the brink of the gulf; but the small flames and smoke which issued from it on every side, and a greenish sulphur, and pumice stones, quite black, which covered the margin, would not permit them to come so near as to have a full view. They only saw distinctly, in the middle, a mass of matter which rose in the shape of a cone, to the height of above 60 feet, and which towards the base, as far as their sight could reach, might be 600 or 800 feet. While they were observing this substance, some motion was perceived on the north side, opposite to that whereon they stood; and immediately the mountain began to send forth smoke and ashes. This eruption was preceded by a sensible increase of its internal roarings; which, however, did not continue, but, after a moment's dilatation, as if to give it vent, the volcano resumed its former tranquillity; but as it was by no means proper to make a long stay in such a place, our travellers immediately returned to their attendants.

View from the summit.

The top of Ætna being above the common region of vapours, the heavens appear with exceeding great splendour. Mr Brydone and his company observed, as they ascended in the night, that the number of stars seemed to be indefinitely increased, and the light of each of them appeared brighter than usual; the whiteness of the milky way was like a pure flame which shot across the heavens; and with the naked eye they could observe clusters of stars that were invisible from below. Had Jupiter been visible, he is of opinion that some of his satellites might have been discovered with the naked eye, or at least with a very small pocket-glass. He likewise took notice of several of those meteors called *falling stars*, which appeared as much elevated as when viewed from the plain; a proof, according to Mr Brydone, that "these bodies move in regions much beyond the bounds that some philosophers have assigned to our atmosphere."

To have a full and clear prospect from the summit of Mount Ætna, it is necessary to be there before sunrise, as the vapours raised by the sun in the daytime will obscure every object. Accordingly, our travellers took care to arrive there early enough; and all agree, that the beauty of the prospect from thence cannot be described. Here Mr Brydone and Sir William Hamilton had a view of Calabria in Italy, with the sea beyond it; the Lipari islands, and Stromboli, a volcano at about 70 miles distance, appeared just under their feet: the whole island of Sicily, with its rivers, towns, harbours, &c. appeared distinct, as if seen on a map. Massa, a Sicilian author, affirms, that the African coast, as well as that of Naples, with many of its islands, has been discovered from the top of Ætna. The visible horizon here is no less than 800 or 900 miles in diameter. The pyramidal shadow of the mountain reaches across the whole island, and far into the sea on the other side, forming a visible track in the air, which, as the sun rises above the horizon, is shortened, and at last confined to the neighbourhood of Ætna. The most beautiful part of the scene, however, in Mr Brydone's opinion, is the mountain itself, the island of Sicily, and the numerous islands lying round it. These last seem to be close to the skirts of Ætna, the distances appearing reduced to nothing.

M. Houel gives the following description of the view he enjoyed from the summit of the mountain. Here, being sheltered from the wind, and the day advancing, they began to enjoy the glorious prospect, which every moment became more extensive. At the rising of the sun, the horizon was serene, without a single cloud. "The coast of Calabria," says our author, "was as yet undistinguishable from the adjoining sea; but in a short time a fiery radiance began to appear from behind the Italian hills which bounded the eastern part of the prospect.

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The fleecy clouds, which generally appear early in the morning, were tinged with purple; the atmosphere became strongly illuminated, and, reflecting the rays of the rising sun, appeared filled with a bright effulgence of flame. The immense elevation of the summit of Ætna made it catch the first rays of the sun's light, whose vast splendour, while it dazzled the eyes, diffused a most cherishing and enlivening heat, reviving the spirits, and diffusing a pleasant sensation throughout the soul. But though the heavens were thus enlightened, the sea still retained its dark azure, and the fields and forests did not yet reflect the rays of the sun. The gradual rising of this luminary, however, soon diffused his light over the hills which lie below the peak of Ætna. This last stood like an island in the midst of the ocean, with luminous points every moment multiplying around, and spreading over a wider extent with the greatest rapidity. It was as if the universe had been observed suddenly springing from the night of non-existence. The tall forests, the lofty hills, and extensive plains of Ætna, now presented themselves to view. Its base, the vast tracts of level ground which lie adjacent, the cities of Sicily, its parched shores, with the dashing waves and vast expanse of the ocean, gradually presented themselves; while some fleeting vapours, which moved swiftly before the wind, sometimes veiled part of this vast and magnificent prospect." In a short time every thing was displayed so distinctly that they could plainly recognise all those places with which they were before acquainted. On the south were seen the hills of Camerata and Trapani; on the north, the mounts Pelegrino and Thermini, with the celebrated Enna once crowned with the temples of Ceres and Proserpine. Among these mountains were seen a great many rivers running down, and appearing like as many lines of glittering silver winding through a variety of rich and fertile fields, washing the walls of 28 cities, while their banks were otherwise filled with villages, hamlets, &c. rising among the ruins of the most illustrious republics of antiquity. On the south and north were observed the rivers which bound by their course the vast base of Mount Ætna, and afford a delightful prospect to the eye; while at a much greater distance were seen the isles of Lipari, Alicudi, Felicocide, Parinacia, and Stromboli.

Regions.

This mountain is divided into three parts or zones, which are distinguished by the names of the *Regione Culta*, the fertile or cultivated region; the *Regione Sylvosa*, the woody or temperate region; and the *Regione Deserta*, the frigid or desert zone or region. All these are plainly distinguished from the summit.

Regione Deserta.

The desert region is a dreary waste of black lava, scoria, and ashes, in the centre of which, in a desolate plain, rises the cone, to the height of eleven hundred feet. Immediately under the cone is an edifice, erected at the expense of the British officers who during the late war were stationed in Sicily, containing rooms and stabling; a great convenience to those travellers who resort to it in the proper season, but during the greater part of the year a single snow storm is sufficient to overwhelm it. Not far from this house are the vestiges of a brick building, called the *Philosopher's Tower*, from the supposition of its having been the dwelling of Empedocles. M. Houel, however, says, "it seems not to be very ancient, neither the materials of which it consists, nor the mode of architecture, bearing any resemblance to those of the Greeks or Romans."

Regione Sylvosa.

Immediately below the desert region is the woody region, which is an extensive forest of about six or seven miles in length, encircling the mountain, and affording pasturage to the numerous flocks and herds that are fed there. The woods are irregularly distributed, according to the ravages of the lava, and the senseless destruction of them by the natives. The neighbourhood of Maletto is richly clothed with fine oaks, pines, and poplars; above Nicolosi and Milo are produced stunted oaks, with fir, beech, cork, hawthorn, and bramble; and in the districts of Mascali and Piraino there are groves of cork, and luxuriant chesnut trees. The vicinity of Bronte abounds with pines of great magnitude; but the Carpinetto boasts that father of the forest, the venerable *Castagno di cento cavalli*, or chesnut of the hundred horses, supposed to be one of the oldest known trees, and, as far as is known, the largest tree in Europe. Some travellers describe it as a single tree; others, and with more plausibility, as produced by the inosculation of several young chesnut trees. It appears to consist of five large and two smaller trees. The largest trunk Captain Smyth found to measure 38 feet in circumference, and the circuit of the whole five, measured just above the ground, is 163 feet. It still bears rich foliage, and much small fruit, though the heart of the trunk is decayed, and a public road leads through them. Besides this, there is abundance of other trees in the neighbourhood, very remarkable for their size. One is mentioned as being upwards of 70 feet in circumference. Many parts of this region are remarkably picturesque, and even romantic; and its cool temperature is extremely grateful when contrasted with the heat of the lower region.

"These majestic forests of Ætna," says Houel, "afford a singular spectacle, and bear no resemblance to those of other countries. Their verdure is more lively, and the trees of which they consist are of a greater height. These advantages they owe to the soil whereon they grow; for the soil produced by volcanoes is particularly favourable to vegetation, and every species of plants grows here with great luxuriance. In several places, where we can view their interior parts, the most enchanting prospects are displayed. The hawthorn trees are of an immense size. Our author saw several of them of a regular form, and which he was almost tempted to take for large orange trees cut artificially into the figures they represented. The beeches appear like as many ramified pillars, and the tufted branches of the oak like close bushes impenetrable to the rays of the sun. The appearance of the woods in general is exceedingly picturesque, both by reason of the great number and variety of the trees, and the inequality of the ground, which makes them rise like the seats in an amphitheatre, one row above another; disposing them also in groups and glades, so that their appearance changes to the eye at every step; and this variety is augmented by accidental circumstances, as the situation of young trees among others venerable for their antiquity; the effects of storms, which have often overturned large trees, while stems shooting up from their roots, like the Lernæan hydra, show a number of heads newly sprung to make up that which was cut off."

Several extensive caverns occur in this region, among which, one is well known by the name of the *Goats' Cavern* or *Grotto*, because it is frequented by those animals, which take refuge there in bad weather. Formerly travellers on their ascent rested here, but since the erection of the more convenient shelter higher up the mountain, called the English House, it has been abandoned.

Regione Culta.

The fertile district or region comprises the delightful country round the skirts of the mountain, and is very unequal in its dimensions, being in many parts from six to nine miles broad, and above Catania nearly eleven; while on the northern side, where the woods encroach, it is little more than half a mile broad. The whole is more or less covered with towns, villages, and monasteries, and

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is well peopled, notwithstanding the danger of such a situation. The soil is made up of decomposed lava and tuffa. It is easily worked and very productive, yielding the finest corn, oil, wine, fruit, and aromatic shrubs, in Sicily. The inhabitants, however, of many of these districts, as Smyth remarks, from the numerous minute particles of volcanic dust that fly about, severely injuring and disfiguring their eyes, and soiling their persons, their furniture, and their houses, have a squalid, slovenly, and dejected appearance. These circumstances, with the want of water, and the numerous and arid patches of lava amidst the surrounding vegetation, leave such a paradise little to be envied. In addition to these inconveniences, the constant danger of losing both landed and movable property by an eruption must be borne in mind; a disaster compared with which, earthquakes, hurricanes, plagues, and other visitations are light, as these may be counteracted in a few years, while the other destroys for ages. The terrible eruption of 1699 burst forth in this region.

In this region the river *Acis*, so much celebrated by the poets, in the fable of Acis and Galatea, takes its rise. It bursts out of the earth at once in a large stream, runs with great rapidity, and about a mile from the source throws itself into the sea.

Season for ascending the mountain.

The most desirable season, according to Smyth, for ascending the mountain, is during the full moons that occur between the middle of June and the first autumnal rains. The latter appear in the form of snow on the summit; and the peasants below attentively observe whether the east or west side is covered earliest, because in the former case they expect a wet season, and in the latter a dry one. After the equinox the weather again becomes settled, and the journey is practicable and easy until the middle of October. The ascent from Catania, through Nicolosi, to the English house, is effected on mules with the greatest ease, or even in a *Lettiga;* but from thence to the top of the cone the journey is very fatiguing. The obstacles are numerous: the surface, towards the summit, is frequently so hot as to make even resting inconvenient, and the materials, being only scoria, puzzolana, and triturated ashes, occasion the foot to sink and recede more or less at every step.

Geognostical structure.

This mighty mountain, which rises suddenly from the surrounding low country, is mostly composed of porphyritic lavas, which in every instance possess such characters as show that in all probability they have been ejected above the surface of the *waters*, and not under pressure. It rises out of a basaltic *crater of elevation*, hence its lower part is of a basaltic nature. The products of the eruptions of this mountain, in point of magnitude, form a striking contrast with those of Vesuvius; for even the greatest bodies of lava erupted from the Neapolitan mountain almost sink into insignificance when compared with those of Ætna, some of the streams or coulées of Ætna being four or five miles in breadth, 15 in length, and from 50 to 100 feet in thickness.

The elevation of Ætna, too, is so great that the lava frequently finds less resistance in piercing the flanks of the mountain than in rising to its summit; and has in this manner formed a number of minor cones, many of which possess their respective craters, and have given rise to considerable streams of lava. The most striking and original feature in the physiognomy of Ætna, says Dr Daubeny, is the zone of subordinate volcanic hills with which it is encompassed, and which look like a court of subaltern princes waiting upon their sovereign. Of these, some are covered with vegetation, others are bare and arid, their relative antiquity being probably denoted by the progress vegetation has made upon their surface; and the great difference which exists in this respect seems to indicate, that the mountain, to which they owe their origin, must have been in a state of activity, if not at a period antecedent to the commencement of the present order of things, at least at a distance of time exceedingly remote. It must be remarked, however, continues Daubeny, that the time which it takes to bring a volcanic mountain or stream of lava into cultivation is very variable;[1] and that the progress is generally more rapid in a cone composed of finely comminuted cinders, than in a stream of lava, which consists of a hard glossy substance, that yields but slowly to the causes of decomposition. There is nothing in the nature of lava, chemically considered, prejudicial to vegetation; but mechanically, the hard surface is inimical, as it gives no support to the tender shoots, and from its vesicularity often carries off all the moisture that falls on its surface. From these causes, the surface of a stream of lava must always require a long time to bring it into cultivation. This being the case, we naturally feel desirous of verifying an observation reported by Brydone, on the authority of the canon Recupero, which might render us doubtful as to the correctness of our received chronologies. This writer, says Dr Daubeny, after giving an instance of a lava, the date of which goes back to the time of the second Punic war, proceeds to state, that at Aci Reale we see seven such beds superimposed one on the other, each of which has its surface thoroughly decomposed and converted into rich vegetable mould. Now, if a single bed of lava has continued for more than 2000 years without experiencing any alteration, what a lapse of time must it have required to reduce seven successive beds of the same material into a state of such decomposition.

" Although I have no reason," says Dr Daubeny, " to doubt that Brydone received from Recupero the observa-

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[1] " This will appear from the following statement of the condition of a few of the lavas of Vesuvius, which I examined with reference to this question in 1823:

Lava of 1551.—Fossa di Gaetano. Much decomposed; heaths grow upon it, and vines begin to be planted.

1737.—But little decomposed; moss alone grows on it.

1760.—Near the hill of the Camalduli. Still unfit for vegetation; surface, however, whitened and crumbly, owing to decomposition, which has proceeded farther than in that of 1737.

1771.—Colour grey; moss grows upon it, but no heath.

1785.—Fossa di Sventurato. Lava still quite hard and rough.

1794.—Fossa di Cucazzello. Surface much decomposed; moss grows upon it, and a few heaths, but no trees or shrubs. It is to be observed, that even the latter are met with on the surface of the crater from which this lava flowed, and which was formed by heaps of scoriæ ejected at the same time; a proof of what I have asserted in the text with respect to the more rapid decomposition of loose ashes than of a bed of lava.

1805.—Fossa del Noce. Colour very white; no moss appears to grow upon it; but, being covered with the loose scoriæ of later eruptions, it has trees growing upon it in a few parts.

1810.—Colour grey; surface rough, though somewhat decomposed; moss grows upon it, but no heaths or trees are seen, except in one part where it is covered with cinders.

1822.—Colour black; surface very rough and irregular; no moss as yet to be seen.

It will be seen that many of these lavas are in a more forward state than that of Ischia, which flowed in 1302, more than 200 years before." (Daubeny's *Volcanoes*, p. 204.)

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tion on which he grounds his inferences, I think it most probable that the conclusion itself was his own, though he perhaps thought it would sound more *piquant* if put into the mouth of the *Canon*, whose scientific knowledge he seems willing to exalt at the expense of his orthodoxy. In reality, however, this good priest appears to have enjoyed in both respects a reputation which he very little deserved. The reports of Dolomieu and other really scientific travellers make him out to have been a man of but slender philosophical attainments, but as one who at least was free from all imputation of scepticism. It is curious, nevertheless, that another foreigner has stated, as an instance of the intolerant spirit prevailing in the country in which he lived, that the poor Abbé was thrown into prison for his religious opinions, although the truth appears to have been, that the reports circulated in his favour by Brydone, Borch, and others, induced the Neapolitan government to grant him a pension on the score of his scientific deserts. Indeed, the only annoyance, it is said, he ever experienced in consequence of his imagined discovery, was the being informed that certain foreigners, to whom he communicated his observation, not content with wresting it to a purpose of which he had never dreamt, had given him credit for the inferences which they had chosen to deduce from it themselves.

"The fact, nevertheless, reported by Brydone, obtained a currency proportionate to the popularity which his work enjoyed; and the heterodox conclusion excited at the time no slight degree of consternation among divines. It was generally combated, by remarking the great variableness as to the period which a bed of lava will take to undergo decomposition; and even Spallanzani, though he visited Sicily, seems to have contented himself with pointing out instances in which newer beds of lava have taken the start of older ones in their progress towards cultivation.

"I was therefore not a little surprised, when, on visiting the celebrated spot of the Abbé's observation, I found that the beds of vegetable mould, which proved, according to Brydone, the degree to which the decomposition of the lava had extended, were in reality nothing more nor less than beds of a ferruginous tuffa, formed probably at the very period of the flowing of the lava, and originating perhaps from a shower of ashes that immediately succeeded its eruption. It is true that the cliff, which exhibits a section of these lava beds with interposed tuffa, shows also the greater facility with which the latter has yielded to the action of the elements, as the bare and mural precipices presented by the lava are in contrast with the gentler slope of the beds of tuffa, which afford a soil sufficient for the hardy cactus, and in some places even for the vine. Still there is not the slightest evidence that the decomposition exists internally, or that it had taken place in any one instance before the superincumbent bed of lava was deposited.

"Even had the tuffa in question been in reality *vegetable mould*, the validity of Mr Brydone's conclusion might very easily be disputed, for I think it cannot be shown that any one of the beds, of which the cliff of Aci Reale exposes a section, are of postdiluvial origin. So abrupt and lofty a face of rock would hardly have been cut by processes now in operation, but may be attributed with more probability to the cause which last reduced our continents to their existing form.

"If we examine, too, the characters of these beds, we shall find them sufficiently distinguished by their greater compactness and stony aspect from modern lavas; whilst the general correspondence in mineralogical characters that exists between them all, affords a strong presumption of their having been produced about the same period.

"But it is useless to multiply proofs of the fallacy of Mr Brydone's statement; and the only circumstance that needs surprise us is, that thirty years should have elapsed without any traveller having visited the spot with the view of ascertaining the correctness of the observation.

"Should the high antiquity I have assigned to this volcano be questioned, I may remark, that there are valleys on the slope of the mountain which appeared to me too considerable to be the result of torrents, and that among the diluvial matter at its foot, I have found rolled masses of cellular as well as compact lava; the presence of the former seeming to prove that the volcano was in activity at some period intermediate between the general retreat of the ocean and the event which formed the valleys, and reduced the fragments of rock detached to the rounded condition in which we observe them." (Daubeny's *Volcanoes*, p. 206.)

We shall close this article with an enumeration of all the different eruptions from Mount Ætna which are found upon record.

List of eruptions.

1. The first is that of which Diodorus Siculus speaks, but without fixing the period at which it happened. That eruption, says he, obliged the Sicani, who then inhabited Sicily, to forsake the eastern and retire to the southern part of the island. A long time after that, the Sicilians, a people of Italy, migrated into Sicily, and took up their abode in that part of the island which had been left desert by the Sicani.

2. The second eruption known to have issued from this volcano is the first of the three mentioned by Thucydides; of none of which he fixes the date, mentioning only in general, that from the arrival of the first Greek colonies that settled in Sicily (which was in the 11th Olympiad, and corresponds to the 734th year before the Christian era), to the 88th Olympiad, or the year 425 before Christ, Ætna at three different times discharged torrents of fire. This second eruption happened, according to Eusebius, in the days of Phalaris, in the 565th year before the Christian era. The assertion of Eusebius is confirmed by a letter from that tyrant to the citizens of Catania, and by the answer of the Catanians (if, after Bentley's Dissertations against their authenticity, any credit be due to the Epistles of Phalaris). But Diodorus gives both these pieces.

3. The third, which is the second of the three mentioned by Thucydides, happened in the 65th Olympiad, in the 477th year before the Christian era, when Xantippus was archon at Athens. It was in this year that the Athenians gained their boasted victory over Xerxes's general Mardonius near Platæa. Both the eruption of the volcano and the victory of the Athenians are commemorated in an ancient inscription on a marble table, which still remains. An ancient medal exhibits a representation of an astonishing deed to which that eruption gave occasion. Two heroic youths boldly ventured into the midst of the flames to save their parents: their names, which well deserve to be transmitted to future ages, were Amphinomus and Anapius. The citizens of Catania rewarded so noble a deed with a temple and divine honours. Seneca, Silius Italicus, Valerius Maximus, and other ancient authors, mention the heroism of the youths with just applause.

4. The fourth eruption, the third and last of those mentioned by Thucydides, broke out in the 88th Olympiad, in the 425th year before the Christian era. It laid waste the territory of Catania.

5. The fifth is mentioned by Julius Obsequens and Orosius, who date it in the consulship of Sergius Fulvius Flaccus and Quintus Calpurnius Piso, nearly 133 years before the Christian era. It was considerable; but no peculiar facts are related concerning it.

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6. In the consulship of Lucius Æmilius Lepidus and Lucius Aurelius Orestes, in the 125th year before the Christian era, Sicily suffered by a violent earthquake. Such a deluge of fire streamed from Ætna as to render the adjoining sea, into which it poured, absolutely hot. Orosius says, that a prodigious quantity of fishes were destroyed by it. Julius Obsequens relates, that the inhabitants of the Isles of Lipari ate such a number of those fishes as to suffer, in consequence of it, by a distemper which proved very generally mortal.

7. Four years after the last mentioned, the city of Catania was desolated by another eruption, not less violent. Orosius relates, that the roofs of the houses were broken down by the burning ashes which fell upon them. It was so dreadfully ravaged, that the Romans found it necessary to grant the inhabitants an exemption from all taxes for the space of ten years, to enable them to repair it.

8. A short time before the death of Cæsar, in the 43d year before Jesus Christ, there was an eruption from Mount Ætna. Livy mentions it. Rhegium suffered during this eruption. It was afterwards considered as an omen of the death of Cæsar.

9. Suetonius, in the life of Caligula, mentions an eruption from Mount Ætna which happened in the 40th year after the Christian era. The emperor fled on the very night on which it happened, from Messina, where he at that time happened to be.

10. Carrera relates, that in the year 253 there was an eruption from Mount Ætna.

11. He speaks of another in the year 420, which is also mentioned by Photius.

12. In the reign of Charlemagne, in the year 812, there was an eruption from Ætna. Charlemagne, who witnessed it, was much alarmed.

13. In the year 1169, on the 4th February, about daybreak, there was an earthquake in Sicily, which was felt as far as Reggio, on the opposite side of the strait. Catania was reduced by it to ruins; and in that city more than 15,000 souls perished. The bishop, with 44 monks of the order of St Benedict, was buried under the ruins of the roof of the church of St Agatha. Many castles in the territories of Catania and Syracuse were overturned; new rivers burst forth, and ancient rivers disappeared. The ridge of the mountain was observed to sink in on the side next Taormino. The spring of Arethusa, so famous for the purity and sweetness of its waters, then became muddy and brackish. The fountain of Ajo, which rises from the village of Saraceni, ceased to flow for two hours, at the end of which the water gushed out more copiously than before. Its waters assumed a blood colour, and retained it for about an hour. At Messina, the sea, without any considerable agitation, retired a good way beyond its ordinary limits; but soon after returning, it rose beyond them, advanced to the walls of the city, and entered the streets through the gates. A number of people who had fled to the shore for safety were swallowed up by the waves. Ludovico Aurelio relates, that the vines, corn, and trees of all sorts were burnt up, and the fields covered over with such a quantity of stones as rendered them unfit for cultivation. At this time a great part of Syria was wasted by an earthquake.

14. Twelve years after this, in the year 1181, a dreadful eruption issued from Ætna, on the east side. Streams of fire ran down the declivity of the mountain, and encircled the church of St Stephen, but without burning it.

Nicholas Speciale, who relates, though he did not see, this event, was witness to another conflagration on Ætna 48 years after this, in the year 1329, on the 23d of June, of which he has given a description.

15. On that day, says he, about the hour of vespers, Ætna was strongly convulsed, and uttered dreadful noises: not only the inhabitants of the mountain, but all Sicily, were struck with consternation and alarm. On a sudden, a terrible blaze of fire issued from the southern summit, and spread over the rocks of Mazzara, which are always covered with snow Together with the fire, there appeared a great deal of smoke. After sunset, the flames, and the stones that issued out with them, were seen to touch the clouds. The fire making way for itself with the most furious impetuosity, burnt up or reduced to ruins all those structures which the piety of former times had consecrated to the Deity. The earth yawning, swallowed up a great many springs and rivulets. Many of the rocks on the shore of Mascali were shaken and dashed into the sea. A succession of these calamities continued till the 15th of July, when the bowels of Ætna were again heard to rebellow. The conflagration of Mazzara still went on unextinguished. The earth opened near the church of St John, called *Il Paparinecca;* on the south side fire issued from the gap with great violence. To add to the horrors of the day, the sun was obscured from morning to evening with clouds of smoke and ashes, as entirely as in an eclipse. Nicholas Speciale went towards the new opened crater, to observe the fire and the burning stones which were issuing from the volcano. The earth rebellowed and tottered under his feet; and he saw red-hot stones issue four times successively in a very short space from the crater with a thundering noise, the like of which, he says, he had never before heard.

In a few days after this, all the adjacent fields were burnt up by a shower of fire and sulphurous ashes; and both birds and quadrupeds, being thus left destitute of food, died in great numbers. A great quantity of fishes likewise died in the rivers and the contiguous parts of the sea. "I cannot think," says he, "that either Babylon or Sodom was destroyed with such awful severity."—The north winds, which blew at the time, carried the ashes as far as Malta. Many persons of both sexes died of terror.

16. Scarcely had four years elapsed after this terrible event, when Ætna made a new explosion, and discharged volleys of stones, causing the neighbouring fields to tremble. This happened in the year 1333.

17. Forty-eight years after this, on the 25th of August 1381, an eruption from Ætna spread its ravages over the confines of the territory of Catania, and burnt up the olive yards in the neighbourhood of that city.

18. In the year 1444, 63 years after the last eruption, a torrent of lava issued from Ætna, and ran towards Catania. The mountain shook; and the shocks were so violent, that several huge masses of rock were broken from its summit, and hurled into the abyss with a tremendous noise.

19. After this Ætna was scarcely at rest for 18 months or two years. On Sunday the 25th of September 1446, about an hour after sunset, an eruption issued from the place called *La Pietra di Mazzara.* This eruption was soon over.

20. In the following year, 1447, on the 21st of September, there was another, with a good deal of fire; but this eruption was likewise of short duration.

21. Ætna now ceased to emit fire, and that for a considerable time. The neighbouring inhabitants not only ascended to the summit of the mountain, but even, if we may credit accounts, went down into the fiery gulf, and believed the volcanic matter to be now exhausted. But on the 25th of April 1536, near a century from the slight eruption in 1447, a strong wind arose from the west, and a thick cloud, reddish in the middle, appeared over the

summit of the mountain. At the very same instant a large body of fire issued from the abyss, and fell, with the noise and rapidity of a torrent, along the eastern side of the mountain, breaking down the rocks, and destroying the flocks and every other animal that was exposed to its fury. From the same crater, on the summit of the mountain, there issued at the same time a stream of fire more terrible than the other, and held its course towards the west. It ran over Bronte, Adrans, and Castelli. It consisted entirely of sulphur and bitumen. On the same day the church of St Leon, which stood in a wood, was first demolished by the shocks of the earthquake, and its ruins after that were consumed by the fire. Many chasms were opened in the sides of the mountain; and from these issued fire and burning stones, which darted up into the air with a noise like that produced by a smart discharge of artillery. Francis Negro de Piazza, a celebrated physician, who lived at Lentini, wishing to have a nearer view of the eruptions, and to make some observations which he thought might be of consequence, was carried off and burnt to ashes by a volley of the burning stones. This conflagration of Ætna lasted some weeks.

22. In less than a year, on the 17th of April 1537, the river Simeto swelled so amazingly as to overflow the adjacent plains, and carry off the country people, and their cattle and other animals. At the same time, the country around Paterno, the neighbouring castles, and more than 500 houses, were destroyed by the ravages of the river; and most of the wood was torn up by the roots by violent blasts of wind. These ravages of the elements were followed by Ætna, which on the 11th of the following month was rent in several places, disclosing fiery gulfs, and pouring out a deluge of fire in more terrible torrents than those of the preceding year. They directed their course towards the monastery of St Nicholas d'Arena; destroyed the gardens and vineyards; and proceeding onwards towards Nicolosi, burnt Montpellieri and Fallica, and destroyed the vineyards and most of the inhabitants. When the conflagration ceased, the summit of the mountain sunk inward with such a noise, that all the people in the island believed the last day arrived, and prepared for their end by extreme unction. These dreadful disturbances continued throughout the whole year, more especially in the months of July and August, during which all Sicily was in mourning. The smoke, the noise, and the shocks of the earthquake, affected the whole island; and if Filotes may be believed, who relates this event, many of the Sicilians were struck deaf by the noise. Many structures were demolished; and among others the castle of Corleone, though more than 25 leagues distant from the volcano.

23. During the succeeding 30 years there was no disturbance of this nature. At the end of that space, Sicily was alarmed by a new eruption from the mountain. Ætna discharged new streams of fire, and covered the adjacent country with volcanic ashes, which entirely ruined the hopes of the husbandman.

24. In the year 1579 Ætna renewed its ravages; but no particular account of the damage which it did upon this occasion has been transmitted to us.

25. Twenty-five years had elapsed, when Ætna, in the month of June 1603, flamed with new fury. Peter Carrera affirms that it continued to emit flames for the space of 33 years, till 1636, without interruption, but not always with the same violence. In 1607 the streams of lava which flowed from it destroyed the woods and vineyards on the west side of the mountain. In 1609 they turned their course towards Aderno, and destroyed a part of the forest Del Pino, and a part of the wood called *La Sciambrita*, with many vineyards in the district Costerna. These torrents of lava continued to flow for three months. In the year 1614 a new effort of the subterraneous fire opened another crater, from which fire was discharged on Randazzo, in the district called *Il Piro*. The fire continued to flame for 10 or 12 years longer.

26. The same Peter Carrera relates, that a dreadful conflagration happened in the year 1664, of which he himself was witness. It happened on the 13th of December, and lasted without interruption, but with different degrees of violence, till the end of May 1678. But in 1669 the inhabitants of Nicolosi were obliged to forsake their houses, which tumbled down soon after they left them. The crater on the summit of Ætna had not at this time a threatening aspect, and every thing there continued quiet till the 25th of March: but on the 8th of that month, an hour before night, the air was observed to become dark over the village La Pedara and all that neighbourhood; and the inhabitants of that country thought that an almost total eclipse was taking place. Soon after sunset, frequent shocks of earthquakes began to be felt: these were at first weak, but continued till day-break to become more and more terrible. Nicolosi was more affected than any other tract of country on that side of Ætna. About noon every house was thrown to the ground; and the inhabitants fled in consternation, invoking the protection of heaven. On the 10th of March a chasm several miles in length, and five or six feet wide, opened in the side of the mountain; from which, about two hours before day, there arose a bright light, and a very strong sulphurous exhalation was diffused through the atmosphere.

About 11 in the forenoon of the same day, after dreadful shocks of earthquake, a crater was opened in the hill called *Des Noisettes*, from which there issued huge volumes of smoke, not accompanied with fire, ashes, or stones, but with loud and frequent claps of thunder, displaying all the different phenomena with which thunder is at different times attended. And what was very remarkable, the chasm was formed on the south side, between the top and the bottom of the mountain. On the same day another chasm was formed two miles lower, from which issued a great deal of smoke, accompanied with a dreadful noise and earthquake. Towards the evening of the same day, four other chasms were opened towards the south, in the same direction, accompanied during their formation with the same phenomena, and extending all the way to the hill called *La Pusara*.

About twelve paces beyond that, another of the same kind was formed. On the succeeding night, a black smoke, involving a quantity of stones, issued from this last chasm: it discharged at the same time flakes of a dark-coloured spongy matter, which became hard after they fell. There issued from the same gulf a stream of lava, which held its course into a lake called *La Hardia*, six miles from Montpellieri, and on its way thither destroyed many dwelling-houses and other buildings in the neighbouring villages.

On the next day, March 12th, this stream of fire directed its course towards the tract of country called *Malpasso*, which is inhabited by 800 people: in the space of 20 hours it was entirely depopulated and laid waste. The lava then took a new direction, in which it destroyed some other villages.

The mount of Montpellieri was next destroyed, with all the inhabitants upon it.

On the 23d of the same month, the stream of fire was in some places two miles broad. It now attacked the large village of Mazzalucia; and on the same day a vast gulf was formed, from which were discharged sand or ashes, which produced a hill with two summits, two miles

Ætna. in circumference, and 150 paces high. It was observed to consist of yellow, white, black, grey, red, and green stones.

The new mount of Nicolosi continued to emit ashes for the space of three months; and the quantity discharged was so great as to cover all the adjoining tract of country for the space of 15 miles. Some of these ashes were conveyed by the winds as far as Messina and Calabria; and a north wind arising, covered all the southern country about Agosta, Lentini, and even beyond that, in the same manner.

While at that height on Nicolosi so many extraordinary appearances were passing, the highest crater on the summit of Ætna still preserved its usual tranquillity.

On the 25th of March, about one in the morning, the whole mountain, even to the most elevated peak, was agitated by a most violent earthquake. The highest crater of Ætna, which was one of the loftiest parts of the mountain, then sunk into the volcanic focus; and in the place which it had occupied, there now appeared nothing but a wide gulf more than a mile in extent, from which there issued enormous masses of smoke, ashes, and stones. At that period, according to the historian of this event, the famous block of lava on Mount Frumento was discharged from the volcanic focus.

In a short time after, the torrent of fire, which still continued to flow, directed its course towards Catania with redoubled noise, and accompanied with a much greater quantity of ashes and burning stones than before. For several months many most alarming shocks of earthquakes were felt, and the city was threatened with destruction by the torrent of fire. In vain they attempted to turn or divert its course: the lava rose over the walls, and entered by an angle near the Benedictine convent on the 11th of June following. This awful event is related by Francis Monaco, Charles Mancius, Vincent Auria, and Thomas Thedeschi.

A description of the lava issuing from Mount Ætna in 1669 was sent to the court of England by Lord Winchelsea, who at that time happened to be at Catania on his way home from an embassy to Constantinople. Sir W. Hamilton gives the following extract from it. "When it was night, I went upon two towers in divers places; and I could plainly see, at ten miles distance, as we judged, the fire begin to run from the mountain in a direct line, the flame to ascend as high and as big as one of the greatest steeples in your Majesty's kingdoms, and to throw up great stones into the air. I could discern the river of fire to descend the mountain, of a terrible fiery or red colour, and stones of a paler red to swim thereon, and to be some as big as an ordinary table. We could see this fire to move in several other places, and all the country covered with fire, ascending with great flames in many places, smoking like a violent furnace of iron melted, making a noise with the great pieces that fell, especially those that fell into the sea. A cavalier of Malta, who lives there, and attended me, told me, that the river was as liquid, where it issues out of the mountain, as water, and comes out like a torrent with great violence, and is five or six fathom deep, and as broad, and that no stones sink therein."

The account given in the Philosophical Transactions is to the same purpose. We are there told, that the lava is "nothing else than divers kinds of metals and minerals, rendered liquid by the fierceness of the fire in the bowels of the earth, boiling up and gushing forth as the water doth at the head of some great river; and having run in a full body for a stone's cast or more, began to crust or curdle, becoming, when cold, those hard porous stones which the people call *sciarri*. These, though cold in comparison of what first issues from the mountain, yet retained so much heat as to resemble huge cakes of sea-coal strongly ignited, and came tumbling over one another, bearing down or burning whatever was in their way. In this manner the lava proceeded slowly on till it came to the sea, when a most extraordinary conflict ensued betwixt the two adverse elements. The noise was vastly more dreadful than the loudest thunder, being heard through the whole country to an immense distance; the water seemed to retire and diminish before the lava, while clouds of vapour darkened the sun. The whole fish on the coast were destroyed, the colour of the sea itself was changed, and the transparency of its waters lost for many months."

While this lava was issuing in such prodigious quantity, the merchants, whose account is recorded in the Philosophical Transactions, attempted to go up to the mouth itself, but durst not come nearer than a furlong, lest they should have been overwhelmed by a vast pillar of ashes, which to their apprehension exceeded twice the bigness of St Paul's steeple in London, and went up into the air to a far greater height. At the mouth itself was a continual noise, like the beating of great waves of the sea against rocks, or like distant thunder, which was sometimes so violent as to be heard 60, or even 100 miles off; to which distance also part of the ashes was carried. Some time after, having gone up, they found the mouth from whence this terrible deluge issued to be only a hole about 10 feet diameter. This is also confirmed by Mr Brydone; and is probably the same through which Sir William Hamilton descended into the subterranean caverns already mentioned.

27. Some years after this conflagration, a new burning gulf opened, in the month of December 1682, on the summit of the mountain, and spread its lava over the hill of Mazzara.

28. On the 24th of May 1686, about ten in the evening, a new eruption burst out from the summit of the mountain, on the side contiguous to the hill Del Bue. Such a quantity of inflamed matter was thrown out as consumed woods, vineyards, and crops of grain, for four leagues round. It stopped its course in a large valley near the castle of Mascali. Several people from the neighbourhood had ascended a hill between the wood of Catania and the confines of Cirrita, to observe the progress of the lava; but the hill on a sudden sunk inwards, and they were buried alive.

29. Ætna was now long quiet; for no less a space of time indeed than one half of the present age. In the year 1755 its eruptions were renewed. During these eruptions, there issued from the mountain a great torrent of boiling-hot salt water.

Eruption of water in 1755.

This water took its course down the west side of the mountain; and the channel which it cut for itself is still visible. The eruption of water from burning mountains is still much less frequent than that of lava or half-vitrified solid matters, ashes, &c. though that of water, and even mixed with the shells of marine animals (though we are not told whether it was salt or not), has sometimes been observed in other volcanoes, particularly Vesuvius. The eruption we now speak of happened in the month of February 1755. It was preceded by an exceedingly thick black smoke issuing from the crater, intermixed with flashes of fire. This smoke gradually became thicker, and the bursts of flame more frequent. Earthquakes and subterraneous thunder convulsed the mountain, and struck the inhabitants of the adjacent parts with the utmost terror. On Sunday the 2d of March, the mountain was seen to emit a huge column of smoke, exceedingly dense and black, with a dreadful noise in the bowels of the earth, accompanied also with violent flashes of lightning. From

Ætna.

time to time there were loud cracks, like the explosions of cannon; the mountain appeared to shake from its foundations; the air on that side next Mascali became very dark, and loud peals of thunder were heard. These seemed to issue from two caverns, considerably below the summit, on the side of the mountain, and were accompanied with violent blasts of wind like a tempest.

These terrible phenomena continued and increased. Ætna seemed ready to swallow up at once all those materials which it had been for so many years disgorging, or rather about to sink at once into the bowels of the earth, from whence it appeared to have been elevated. The prospect was far beyond any idea that can be given by description of this tremendous scene. The inhabitants were alarmed beyond measure; the sight of the flames driven by the winds against the sides of the mountain, the shocks of the earthquake, and the fall of rocks, struck the imagination with a horror not to be conceived. During this dreadful commotion, an immense torrent of water was emitted from the highest crater of the mountain. The whole summit of Ætna was at that time covered with a thick coating of snow. Through this the boiling water directed its course eastward, and in its passage met with frightful precipices. Over these it dashed with the utmost violence, adding its tremendous roaring to the complicated horrors of this awful scene. The snow, melting instantaneously as the boiling torrent advanced, increased its destructive power by augmenting its quantity; while the mischievous effects of the heat were scarcely diminished, by reason of the immense quantity of boiling liquid which continued to pour from the summit of the mountain.

This boiling torrent having dashed its awful cataracts from one chain of rocks to another, at length reached the cultivated plains, which it overflowed for a number of miles. Here it divided itself into several branches, forming as many deep and rapid rivers, which, after several other subdivisions, discharged themselves into the sea.

Though the mountain continued to discharge water in this manner only for half an hour, the ravages of it were very terrible. Not only those of common inundations, such as tearing up trees, hurrying along rocks and large stones, took place here, but the still more dreadful effects of boiling water were felt. Every cultivated spot was laid waste, and every thing touched by it was destroyed. Even those who were placed beyond the reach of the torrent, beheld with inexpressible horror the destruction occasioned by it; and though the alarming noises which had so long issued from the mountain now ceased in a great measure, the shocks of earthquakes, and the violent smoke which continued to issue from the mountain, showed that the danger was not over. Two new openings were now observed, and two torrents of lava began to make their way through the snow.

On the 7th of March a dreadful noise was again heard in the bowels of the mountain, and a new column of very thick and black smoke began to issue from it. A horrid explosion of small stones succeeded, some of which were carried as far as the hills of Mascali, and great quantities of black sand to Messina, and even quite over the strait to Reggio in Calabria. On the shifting of the wind to the northward this sand reached as far as the plains of Agosta. Two days after, the mountain opened again, and a new torrent of lava was discharged; which, however, advanced very slowly towards the plain, moving only at the rate of a mile in a day. It continued to flow in this manner for six days, when every thing appeared so quiet that the canon Recupero set out to view the changes which had taken place.

That gentleman's design was to trace the course of the dreadful torrent of water above mentioned. This he was very easily enabled to do by the ravages it had made; and, by following the channel it had cut all the way from the sea to the summit of the volcano, he found that this immense quantity of water had issued from the very bowels of the mountain. After issuing from the crater, and increasing its stream by passing through and melting the snow which lay immediately below the summit, it destroyed in an instant a fine and extensive forest of fir-trees. All of these were torn up by the violence of the current, though many were no less than from 24 to 30 inches in diameter. He observed that the great stream had in its descent divided itself into four branches; and these had again subdivided themselves into several smaller ones, easily distinguishable by the quantity of sand they had deposited. Afterwards re-uniting their streams, they formed many islands, and rivers 900 feet in breadth, and of a depth which could not easily be determined. Proceeding farther down, and still forcing its way among the beds of old lava, the channel of the waters was widened to 1500 feet, until it was again contracted in the valleys as before. Every object which stood in the way of this tremendous torrent was moved from its place. Enormous rocks were not only hurried down, but several of them moved to more elevated situations than those they formerly occupied. Whole hills of lava had been removed and broken to pieces, and their fragments scattered along the course of the river; and the valleys were filled up by vast quantities of sand which the waters had deposited. Our author observed, that even at the time he visited the mountain, about ten years after the eruption, the whole side of it still bore the marks of this deluge.

Ætna.

Course of the current traced by Recupero.

30. In the year 1763 there was an eruption, which continued three months, but with intervals. Ætna was at first heard to rebellow. Flames and clouds of smoke were seen to issue out, sometimes silver-coloured, and at other times, when the rays of the sun fell upon them, of a purple radiance. At length they were carried off by the winds, and rained, as they were driven before them, a shower of fire all the way to Catania and beyond it. An eruption soon burst out: the principal torrent divided into two branches, one of which ran towards the east, and fell into a deep and extensive valley.

The flames which issued from this new crater afforded a noble spectacle. A pyramid of fire was seen to rise to a prodigious height in the air, like a beautiful artificial firework, with a constant and formidable battery, which shook the earth under those who were spectators of the scene. Torrents of melted matter, running down the sides of the mountain, diffused a light bright as day through the darkness of night.

At sunrising the burning lava was observed to have run round some oaks that were still standing unburnt. Their leaves were all withered. Some birds had fallen from their branches, and been burnt to death. Some people cast wood upon the lava, and it was immediately burnt. This lava continued hot, and exhaled smoke, for two years. For five years after this, no snow appeared on the summit of Ætna.

31. In the year 1764 a new crater was opened at a great distance from Mount Ætna.

32. In the year 1766 another was opened at the grotto of Paterno: fire, smoke, and an inconsiderable torrent of lava, issued out of it.

33. On the 27th of January 1780 a new opening was formed two miles under the last-mentioned crater. On the 28th of February and the 14th of March the earthquake was renewed on the north side, and accompanied with terrible noises.

Ætna.

Between the 6th of April and the 7th of May the convulsions were renewed, accompanied with noise as before. A quantity of pumice stones and fine sand was discharged from it.

On the 18th of May the shocks were renewed. On the 23d a new crater was formed on the side of Mount Frumento on the summit of Ætna, and from it a torrent of lava discharged, which spread through the valley of Laudunza. It was 200 paces in breadth. Two other chinks were opened in the mountain near Paterno, and very near one another. The lava issuing from them proceeded, in the space of seven days, six miles; on the 25th it had run nine miles.

A new crater was likewise opened on the 25th, from which a quantity of red-hot stones continued to issue for half an hour, and fell at a very great distance. There proceeded likewise from it a stream of lava, which in the same space of time ran over a tract of country two miles in extent.

Several parts of those streams of lava were observed to be cold on the surface, and formed into solid masses, but melted again by a new stream of burning lava, which, however, did not melt the old lava.

Account of the eruption in 1787.

34. In 1787 there was a great eruption. From the 1st to the 10th of July there were signs of its approach. On the 11th, after a little calm, there was a subterraneous noise, like the sound of a drum in a close place, and it was followed by a copious burst of black smoke. It was then calm till the 15th, when the same prognostics recurred. On the 17th the subterraneous noise was heard again: the smoke was more abundant, slight shocks of an earthquake followed, and the lava flowed from behind one of the two little mountains which form the double head of Ætna. On the 18th, while the spectators were in anxious expectation of a more severe eruption, all was quiet, and continued so for more than 12 hours. Soon after they perceived some new shocks, accompanied with much noise; and the mountain threw out a thick smoke, which, as the wind was westerly, soon darkened the eastern horizon. Two hours afterwards a shower of fine black brilliant sand descended: on the east side it was a storm of stones, and at the foot of the mountain a deluge of flashes of fire, of scoria and lava.

These appearances continued the whole day. At the setting of the sun the scene changed: a number of conical flames rose from the volcano; one on the north, another on the south, were very conspicuous, and rose and fell alternately. At three in the morning, the mountain appeared cleft, and the summit seemed a burning mass. The cones of light which arose from the crater were of an immense extent, particularly the two just mentioned. The two heads seemed to be cut away; and at their separation was a cone of flame, seemingly composed of many lesser cones. The flame seemed of the height of the mountain placed on the mountain, so that it was probably two miles high, on a base of a mile and a half in diameter. This cone was still covered with a very thick smoke, in which there appeared very brilliant flashes of lightning, a phenomenon which Ætna had not before afforded. At times, sounds like those from the explosion of a large cannon were heard, seemingly at a less distance than the mountain. From the cone, as from a fountain, a jet of many flaming volcanic matters was thrown, which were carried to the distance of six or seven miles. From the base of the cone a thick smoke arose at the time when the rivers of lava broke out, which for a moment obscured some parts of the flame. This beautiful appearance continued three quarters of an hour. It began the next night with more force, but continued only half an hour. In the intervals, however, Ætna continued to throw out flames, smoke, ignited stones, and showers of sand. From the 20th to the 22d, the appearances gradually ceased. The stream of lava was carried towards Bronte and the plain of Lago.

After the eruption, the top of the mountain on the western side was found covered with hardened lava, scoria, and stones. The travellers were annoyed by smoke, by showers of sand, mephitic vapours, and excessive heat. They saw that the lava which came from the western point divided into two branches, one of which was directed towards Libeccio, the other, as we have already said, towards the plain of Lago. The lava on the western head of the mountain had, from its various shapes, been evidently in a state of fusion; from one of the spiracula, the odour was strongly that of liver of sulphur. The thermometer, in descending, was at 40 degrees of Fahrenheit's scale; while near the lava, in the plain of Lago, it was 140 degrees. The lava extended two miles; its width was from $13\frac{3}{4}$ to 21 feet, and its depth $13\frac{3}{4}$ feet.

35. Eruptions in 1792. Eruptions of greater and less magnitude from May until the close of the year.

36. A small eruption in June 1798.

37. Smaller eruption in June 1799.

38. Eruption of lava and flood of water in February 1800.

39. Eruption in 1802.

40. Eruption 27th March 1809.

41. Eruption 28th October 1811.

42. Eruption 29th May 1819.

43. Eruption in November 1832.

44. Eruption in August 1852.

The eruption of August 1852 is the most violent which has occurred for a very long period. After some days of premonitory symptoms, such as the drying up of springs in the vicinity, *bramidas* or subterranean thunderings, three shocks of an earthquake, and a vast column of white smoke from the mountain that rose and spread out like a gigantic pine tree; on the night between the 20th and 21st of August, two new mouths opened on the east flank of Ætna, in the *Val de Leone*, and began to eject clouds of an ash-grey dust, that completely covered the adjacent country to a great extent, and was carried by the winds far to sea. Soon after a vast torrent of molten lava began to issue from those mouths, which were speedily converted into one by the force of the imprisoned lava; and vast masses of rock and scoriæ were projected to a great height into the air. The lava divided into two principal streams; the first flowing in the direction of Zaffarana, the second towards Giarra. This river of liquid fire was two miles wide at its greatest breadth, though where it issued from the mountain it was only about 60 feet wide; its thickness increasing from seven feet on the 21st., to 15 feet on the 22d, and to 170 feet on the 30th of August. Its progression was more than usually rapid where widest, being about 600 feet per hour; but when it descended the steeps of the mountain it was precipitated like a torrent, in cascades of fire. After the first week the violence of the eruption seemed to abate, until the 4th of September when it burst out with fresh fury, and the lava took the road to Milo. Eruptions, too, of dust and huge stones continued through October, but diminished in November; when the convulsion appeared to be subsiding. The country devastated was one of extraordinary fertility, and produced the finest wines of the island. But the labour of many years has been destroyed, and the peasantry about Zaffarana and in the commune of Giarra are utterly ruined, and the destruction of property of every kind has been immense. Persons whom curiosity led to behold the terrors of an eruption more nearly, describe the scene around the apertures from which the torrent issued as sublimely terrible.

"After scrambling with difficulty," says one observer, "to the summit of a hill composed of irregular blocks of lava, we beheld on our right, at the distance of a quarter of a mile, and towering far above us, an enormous hill of red hot rock and half molten lava, from which at our level issued liquid lava, which descended in a stream of about 60 feet wide into a chasm far below us, that presented the appearance of a lake of fire. Opposite to our station was a dark, frowning cliff, which sent forth clouds of lurid red smoke and steam, round which forked lightnings terrifically played. At intervals, vast masses of rocks, some the size of a small house, and intensely hot, were hurled high into the air, accompanied by *bramidas* and peals of thunder, amid clouds of steam and showers of volcanic dust. Another stream of lava glowed in a deep chasm on our left, and this aperture also projected stones with fearful violence. The thunder and lightning overhead, and the danger from those missiles rendering our station alarming, we soon retired farther from this terrific scene; which was rendered still more impressive by a storm of wind that obliged us to cling for security to adjacent rocks, or to throw ourselves to the ground." (R. J.)

ÆTNA, the name of an ancient town, built by Hiero, on the southern declivity of the mountain. Its more ancient name was Inessum, which was changed to Ætna when the Catanians took possession of it. In the the time of Cicero it was still a place of some importance. It is now Centorbi.

ÆTOLIA, a country of ancient Greece, bounded on the north by Epirus and Thessaly; on the east by the province of the Locri Ozolæ; on the south by the Gulf of Corinth; and separated on the west from Acarnania by the river Achelous. The part which lay westward of the river Evenus was called old Ætolia, and that lying to the east, new or acquired Ætolia.

The Ætolians were a restless and turbulent people, seldom at peace among themselves, and ever at war with their neighbours; utter strangers to all sense of friendship or principles of honour; ready to betray their friends upon the least prospect of reaping any advantage from their treachery: in short, they were looked upon by the other states of Greece no otherwise than as outlaws and public robbers. On the other hand, they were bold and enterprising in war; inured to labour and hardships; undaunted in the greatest dangers; jealous defenders of their liberties, for which they were on all occasions willing to venture their lives, and sacrifice all that was most dear to them. They distinguished themselves above all the other nations of Greece in opposing the ambitious designs of the Macedonian princes, who, after having reduced most of the other states, were forced to grant them a peace upon very honourable terms. The constitution of the Ætolian republic was copied from that of the Achæans, and with a view to form, as it were, a counter-alliance; for the Ætolians bore an irreconcilable hatred to the Achæans, and had conceived no small jealousy at the growing power of that state. The Cleomenic war, and that of the allies, called the *social war*, were kindled by the Ætolians in the heart of Peloponnesus, with no other view than to humble their antagonists the Achæans. In the latter they held out, with the assistance only of the Eleans and Lacedemonians, for the space of three years, against the united forces of Achaia and Macedon; but were obliged at last to purchase a peace, by yielding up to Philip all Acarnania. As they parted with this province much against their will, they watched all opportunities of wresting it again out of the Macedonian's hand; for which reason they entered into an alliance with Rome against him, and proved of great service to the Romans in their war with him; but growing insolent on account of their services, they made war upon the Romans themselves. By that warlike nation they were overcome, and granted a peace on the following severe terms:—



1. The majesty of the Roman people shall be revered in all Ætolia. 2. Ætolia shall not suffer the armies of such as are at war with Rome to pass through her territories, and the enemies of Rome shall be likewise the enemies of Ætolia. 3. She shall, in the space of 100 days, put into the hands of the magistrates of Corcyra all the prisoners and deserters she has, whether of the Romans or their allies, except such as have been taken twice, or during her alliance with Rome. 4. The Ætolians shall pay down in ready money, to the Roman general in Ætolia, 200 Euboic talents, of the same value as the Athenian talents, and engage to pay 50 talents more within the six years following. 5. They shall put into the hands of the consul 40 such hostages as he shall choose, none of whom shall be under 12, or above 40 years of age: the prætor, the general of the horse, and such as have been already hostages at Rome, are excepted out of this number. 6. Ætolia shall renounce all pretensions to the cities and territories which the Romans have conquered, though these cities and territories had formerly belonged to the Ætolians. 7. The city of Oenis and its district shall be subject to the Acarnanians.

After the conquest of Macedon by Æmilius Paullus, they were reduced to a much worse condition; for not only those among them who had openly declared for Perseus, but such as were only suspected to have favoured him in their hearts, were sent to Rome, in order to clear themselves before the senate. There they were detained, and never afterwards suffered to return into their native country. Five hundred and fifty of the chief men of the nation were barbarously assassinated by the partisans of Rome, for no other crime than that of being suspected to wish well to Perseus. The Ætolians appeared before Æmilius Paullus in mourning habits, and made loud complaints of such inhuman treatment, but could obtain no redress; nay, ten commissioners, who had been sent by the senate to settle the affairs of Greece, enacted a decree, declaring that those who were killed had suffered justly, since it appeared to them that they had favoured the Macedonian party. From this time those only were raised to the chief honours and employments in the Ætolian republic who were known to prefer the interest of Rome to that of their country; and as these alone were countenanced at Rome, all the magistrates of Ætolia were the creatures and mere tools of the Roman senate. In this state of servile subjection they continued till the destruction of Corinth and the dissolution of the Achæan league, when Ætolia, with the other free states of Greece, was reduced to a Roman province, commonly called the *province of Achaia.* Nevertheless, each state and city was governed by its own laws, under the superintendency of the prætor whom Rome sent annually into Achaia. The whole nation paid a certain tribute, and the rich were forbidden to possess lands anywhere but in their own country.

In this state, with little alteration, Ætolia continued under the emperors till the reign of Constantine the Great, who, in his new partition of the provinces of the empire, divided the western parts of Greece from the rest, calling them *New Epirus*, and subjecting the whole country to the *præfectus prætorii* for Illyricum. Under the successors of Constantine Greece was parcelled out into several principalities, especially after the taking of Constantinople by the western princes. At that time Theodorus Angelus, a noble Grecian of the imperial family, seized on Ætolia and Epirus. The former he left to Michael his son, who maintained it against Michael Palæologus, the first emperor of the Greeks, after the expulsion of the Latins. Charles, the last prince of this family, dying in 1430 without lawful issue, bequeathed Ætolia to his brother's son, named also *Charles;* and Acarnania to his natural sons Memnon, Turnus, and Hercules. But great disputes arising about this division, Amurath II., after the reduction of Thessalonica, laid hold of so favourable an opportunity, and drove them all out in 1432. The Mahometans were afterwards dispossessed of this country by the famous prince of Epirus, George Castriot, commonly called *Scanderbeg*, who with a small army opposed the whole power of the Ottoman empire, and defeated these barbarians in 22 pitched battles. That hero at his death left great part of Ætolia to the Venetians; but they not being able to make head against such a mighty power, the whole country was soon reduced by Mahommed II. It is now included in the kingdom of Hellas.

AFER, Domitius, a famous orator, born at Nismes, flourished under Tiberius, and the three succeeding emperors. Quintilian makes frequent mention of him, and commends his pleadings. But he disgraced his talents, by turning informer against some of the most distinguished personages in Rome. Quintilian, in his youth, cultivated the friendship of Domitius very assiduously. He tells us that his pleadings abounded with pleasant stories, and that there were public collections of his witty sayings, some of which he quotes. He also mentions two books of his *On Witnesses.* Domitius was once in great danger from an inscription he put upon a statue erected by him in honour of Caligula, wherein he declared that this prince was a second time consul at the age of 27. This he intended as an encomium; but Caligula taking it as a sarcasm upon his youth and his infringement of the laws, raised a process against him, and pleaded himself in person. Domitius, instead of making a defence, repeated part of the emperor's speech with the highest marks of admiration; after which he fell upon his knees, and begging pardon, declared that he dreaded more the eloquence of Caligula than his imperial power. This piece of flattery succeeded so well, that the emperor not only pardoned, but also raised him to the consulship. Afer died in the reign of Nero, A.D. 60.

AFFA, a weight used on the Gold Coast of Guinea, equal to an ounce: the half of it is called *eggeba.* Most of the blacks on the Gold Coast give these names to these weights.

AFFECTION, in a general sense, implies an attribute inseparable from its subject. Thus magnitude, figure, weight, &c. are affections of all bodies; and love, fear, hatred, &c. are affections of the mind.

Affection is a term used by various writers on *Moral Philosophy* to denote all those active principles whose direct and ultimate object is the communication either of enjoyment or of suffering to any one of our fellow-creatures. —Stewart's *Philosophy of the Active Powers*, vol. i. p. 75.

Affection, among *Physicians*, is the same as disease. Thus, hysteric *affection* is the same as hysteric disease.

AFFERERS, or Afferors, in *Law*, persons appointed in courts-leet, courts-baron, &c. to settle, upon oath, the fines to be imposed upon those who have been guilty of faults arbitrarily punishable.

AFFETTUOSO, or *Con Affetto*, in the Italian music, intimates that the part to which it is added ought to be played in a tender, moving way, and consequently rather slow than fast.

AFFIANCE, in *Law*, denotes the mutual plighting of troth between a man and woman to marry each other.

AFFIDAVIT means a solemn assurance of a matter of fact known to the person who states it, and attested as his statement by some person in authority. It is generally applied to a statement so certified by a justice of peace or other magistrate. Affidavits are sometimes necessary as certificates that certain formalities have been duly and legally performed. They are extensively used in the practice of bankruptcy, and in the administration of the revenue. Recently they were invariably taken on oath, but this practice has been much narrowed. Quakers, Moravians, and Separatists, are privileged in all cases to make a solemn declaration or affirmation. An act of 1835 (5th and 6th Will. IV. c. 62) authorised the lords of the treasury to substitute declarations for oaths in transactions connected with the different departments in the revenue and public offices. The same Act prohibited justices of peace from administering oaths in any matter in which they had not jurisdiction as judges, except when an oath was specially authorised by statute, as in the bankrupt law, and excepting criminal inquiries, parliamentary proceedings, and instances where oaths are required to give validity to documents abroad. But justices are permitted to take affidavits in any matter by declaration, and a person taking a false affidavit is liable to punishment.



AFFILIATION. See Bastard.

AFFINITY, in *Law*, as distinguished from consanguinity, is applied to the relation which each party to a marriage, the husband and the wife, bears to the kindred of the other. The marriage by making them one person is presumed to have given them the same kindred. Thus the wife's sister is the husband's sister, and the husband's brother is the wife's brother in affinity. But the relation is only with the married parties themselves, and does not bring those in affinity with them in affinity with each other: so a wife's sister has no affinity to her husband's brother. The subject is chiefly important from the matrimonial prohibitions which the canon law has applied to relations by affinity. Taking the table of degrees within which marriage is prohibited on account of consanguinity, the rule has been thus extended to affinity, and it has been maintained that wherever relationship to a man himself would be a bar to marriage, relationship to his deceased wife will be the same bar, and *vice versa* on the husband's decease. This rule has been founded on scriptural interpretations, chiefly of the eighteenth chapter of Leviticus, which have been subject to much discussion. Formerly by law in England, marriages within the degrees of affinity were not absolutely null, but they were liable to be annulled by ecclesiastical process during the lives of both parties. By an act passed in 1835 (5th and 6th Will. IV., c. 54), all marriages of this kind not disputed before the passing of the Act are declared absolutely valid, while all subsequent to it are declared null. This renders null in England a marriage with a deceased wife's sister or niece. The Act does not extend to Scotland, and it is a matter of doubt whether marriages within the degrees of affinity corresponding to the prohibited degrees of consanguinity are there null.

Affinity is also used to denote conformity or agreement. Thus we say, the *affinity* of languages, the *affinity* of words, the *affinity* of sounds, &c.

Affinity, in *Chemistry*, a term employed to express that peculiar propensity which the particles of matter have to unite and combine with each other exclusively, or in preference to any other connection.—The attractions between bodies at insensible distances, and which of course are confined to the particles of matter, have been distinguished by the name of *affinity;* while the term *attraction* has been more commonly confined to cases of sensible distance.

AFFIRMATION, in *Logic*, a positive judgment, implying the union or junction of the two terms of a proposition.

Affirmation used to be applied to the privilege enjoyed by Quakers of making an affirmation or declaration where other persons required to make oath in civil matters. The form now more commonly called declaration has been extended to criminal inquiries, and the privilege of taking it combines Moravians and Separatists. In other instances, affirmations or declarations have been substituted for oaths. See Affidavit.

Affirmation is also used for the ratifying or confirming of the sentence or decree of some inferior court. Thus we

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say, the house of lords affirmed the decree of the chancellor, or the decree of the lords of session.

AFFIRMATIVE, in *Grammar*. Authors distinguish affirmative particles, such as *yes*. The term *affirmative* is sometimes also used substantively. Thus we say, the affirmative is the more probable side of the question: there were so many votes, or voices, for the affirmative.

AFFIX, in *Grammar*, a particle added at the close of a word, either to diversify its form or alter its signification. We meet with *affixes* in the Saxon, the German, and other northern languages, but more especially in the Hebrew, and other oriental tongues. The Hebrew *affixes* are single syllables, frequently single letters, subjoined to nouns and verbs, and contribute not a little to the brevity of that language. The oriental languages are much the same as to the *radicals*, and differ chiefly from each other as to *affixes* and *prefixes*.

AFFLATUS literally denotes a blast of wind, breath, or vapour, striking with force against another body. The word is Latin, formed from *ad*, to, and *flare*, to blow. Naturalists sometimes speak of the afflatus of serpents. Cicero uses the word figuratively, for a divine inspiration; in which sense he ascribes all great and eminent accomplishments to a divine afflatus. The Pythian priestess being placed on a tripod or perforated stool, over a holy cave, received the divine afflatus, as a late author expresses it, in her belly; and being thus inspired, fell into agitations, like a phrenetic; during which she pronounced, in hollow groans and broken sentences, the will of the Deity. This afflatus is supposed by some to have been a subterraneous fume or exhalation, wherewith the priestess was literally inspired. Accordingly, it had the effects of a real physical disease, the paroxysm of which was so vehement that, as Plutarch observes, it sometimes proved mortal. Van Dale supposes the pretended enthusiasm of the Pythia to have arisen from the fumes of aromatics.

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AFFORESTING, AFFORESTATIO, the turning of ground into forest. The Conqueror and his successors continued afforesting the lands of the subject for many reigns, till the grievance became so notorious, that the people of all degrees and denominations were brought to sue for relief; which was at length obtained, and commissions were granted to survey and perambulate the forest, and separate all the new-afforested lands, and reconvert them to the uses of their proprietors, under the name and quality of *purlieu* or *pouralle land*.

AFFRAY, or AFFRAYMENT, in *Law*, formerly signified the crime of affrighting other persons, by appearing in unusual armour, brandishing a weapon, &c.; but at present *affray* denotes a skirmish or fight between two or more.

AFFRONTEE, in *Heraldry*, an appellation given to animals facing one another on an escutcheon; a kind of bearing which is otherwise called *confrontée*, and stands opposed to *adossée*.

AFFUSION, the act of pouring some fluid substance on another body. Dr Grew gives several experiments of the luctation arising from the affusion of divers menstruums on all sorts of bodies. Divines and church historians speak of baptism by affusion, which amounts to much the same with what we now call *sprinkling*.

# AFGHANISTAN,

An extensive and powerful kingdom of Asia, which formed at one time a considerable portion of the Mogul empire. On the decline of that power, it rose to the rank of an independent state; and from its population and extent, and still more from the character of the people, who are brave, hardy, and enterprising, as well as from its commanding position in the heart of Asia, it soon acquired political importance, and has since acted a principal part in all the revolutions which have occurred either in Hindostan or in Persia.

It is only of late years that Europeans have obtained any authentic account of this interesting country. In 1783, Mr Foster, in the course of an overland journey from India, in which he was exposed to the greatest danger from the predatory habits and religious prejudices of the people, succeeded in penetrating into those mountainous regions. He visited the cities of Cabul and Candahar, respecting which his information is equally curious and instructive. A more complete and satisfactory account of Afghanistan is derived from the work of Mr Elphinstone, by whom it was visited in 1808. It was supposed that about this time the French were meditating an invasion of British India; and Afghanistan being in a manner one of the outworks of Hindostan through which an invading army must make its approaches on the north, it was judged necessary to apprize the sovereign of his danger, in order to secure his co-operation against the common enemy. With this view, a mission was sent to him by the British government, at the head of which was Mr Elphinstone, who, with the other members of the embassy, determined, with a laudable and enlightened zeal, to profit by so favourable an opportunity for collecting information. More recent travellers have contributed largely to the stock of materials previously existing, and by the aid of their interesting works, satisfactory and ample details may now be furnished respecting the geography and productions of the country, the manners of the people, and their condition, character, and habits.

Boundaries.

The boundaries of Afghanistan have fluctuated with the vicissitudes of war from the middle of the tenth century, when the Turkish slave, Alptegin, first founded the dynasty of Ghuzni, to the date of the recent invasion of the country by the British. At the latter period the kingdom consisted of four subdivisions, Cabul, the Huzareh country, Candahar, and Herat. Taken in this extent, Afghanistan is bounded on the north by Bokhara, Kunduz, and Kaferistan; on the east by the British province of Peshawur and the Soliman range of mountains; on the south by Beloochistan, and on the west by Persia. Its greatest length from north to south is about 600 miles; its breadth measures about the same distance. The Afghans have no general name for their country but that of Afghanistan, which, Mr Elphinstone thinks, was probably first employed in Persia. It is frequently used in books, and is not unknown to the inhabitants. It is sometimes known under the appellation of the kingdom of Cabul.

Aspect of the country, mountains, and rivers.

Afghanistan to the west of the Soliman Mountains, which form its eastern barrier, may be described generally as a table-land, lying higher than most of the neighbouring countries. The Hindoo Khosh Mountains, its north-eastern bulwark, overlook the low country of Balk, the ancient Bactria, formerly a province of Persia. On the east it is equally elevated above the lower plains of the Indus. On the south it overlooks Seweestan; and on the south-west a deep valley runs between it and Beloochistan. It slopes gradually to the west, and loses the appearance of elevation as it approaches the Paropamisan Mountains. The mountainous chain of Hindoo Khosh is a continuation of the great Himalaya ridge, which it rivals in grandeur and elevation. From the elevated plains of Afghanistan these mountains are seen on the north in four distinct ranges. The first and lowest had

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no snow in February, when it was observed by Mr Elphinstone from the plain of Peshawur; but the tops of the second still had their winter covering, and the third had snow half-way down. The fourth and highest range is covered with snow at all seasons. It is of great elevation, some of its peaks rising, according to measurement, to the height of 20,493 feet, and is conspicuous from Bactria, from the borders of India, and from places in Tartary at the amazing distance of 250 miles. "The stupendous heights of these mountains," says Elphinstone, "the magnificence and variety of their lofty summits, the various nations by whom they are seen, and who seem to be brought together by this common object, and the awful and undisturbed solitude which reigns amid their eternal snows, fill the mind with an admiration and astonishment which no language can express." The inferior ranges of the Hindoo Khosh Mountains decrease in height according to their distance from the principal chain. The title of table-land, which has been applied to Afghanistan, if it be understood to imply anything more than that it is raised above the level of the surrounding regions, will convey a very inaccurate idea of the nature of the country, which, so far from being a plain, is of the most diversified surface, being intersected everywhere with chains of mountains, which diverge in various directions from the main ridge of Hindoo Khosh. We will not enter into any detailed description of this complicated mass of mountains, which, however accurate, would fail to present any very clear view of the topography of the country. It may be generally stated, that the ridges branch off southward, not exactly at right angles from the main ridge, but in irregular lines, to the distance of 60 or 70 miles, when they decline to a lower level; and that those ridges are separated by intervening valleys, each of which is watered by a river flowing down the southern declivity of the Hindoo Khosh Mountains into the Cabul, which, after an easterly course along the base of the mountains of about 350 miles, joins the great Indus. These valleys or glens all open from the south into the great valley of Cabul; and the country is described as being fertile, and of a pleasing appearance. On the lower hills by which the valleys are closed in, the snow generally lies for four months in the year; there are few trees on the tops, but their sides are covered with forests of pine, oak, and wild olive. Lower down, the country improves, and is interspersed with many little valleys, watered by clear and beautiful streams, and enjoying a delicious climate, under which European fruits and flowers grow wild in the utmost variety and perfection; and even the rocks add to the beauty of the scenery, from the rich verdure of mosses with which they are covered. The narrow and alluvial plain at the bottom, through which the river runs, is in general highly productive. The valleys yield two harvests, and produce most sorts of grain; and on the plains are numerous mulberry trees and planes, besides other fruit-trees improved by culture.

An immense curve or angle projects southward from the mountain barrier to the north eastern frontier of the country, when the snowy mountain abruptly descends into the low and hot plain of Jellalabad. The range then resumes its westerly course, when lower hills assume their former appearance and character, and form the Cohistan or high lands of Cabul, a country watered by the river of this name and its tributary streams, and described as fruitful and of a delightful aspect. Thirty miles south of Jellalabad the aspect of the country is varied by the range of the Soliman Mountains, which, commencing with Suffaid Coh, or the White Mountain, so called from the snow with which it is covered at all seasons, extend south-south-west almost parallel to the course of the Indus. These mountains decline towards the west by lower ridges, which run nearly in the same direction as the main ridge; while other ridges branch off eastward toward the Indus. The height of these mountains is greatly inferior to that of the Hindoo Khosh; but it is still great, as they are covered with snow to the end of spring, which, in the latitude of 31 degrees, gives a considerable altitude. Beyond the Soliman ridges on the west, the country consists for the most part of high and bleak downs, interspersed with moderate hills; in some places desert and ill cultivated, bare and open, better fitted for pasturage than for the plough, and inhabited by migratory tribes of shepherds. There are exceptions, however, to this general description. In the country which is watered by the Helmund and its tributary streams are found many fertile and delightful spots, which afford pleasant retreats to the shepherds, and pasturage to their flocks. The country round Candahar is fertile and highly cultivated; but to the south and especially as it recedes west from the Helmund, it is a complete desert.

Afghanistan has few large rivers for a country of such extent, and so interspersed with mountains; and of these there is not one which is not fordable throughout its course for the greater part of the year. They partake generally of the character of mountain torrents, swelling rapidly, and running off; or they are sometimes all drained away for the irrigation of the fields. All the rivers of this country which take their rise in the Hindoo Khosh Mountains are feeders of the Cabul, which drains the waters falling on the southern declivity of that range, and conveys them to the Indus. The most important tributary of the Cabul is the Kooner. Lower down the country is traversed in an easterly direction by the Koorum, a tributary of the Indus; and the only river south of this which runs into the Indus is the Gomul, which, however, unless when swollen by the rains, never reaches its destination, being generally consumed in the irrigation of the country. The greatest of the rivers which run through the rest of Afghanistan is the Helmund. This river is the drain of that extensive slope which lies between the Soliman and the Paropamisan Mountains. It has its rise in the latter, and running a south-west course of 550 miles, terminates in the Lake Hamoon. The Urghundaub rises 130 miles north-east of Candahar, and after passing within a few miles of that city, joins the Helmund. It is never more than 150 yards broad. The Kashrood, after a course of 150 miles, falls into the Lake Hamoon; as does also the Farrahrood, after a course of about 60 miles. The Turnuk is a tributary of the Urghundaub, which it joins about 25 miles south-west of Candahar. It is a rapid torrent and receives the Doree and other smaller rivers. Nothwithstanding these additions, its stream rather decreases, being consumed in the irrigation of the country, or in the parched and barren sands through which it passes. The Lora, which rises in the south of Afghanistan, has a western course of 80 miles, when it disappears in the sands of the desert.

Climate.

The climate of Afghanistan is extremely various, owing to the height and inequality of its surface. According to its latitude, which is between the 28th and 37th degrees, it should have a decidedly hot temperature; but the general law of climate is here modified by the elevation of the ground, and great diversities of heat and cold are accordingly experienced within a very limited space. The mountainous nature of the country also occasions peculiarities in its climate, and distinguishes it in some degree from that of the adjacent regions. In almost all the countries of Asia within the same latitude as Afghanistan, one important circumstance in their climate is the season and quantity of the periodical rains. Throughout the greater part of India the rainy season is ushered in by the south-west monsoon, which drives the rolling clouds from the ocean on the land, where they descend in rains. The monsoon is earlier in the south of India, and in the vicinity of the ocean, than in the north, and

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the rains are heavier. In many cases the opposition of mountains in the interior either arrests entirely the progress of the clouds, or it varies their direction; and hence large tracts of country are exempted from, or only partially experience, the influence of the monsoons. Before they make their way from the Indian Ocean to Afghanistan, these periodical tempests are greatly moderated, having to traverse the whole extent of Bengal in their progress to the Himalaya Mountains, when they are forced by this impassable barrier out of their original course towards the north-west by the range of Hindoo Khosh; and it is from that quarter that such parts of Afghanistan as are exposed to the monsoon receive the periodical rains. But the clouds are exhausted as they pass on westward to this country, the rains gradually become less heavy, and are at last merely sufficient to water the mountains, without much affecting the plains below. In some of the valleys to the south, the monsoon appears only in some clouds and showers: it is still less felt in the valley of the Cabul river, the passing clouds being opposed by the southern projection of the Hindoo Khosh Mountains and the Soliman range. Besides the partial influence of the south-west monsoons to which the north-eastern provinces of Afghanistan are exposed, it has the winter and the spring rains, which are of great consequence to agriculture in all those countries between the Indus and the Hellespont which are not subjected to the full effect of the south-west monsoon.

The temperature of Afghanistan varies of course with the difference of level, and also from local causes. It is affected by the direction of the prevailing winds, some blowing over snowy mountains, others being heated in summer and rendered cold in winter by their passage over deserts and arid tracts of great extent. The heat of summer is refreshed in some places by the breezes from moister countries, and others are so environed with hills as to be sheltered from all winds. Thus, throughout this extensive country, great diversity of temperature takes place often within very short distances. In the Hindoo Khosh Mountains perpetual winter reigns, and among the lower ranges snow frequently lies for four months in the year. In the plain of Peshawur, which is within view of these snowy summits, the thermometer in summer rises as high as in the hottest parts of India. It is mentioned by Mr Elphinstone, that in a tent artificially cooled, the thermometer stood for several days of summer at 112° and 113° in the shade. But the heat is not so uniform, nor does it last so long, as that of an Indian summer. At intervals in June and July cold north-west winds set in, which refresh the air, and render it pleasant. The last half of September is so cold as to be counted among the winter months, and the cold continues to increase till February. But the winter is not severe; and though there is frost in the night, it is always dispelled during the day by the influence of the sun. The temperature of the different valleys depending in this manner on their respective levels, they frequently exhibit the most remarkable contrasts of heat and cold. The plain of Jellalabad during summer is intolerably hot, while to the south, and immediately above it, the mountain of Suffaid Coh lifts its snowy summit to the clouds. To the north the nearest hills are cold; and in the distance the Hindoo Khosh Mountains are seen skirting the horizon with a bright outline of perpetual snow, while the table-land of Cabul, immediately to the west, enjoys the coolness and verdure of a temperate summer. Among the Soliman Mountains, the higher countries are exposed to severe cold; but there are some of the lower valleys on the western plains where the heat predominates, and they are accordingly deserted in the summer by the wandering shepherds, for the cool retreat and grassy valleys of the mountains. At Candahar the heat of summer is excessive, and is occasionally aggravated by the simoom winds. In proceeding north-east, however, from Candahar, along the course of the Helmund and its tributary streams, we reach elevated ground, where the cold is excessive, and where winter is experienced in all its severity. If we ascend the course of the Turnuk, and thence proceed onward to Ghuzni, we find the snow lying deep for some time after the equinox, and so thick a covering of ice on the rivers as to afford a passage for camels. At Cabul the winter is more steady and severe than in England, while the summer heat is greater. The great difference between the seasons, and the quickness with which they change, are marked by the changes which take place in the dress of the inhabitants. In winter they wear woollen garments, and in some places clothes of felt, and over these a large great-coat of well-tanned sheep-skin with the long shaggy wool inside. With the vernal equinox the snow disappears, the country is covered with young grass, the buds burst forth, and are soon followed by a profusion of flowers; and the inhabitants change their winter dress for a thin one of chintz or cotton, and frequently sleep at night under trees in the open air. The prevailing winds throughout Afghanistan are from the west, and they are generally cold; while the easterly wind is hot, and brings clouds. On the whole, the climate of this extensive country seems little subject to rains, clouds, or fogs; and judging from the size and strength of the inhabitants, it must be considered salubrious. Some fatal diseases are, however, common; such as fevers and agues, which prevail in autumn and in spring; and the small-pox still carries off many persons, though the practice of inoculation has long been introduced.

Animals.

Afghanistan abounds in wild animals, which find ample range in the extensive forests and large tracts of unfrequented deserts which it contains. The lion, however, though so common in Persia, and though it has been lately found in such numbers in Guzerat, and in the Hurriana, north-west of Delhi, is rare. In the hilly country around Cabul there is a small animal which bears the name without any of the qualities of the lion. Tigers and leopards are to be found in most of the woody tracts of the country. Wolves, hyenas, jackals, foxes, hares, porcupines, and hedgehogs, are to be seen everywhere. The wolves are formidable during the winter in the cold parts, where they assemble in troops, destroying cattle, and frequently attacking men. The hyenas sometimes attack a bullock singly, and, as well as the wolves, they make great havock among the sheep. Bears of two kinds, the one the black bear of India, and the other of a dirty white, are quite common in all the woody mountains; but they rarely leave their haunts, except when they are tempted by the sugar-cane. There are also ichneumons, ferrets, and wild dogs. Monkeys are common in the north-eastern parts. The wild boars of Persia and India are seldom seen; and the wild ass is confined to the south-western districts, on the lower Helmund, and to the sandy country round Candahar. The mountains abound with many kinds of deer, including the elk; but the antelope is rare, and confined to the plains. A species of deer is seen, which is remarkable for the size of its horns, and the strong but not disagreeable smell of its body. The chiefs are in possession of a few elephants; but neither that animal nor the rhinoceros is to be found wild in any part of the country.

Among the domestic animals is the horse, a considerable number of which are bred in the Afghan dominions; and those bred near Herat are very fine, uniting the figure of the Arab horse with superior size. In general, however, the breed of Afghan horses is not good. There is a very strong and useful breed of ponies. On the other hand, the mules and asses are the most wretched that can be conceived. The camel is the animal most employed in carrying burdens.

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The dromedary, the tall long-legged animal common in India, is found all over the plains. The Bactrian camel, with two distinct humps, which is lower than the other by one-third, but stout, and covered with shaggy black hair, is much more rare, and is brought from the country beyond the Jaxartes. Buffaloes are to be found in many parts; and oxen are universally employed in the plough, and sometimes camels. They are not reared in the country, but are imported from the Rajpoot States, where they are the best in India. The sheep forms the principal stock of the pastoral tribes: it is remarkable for a tail about a foot in breadth, and consisting almost entirely of fat; in other respects it resembles the English sheep. The goat abounds in all the mountains, and is not scarce in the plains. Some of the breeds have remarkably long and curiously twisted horns. The pastoral tribes in the country, who are extremely fond of hunting, breed great numbers of excellent greyhounds, and even pointers, resembling those in England both in shape and quality. There is a breed of long-haired cats in great esteem, and of which great numbers are exported.

Of the birds, there are three sorts of eagles, and many kinds of hawks; namely, the gentle falcon, a large grey short-winged bird; the gos-hawk; the shauheen, which soars over the falconer's head, and strikes the quarry as it rises; and the chirk, which is trained to strike the antelope, and, by fastening on its head, to retard its flight till the greyhounds come up. The other birds are, herons, cranes, storks, wild ducks, geese, swans, partridges, quails, and a bird known in Europe under the name of the Greek partridge. There is another smaller bird resembling it, which is found nowhere except in Afghanistan. Pigeons, doves, crows, and sparrows, are common in all countries. Cuckoos, which are rare, and magpies, which are unknown in India, abound in the colder climate of those northern mountains; while peacocks, so commonly found wild in India, are here seen only in their domesticated state. Parrots make their appearance in the eastern provinces near the Indus.

The country is not infested with venomous reptiles. The snakes are mostly harmless. There are no crocodiles, but there are turtles, as well as tortoises. In Khorassan, great flights of locusts have sometimes occasioned famine by their devastations, though this rarely occurs. Musquitoes are less troublesome than in India, except in the southern district of Seestan, where they bite as severely as in Bengal.

In most parts of Afghanistan there are two harvests, one in spring and the other in autumn. The former is the more important. The produce of the first, which is sown in autumn and reaped in spring, is wheat, barley, peas, beans, and other grains; that of the second, sown in the end of spring and reaped in autumn, is rice, Indian corn, and various kinds of pulse. Cotton is confined to the hot climates, and sugar is cultivated in some of the rich plains. Tobacco is produced in most parts. There is another distinct harvest, which is counted of great importance, of musk-melons, water-melons, the scented melon, and various sorts of cucumbers, pumpkins, and gourds, which are grown in the open fields. All common garden-stuffs are abundant, such as carrots, turnips, beetroot, lettuce, onions, garlic, spinach, greens of all kinds, cabbages, cauliflowers, and many of the Indian vegetables. The castor oil plant is found everywhere. Madder abounds over all the western provinces, and the assafœtida plant in the hills. In the west, lucerne and a sort of trefoil are among the most important products of husbandry. Of the fruits and trees which abound in tropical countries, none are to be found; but almost all the European trees and fruits are indigenous in the congenial climate of those elevated regions. They are frequently found growing wild in different parts of the country, and are still more common in gardens and orchards. The most common trees in the mountains are pines, oaks, cedars, a sort of gigantic cypress, the walnut and the wild olive tree, the birch, the holly, and the hazel. In Hindoo Khosh the pistachio tree grows wild; and on the plains are the mulberry, the tamarisk, and the willow; also the plane and the poplar. English flowers, such as roses, jessamines, poppies, narcissuses, and hyacinths, are found in the gardens, and often in a wild state.

Vegetable products.

Minerals.

Of the minerals produced in the country little is known. Gold is said to be washed down the streams that flow from the Hindoo Khosh Mountains. Small quantities of silver are found in Kaferistan; also lead, copper, iron, and antimony, in different parts; sulphur and rock-salt in the salt range of mountains, and saltpetre everywhere in the soil.

Government.

The political institutions of the Afghans present the rude and disjointed materials of a free constitution. The form of the government is patriarchal. The nation is supposed to derive its origin from four tribes, which are divided and subdivided into inferior clans, until the last subdivision does not include more than a few families. The chief of a tribe is called Khan. The head of one of the inferior divisions owes his choice to the people. Each inferior division of the tribe has its respective head; and in cases of emergency these all meet together and form a general assembly, called a Jeerga, which, with the khan presiding over it, deliberates and decides in all matters of public importance. The heads of the inferior branches of the tribe hold similar assemblies, which decide on minor matters, and are guided by the same rules as the greater convention. When wars arise among the different tribes, it is the business of the assemblies to provide the means of carrying them on, to concert the plan of operations, or to settle the terms of peace. They have the power, along with the khan, to call out all the fighting men of the tribe, or they may levy taxes for any purpose of public utility. There is scarcely a petty community throughout the nation which does not make its own arrangements for the support of moollahs, an order of Mahometan priests, and for the maintenance and reception of strangers into the tribe, whom it is always reckoned a duty to treat with peculiar attention.

The Afghan nation consists in this manner of numerous rude democracies, which were subjected for many years to one paramount sovereign, who exercised a general superintendence over the whole kingdom, and could levy troops or money from each tribe for the common defence. But the authority of the sovereign was not equally respected by all the tribes. In the plains around the towns, throughout a considerable portion of the country, and in all the foreign provinces, he ruled with full power, and collected a revenue and maintained an army without the aid of the khans or the popular assemblies. He employed for this purpose officers of his own appointment, namely, a haukim, to collect the revenue and command the militia; a sirdar, who commanded the regular troops, and whose duty it was to enforce submission to the haukim, and to the cauzy, who presided over the administration of justice. The heads of tribes, and under them the heads of the divisions of tribes, acted in the revenue and police departments, under the haukim and the sirdar. Where the royal authority was strong, the khans had comparatively little influence; but, on the other hand, where weak, it was frequently resisted by the powerful influence of the khans, who form the aristocracy of the land, as their authority was also resisted by the inferior assemblies; and it sometimes happened that those assemblies differed with each other about the limits of their own powers; and hence the democratic tribes are often involved in dissension by this complicated collision of rival authorities. In the concerns of some of the tribes the king never interfered; he merely levied supplies of money for the public service, which, notwithstanding the presence of one of the royal sirdars, were

Afghanistan. frequently withheld or granted, according to the discretion of the khan: and in like manner the khan and the cauzy contended with more or less success, according to the state of the king's authority, for the exercise of the judicial power. Under Nadir Shah, and the earliest of the Douranee emperors, the kingdom of Afghanistan comprehended Cashmere, together with the whole extent of territory stretching westward of the Indus, and its tributaries, to the mountains; but during the distraction of the country, the Punjaub and Scinde, together with the other districts of this tract, aspired to independence, and the limits of Afghanistan, for several years past, have been contracted within the boundary of the Soliman range of mountains.

The government of the Afghans, though it contains in this manner the elements of freedom, fails entirely in the great end of securing to the community the blessings of good order and peace. The people are bold and independent, and spurn the restraints of law. Among such a variety of independent communities, imperfectly controlled by superior authority, wars arise, which are waged with great fierceness, and in which the tumultuary militia of the tribes frequently come to blows, and waste each other's territories. Private revenge, also, though prohibited by the laws, is sanctioned by manners; it is accordingly practised by all classes, and is accounted the unalienable right of every freeman. Hence family feuds arise, which are not only carried on with bitterness at the time, but being transmitted from generation to generation, produce a long-continued course of violence and bloodshed. Afghanistan, with its bold and turbulent aristocracy, and the rude independence of its people, presents a lively picture of the state of society in Europe under the feudal system, when every potent baron could defy the authority of the crown, and when, owing to the private feuds of the nobles, the whole country was frequently one general scene of rude commotion. But the liberty of the Afghans, notwithstanding all its disadvantages, is preferable to a state of despotism. The rude and stormy independence which they enjoy is calculated to give to the national character a manly and heroic cast, to inspire the Afghan with proud and elevated sentiments, and to raise him, in point of courage and intelligence, far above the wretched slaves of Asiatic despotism. The Afghan himself, far from desiring to exchange his disorderly independence for the peace of tyranny, glories in the freedom of his institutions; and it is well observed by Elphinstone, that a European visiting the country, however he might lament that the inhabitants were "trained by their unhappy situation to fraud and malice, to rapine, deceit, and revenge, could yet scarce fail to admire their martial and lofty spirit, their hospitality, and their bold and simple manners, equally removed from the suppleness of the citizen, and the awkward rusticity of the clown; and he would probably before long discover, among so many qualities that excited his disgust, the rudiments of many virtues."

The judicial institutions of the Afghans are rude and imperfect. There are no regular tribunals of justice, nor any organized systems of police. The popular assemblies of the tribes, composed of khans, mulliks, or elders, assisted by moollahs, and even by grave and experienced persons of inferior rank, discharge the functions of judges in criminal cases. Petty offences are settled by the elders of the village in which they occur; and in loosely governed tribes, every village or subdivision acts for itself. When the members are assembled, they hear the accuser's story; and after examining witnesses and other evidence, they proceed to give judgment. The right of private revenge, which is congenial to the habits of a barbarous nation, is but feebly restrained by the judicial tribunals. Among several tribes the adjustment of disputes is attempted by mediation and persuasion, to which the chief and the elders lend their influence. But if, notwithstanding this mediation, the aggressor refuses compensation, and the injured party to forgive, the latter is no longer restrained from pursuing his revenge. Among some tribes the obstinate party is compelled to yield obedience to the award of the court. The general law of the country is that of Mahomet; but there is the code of Pooshtoon-Wallee, or the peculiar usages of the Afghans, which has all the force of law. In towns justice is administered by the cauzy, who decides both in civil and in criminal cases, aided by the mooftees. There is an officer named Ameeni Mehkemeh, who takes charge of all deposits; and the Darogha of the Adawlut superintends the whole proceedings. There are also three officers who superintend the police of the towns. But in the judicial as well as the police departments the greatest abuses are said to prevail, and justice is frequently sold to the highest bidder.

Manners of the people. The Afghans are strict Mahometans, and the moollahs or priests have great influence over them. They are looked upon with extraordinary reverence. They frequently gratify their private enmities by raising a charge of heresy against obnoxious individuals, and exposing them to persecution. In the remote districts of the country an insult to any of those personages would of itself be sufficient to raise a tumult. Being intrusted with the education of youth, the practice of the law, and the administration of justice, and in possession of all the learning and science which are to be found in the country, they take the lead in popular assemblies, or in judicial proceedings, and are frequently of use in moderating the violence of an ignorant people. In some circumstances they are enabled, by their superior knowledge and habits of business, to exercise an almost unlimited influence over individuals, and even over bodies of men; to check and control the governors and other civil officers; and sometimes even to overawe and control the power of the khan himself. These priests are generally taught to read the Persian classics and the Arabic grammar, which they study diligently. They afterwards repair to Bokhara, or Peshawur, or some other seat of Mahometan learning, where they are initiated in logic, law, theology, and the system of physics known in the East, as well as in history, poetry, and medicine, which last is a favourite study. The moollahs are not so intolerant as Mahometans generally are; and the people, when they are not instigated by them, are still less disposed to religious persecution. The Hindoos in Afghanistan are allowed the free exercise of their religion, though they are prohibited from all religious processions or public exposure of their idols. But among so rude a people dissenters from the popular creed can have little security for their freedom; and among the Afghans, accordingly, there are not wanting some cruel examples of religious tyranny. Yet the Hindoos, though they are held to be impure, and though no strict man would consent to eat meat of their dressing, are employed in public situations of trust and emolument, and appear to enjoy as much security as the other inhabitants. All the Afghans are sent in their infancy to a moollah for education, by whom they are frequently taught nothing more than some prayers and passages of the Koran, and the ceremonies of their religion. A great portion of them remain consequently in a state of ignorance, and cannot read their own language. The rich maintain moollahs in their own houses, to teach their children, some of whom are taught to read the Persian classics and the Arabic. The Afghans have no literature of their own beyond a few patriotic songs or tales of love, of which passion they speak in the most romantic strain. The Mahometan religion exercises, as usual, its injurious influence on the character and condition of the women, who, especially among the higher classes, are shrouded in concealment. Polygamy is allowed, and any woman may be divorced at

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the caprice of her husband. Among the lower classes the women are more freely exposed, and do all the drudgery of the house, being forced to bring in water, and, among the ruder tribes, to do the work of the men out of doors. Slavery is allowed, as in all Mahometan countries. The greater part of the slaves are born at home; but supplies are received of Abyssinians, and negroes from Arabia; and of Persians from the inhabitants of Beloochistan, who seize them in their forays. Kaufirs are purchased from their own nation, or carried off by some of their own border tribes. These last are generally women, who are in great request on account of their beauty.

The low state of knowledge among the Afghans is evinced by some of their favourite studies and amusements. They are greatly addicted to alchemy and to magic; they have implicit faith in ghosts, in dreams, in the arts of divination, the power of talismans, and in the possibility of controlling genii and demons. Grown up men play at marbles. Prisoners base, quoits, and a game like hunt the slipper, are also common; as are wrestling and other trials of strength and skill. Fighting quails, cocks, dogs, rams, and even camels, are much admired. Some of their sports are, however, more manly. The chase is the favourite amusement of all classes, for which the abundance of game in the country affords ample scope. Horse-racing is common. An amusement of the better classes is to tilt with their lances, or to shoot at a mark with carbines or matchlocks on horseback; or with guns or bows and arrows on foot. They also practise a complicated sort of dance, which gives them great delight.

The Afghan women are described as large compared with those of India, and very fair and handsome. The men are all of a robust make, and are generally lean, though bony and muscular; and with high noses, high cheek-bones, and long faces. Their hair is always coarse and strong, and they wear long and thick beards, which are generally black or brown, but rarely red. There is an expression of manliness and deliberation in their countenance, joined to an air of simplicity, not allied to weakness. The eastern Afghans have the natural features most strongly marked. Those of the western tribes are less distinct, and exhibit a greater variety of countenance, some of their features being the reverse of sharp, though their high cheek-bones never leave them. The western Afghans are larger and stouter than those of the east, some being of surprising strength and stature; but in general the Afghans are not so tall as the English. The eastern Afghans, owing to the heat of their climate, have generally dark complexions, approaching to that of the natives of Hindostan; while those of the west are olive, with a healthy colour and appearance. But among them, as among the eastern Afghans, are to be found men of swarthy complexions like the natives of India; and others, again, as fair as Europeans. In the east, however, it is more common for the complexion to have a swarthy tinge than in the west. But the two races, the eastern and the western, are distinguished by still more striking peculiarities in their manners than in their complexion. Having derived their civilisation from the Persians and Indians, they each retain the usages of the respective nations with whom they have been connected. The Persian dress, language, and manners, distinguish the western tribes; and from the supremacy which two of these, particularly that of Dooraunee, have at times maintained over the whole, they decidedly prevail in the nation, and are even recognised where the Indian customs are more in repute. The manners of the Afghans are frank and open; sometimes rustic, but seldom fierce or insolent, except among the eastern tribe of the Eusofzyes, who have naturally an arrogant carriage. In the towns they are more polished than in the country, and are accustomed to pay respect to their superiors. In all cases they show a great reverence for old age. They are altogether a superior people to the Hindostanees, being free from their puerility, and from the apathy which they display in all matters not bearing on their own interest; nor are they delighted with the baubles which form the most acceptable presents in India. The bulk of the people are rather remarkable for prudence, observation, and, though not very enlightened or enlarged in their views, for a rational spirit of inquiry. Though they have not the same regard to truth as the Europeans, they do not indulge in the practice of gratuitous falsehood, to which the natives of Hindostan and Persia are universally addicted. From the nature of their country, which admits of no travelling except on horseback, they are inured to cold and heat, and to the exertion of making long journeys, of climbing mountains, and of swimming across rapid torrents. Old men who seem hardly able to sit on horseback, will ride at a good pace up and down the steepest and roughest passes, or along the edge of precipices, where it is even dangerous to walk. They are hospitable to strangers under certain circumstances; but they are notorious freebooters, especially the mountain tribes, and plunder travellers without scruple.

The inhabitants of the towns differ in their origin and character from the cultivators and peasantry. The greater part of them in the western country consists of a race called Taujiks, originally descended from the Arabs and Persians; and in the east, of Hindikies, who are of Indian origin. No Afghan ever keeps a shop, or exercises any handicraft trade. Those employments are chiefly left to the classes mentioned above, and to the Persians, some of whom have acquired great wealth. The banking business is chiefly prosecuted by the Hindoos. They lend money at an enormous interest by negotiating bills of exchange; and they occasionally accommodate government with loans, for which they receive bills on the revenues of the provinces. Many of them are rich, and they conceal their wealth. Mr Elphinstone relates, that one of them, who gave him cash for bills on India, would only make his payments in the dead of night, when he dug up the money, and paid it with the utmost secrecy. There is a very strict police in the towns, which being exercised by the Mahometan priests, often affords pretexts for extortion. The food of the common people is leavened bread, rice, flesh, vegetables, sometimes cheese, and always dried curds, of which all classes are fond. Provisions are cheap, and there is a prodigious abundance of fruit.

Trade.

In an inland country such as Afghanistan, mountainous, destitute of navigable rivers or of proper roads, commerce is carried on entirely by beasts of burden. There are no wheeled carriages, and camels are the animals chiefly employed. The merchants travel at the rate of about 8 or 10 miles a day in large caravans, the roads often lying through close and craggy defiles, and narrow stony valleys, among bare mountains, or along the beds of torrents, or over waste plains, where there is neither water nor provisions. The principal trade is with India, Persia, and Chinese and Independent Tartary. The caravans which set out for Tartary consist of horses or ponies, which are alone able to traverse the mountainous roads that lie in one part over the snowy ridges of Hindoo Khosh. Cabul is the great mart of Independent Tartary, Candahar and Herat that of Persia. The trade carried on by sea comes to Kurrachee, and thence to Shikarpoor and Candahar. The exports to Hindostan, which form by far the most considerable trade carried on by the Afghans, consist of horses and ponies, which chiefly come from Balkh on the northern side of the Hindoo Khosh Mountains, and fruits. The imports are coarse cotton cloths, which are worn by all the common people of the country; muslins, silken cloth, brocade, indigo in great quantities, ivory, chalk, bamboos, wax, tin, sandal wood, sugar, musk, coral, drugs, and spices of all kinds. To Independent Tartary the exports are chiefly white cloth, shawls, Indian turbans, chintz, and indigo previously imported from India. The imports are horses, gold, and silver; the latter consisting of the gold coin of Bokhara, Dutch ducats, Venetian sequins, and ingots of silver from China; cochineal, cloth, British hardware, looking glasses, Russian leather from Bokhara, to which place they come from Russia; also a fine cloth made of camels' wool. The exports to Persia are shawls and shawl goods, indigo, carpets of Herat, chintz, Indian brocades, muslins, and other cotton cloths. The imports are raw silk, silken stuffs, a coloured cotton manufacture, and silken manufactures, which are used in large quantities by all ranks; embroidered satin, velvet, and Persian brocade, which are confined to the rich. Indian chintz, manufactured at Masulipatam on the Coromandel coast, comes by sea to Busheer in the Persian Gulf, and is thence brought by land to Afghanistan, where it is much used. The exports to Chinese Tartary are the same as to Bokhara. The imports are woollens, Chinese silk and satin, tea in small boxes of thin lead, china, porcelain, raw silk, cochineal, crystal, gold dust, and ingots of gold and silver with the Chinese stamp.

Agriculture.

There are five classes of cultivators in Afghanistan: 1. the proprietors, who cultivate their own lands; 2. tenants, who pay a rent in money, or in part of the produce; 3. buzgurs, who, like the metayers, are supplied with seed, cattle, the implements of husbandry, and furnish only their labour; 4. hired labourers; and, 5. villains, who are the property of the landlord. From the influence of various causes, landed property is more equally divided than in most countries. The Mahometan law, which divides the father's property equally among his children, soon breaks down the largest landed estates; and rendering the portions too small for the support of their proprietors, they are consequently sold to those who have acquired wealth in public employments, or by agriculture or commerce. Hence small proprietors, who cultivate their own lands either with the aid of their families or labourers, are numerous. The number of tenants is not great; and many of these sublet it to others, who let it to metayers. The common term of a lease is one or two years; the longest is for five. The rent varies from one-tenth to two-thirds of the produce, the latter being the rent of the fertile lands around Cabul. The value of land is from nine to twelve years' rent. Labourers in husbandry are paid by the season.

The Afghan nation is divided into a variety of clans, which we cannot even enumerate; nor does it appear to be necessary, since a mere list of names, even if it were given, would throw no light whatever on the peculiar character and manners of the different tribes. One important distinction, however, divides the community into two great classes; namely, the pastoral tribes, who live in tents, and who migrate with the seasons in quest of subsistence for their flocks and herds; and those again who follow agriculture, and have fixed habitations. The country of Afghanistan which is near the hills consists of flat and low-lying plains, or of strongly-marked ranges of mountains. Western Afghanistan has an entirely opposite character, consisting of extensive and open plains, inhabited chiefly by pastoral tribes. These wandering hordes select the grassy valleys among the mountains for their summer habitation; but the approach of winter warns them to go in quest of more genial regions; and they accordingly migrate, some to the lower valleys at the foot of the Paropamisan Mountains, some to the low countries in the south, and others of the more purely pastoral tribes, wandering from the mountain valleys of Khorassan, along the course of the Gomul, and across the Soliman hills, fix their winter habitations in the plains of Damaun, along the western shores of the Indus. The Dooraunees form one of the greatest pastoral tribes. It consists of many subordinate tribes, all of whom are more or less addicted to the wandering life; though a considerable proportion combine agriculture with pasturage, and have fixed residences. The pastoral part of the Dooraunee people are mostly to be found in the eastern hilly tracts near the frontiers of Persia, between Herat and Seestan, and in the waste plains of the south. To the south-east of Candahar the inhabitants are shepherds; in other parts of the country the husbandmen and shepherds are intermixed. North of Candahar, the migrating tribes seek the plains in winter and the hills in summer. Those to the south retire from the summer heat to the northern hills. The numerous tribes still farther south beyond the Helmund also quit the plains, which are thus left with scarcely a single inhabitant before the middle of spring. There are some tribes, such as the Naussers, who are purely pastoral in their habits, who live in tents, and have no fixed dwelling-place, and who regularly wander with the change of the season from their winter to their summer habitations. As they approach the populous parts of the country, they have to make their way through hostile tribes, who beset them in the mountain passes, and either attack the main body or cut off the stragglers. Hence they are compelled to adopt the strictest precautions. Scouts are planted on all sides, the flanks and rear are protected by armed bands, and the main body advances with all the caution and exact discipline of a regular army. These shepherds are all plunderers; and no single travellers, if they be rich, are safe in any part of the country. They are fierce and warlike in their actions, and enterprising in their habits; yet are they capable of strong attachments, and are keenly alive to the force of social and domestic ties. In distant countries they dwell with the fondest enthusiasm on the valleys of their native land, on the varieties of its scenery, on the beauties and delights of spring, and on all the pleasing vicissitudes of their wandering life; and it is seldom that they quit their own happy abodes for foreign adventures. Their camps usually consist of from ten to fifty tents. One hundred is an unusually large number. The tent is formed of coarse black camlet, and affords excellent shelter from the weather, the threads of the blanket swelling as soon as they become wet; so that its texture, naturally close, is rendered quite impervious to rain. The tents of the common people are from 20 to 25 feet long, 10 or 12 feet broad, and 8 or 9 feet high. The tents of the khans are of a superior description, being large enough to contain a numerous assembly, and so high as easily to admit a camel.

Population.

Mr Elphinstone estimates the population at 14,000,000, to which he supposes that the different natives who inhabit the country contribute in the following proportions: Afghans, 4,300,000; Beloochees, 1,000,000; Tartars of all descriptions, 1,200,000; Persians, including Taujiks, 1,500,000; Indians, Cashmeres, &c. 5,700,000; miscellaneous, 300,000.

It must be borne in mind, however, that this estimate applies to a period antecedent to the dismemberment of the kingdom of Cabul, and when Cashmere and Scinde, with Lahore, Moultan, and other populous provinces, acknowledged the supremacy of its ruler. Looking to the boundaries by which Afghanistan is now circumscribed, and to the character of the country, which is for the most part rugged and ill cultivated, we shall in all probability be nearer the truth, by reducing the estimate of its population to five millions of inhabitants.

The Afghans, like most barbarous nations, derive their origin from high antiquity. They claim their descent from Afghan, the son of Irmia or Birkia, son of Saul, king of

Israel; but this is a vain tradition, unsupported by the slightest historical evidence. The first account we have of them is in the 9th century, when they were established in the north-eastern mountains of Afghanistan.

In 997 Afghanistan was conquered by a Tartar officer, Sebuctaghi, who, marrying the daughter of Alptegin, the founder of the dynasty of Ghuzni, had been acknowledged as his successor. His son Mahmood greatly enlarged the limits of his empire, which extended over the present kingdom of Cabul, India, Balkh, Badukshan, and a great part of Khorassan. His dynasty lasted till the year 1159, from which period the house of Ghor reigned in Afghanistan till the death of Shahabudin in 1206. The country was afterwards subdued by Ghengis Khan and Tamerlane; and during their government, and that of their descendants, the native Afghans appear to have maintained their independence in the mountains. Baber, the descendant of Tamerlane, began his career by the conquest of Cabul in 1504, and extending his conquests to India, established the Mogul empire of Delhi, from the ruins of which all the existing states in India are now composed. After the death of Baber, the plains of Afghanistan were divided between the empires of Hindostan and Persia, while the mountains as before afforded an asylum to those who rejected a foreign yoke.

In 1720 the Afghan tribes threw off their allegiance to Persia, and advancing into the country, took Ispahan. But in 1728 they were driven back by the celebrated usurper Nadir Shah, who pursuing his success, in the year 1737 subdued the whole of Afghanistan. He established his power over all the countries to the west of the Indus, which continued subject to Persia till his assassination in 1747. On this event an Afghan officer of the Dooraunee tribe, Ahmed Shah, who had risen to high command in Nadir's army, took possession of Candahar, and having united all the Afghans under his authority, founded the kingdom of Afghanistan. He was a wise and politic prince, who united courage and activity with great military talents. He invaded Hindostan at different times; and in the memorable battle of Paniput, fought in 1761, on the 7th January, he gave a decisive blow to the Mahratta power. He died in 1773, and was succeeded by his son Timour Shah, whose indolence was as noted as his father's activity. He died in 1792, after a despotic reign, leaving his dominions to his two sons, Homayon and Zemaun Shah. War soon broke out between the two brothers; and the elder being defeated, the whole kingdom acknowledged the authority of Zemaun Shah. In 1796 this prince invaded Hindostan with a large army, and advanced to Lahore; but he was obliged to retreat in consequence of an insurrection in his own country. In 1800 Zemaun Shah was dethroned and deprived of his sight by his brother Mahmood. He was in 1803 expelled by his brother Shuja, but Mahmood reappearing in arms against his competitor, the result was disastrous to Shuja, who ultimately found a retreat in British territory. Meantime Runjeet Singh, the Sikh chief of Lahore, profiting by the confusion, conquered Peshawur, the modern capital of Afghanistan. In 1818 Shah Shuja, impatient of retirement, attempted to regain his former dignity, but failed. A later revolution deprived Mahmood of his throne, when the country, with the exception of Herat, passed to the brothers of Mahmood's minister; the most able of them being Dost Mahomed Khan. Herat continued in the possession of Camran the son of the expelled Mahmood.

About the year 1837 the attention of the British Government in India having been attracted by the conduct of certain supposed agents of Russia in the counties to the west of the Indus, it was considered desirable to establish an alliance with the rulers of Afghanistan, and overtures were accordingly made to Dost Mahomed Khan, the chief of Cabul. These having failed, the British Government sought to establish a friendly power in Afghanistan by aiding the exiled Prince Shah Shuja in another attempt to regain his throne. At that time Dost Mahomed held Cabul with a considerable tract of adjoining territory, yielding a revenue of L.260,000 a-year. His army was composed of 14,000 men, of whom 6000 were cavalry, and his artillery consisted of 40 field pieces. The brothers of Dost Mahomed held Candahar, with the surrounding country, affording a revenue of L.80,000 a-year, while their military force was estimated at 3000 cavalry, 1000 infantry, and 50 guns. The British force assembled to support the claims of Shah Shuja, amounted to 28,350 men, aided by a contingent force of 6000 Sikhs furnished by Runjeet Singh, the ruler of the Punjaub, and by a levy of 4800 troops raised in the name of the Shah's eldest son. These formed the invading force designated "The army of the Indus." The British force was furnished partly from Bengal, and partly from Bombay. Both divisions advanced to the town of Dadar and thence pursued their march by the same route through the Bolan and Kojuck passes to Candahar, under the chief command of Sir John Keane. The city of Candahar was occupied without opposition, and there, on the 8th May 1839, Shah Shuja was solemnly enthroned. After a brief interval, the march was resumed towards Cabul. On the 21st, the army arrived before Ghuzni, a fortress believed by the Afghans to be impregnable. Two days later the gates of the fort were blown in with gunpowder and the place taken by storm. Pursuing its march, the army reached Cabul, and on the 7th August Shah Shuja made his public entry into his capital. The war was now considered at an end, and the "Army of the Indus," leaving behind them a detachment of 8000 men, prepared to return home.

During the two succeeding years, Shah Shuja and his allies remained in possession of Cabul and Candahar. Dost Mahomed had surrendered himself prisoner, and efforts were made to reduce the remaining refractory chiefs. These attempts, however, proved unsuccessful, and indications were not wanting of the difficulty of maintaining Shah Shuja on his throne. At length, on the 2d November 1841, a fearful outbreak occurred in Cabul, in which Sir Alexander Burnes and several other British officers were massacred. The position of the British now became critical. In a conference held between Sir William Macnaughten and Akbar Khan, son of Dost Mahomed, the British representative and several officers were treacherously murdered. Shortly after, the British entered into a convention to evacuate Afghanistan, and in January 1842, the remnant of the army began to move. In addition to the hardships and privations incident to a winter march in so elevated a region, this miserable band, destitute and spiritless, were exposed to the continual attacks of a pursuing enemy, into whose hands several of the fugitives fell. The remainder pushed on for Jellalabad; but out of 4500 soldiers who quitted Cabul, with a host of camp followers, one European (Dr Bryden of the Medical Service) alone succeeded in reaching that place, and he arrived but to report the capture or destruction of all his companions. The Cabul tragedy gave rise to a further disaster; Ghuzni was surrendered to the enemy by the British garrison. But General Nott retained possession of Candahar, and Colonel Sale maintained his position in Jellalabad, against all the efforts of Akbar Khan to dislodge him. Shah Shuja died by the hands of assassins.

To avenge these disasters, and rescue the prisoners who had fallen into the hands of the enemy, preparations on a large scale were made in India. An army of 12,000 men assembled in the Punjaub under General Pollock, who succeeded in forcing his way through the Khyber Pass and joined the force of Colonel Sale at Jellalabad. General

Afghanistan.

Pollock then advanced to Cabul, where he was met by General Nott from Candahar. Ghuzni had been retaken and dismantled by the last named commander, and on the 16th September 1842, General Pollock, amid the shouts of the soldiery, and the roar of artillery, planted the British colours on the towers of Cabul. All idea of retaining a footing in Afghanistan was abandoned. The rescue of the prisoners from the hands of Akbar Khan had been effected; the fort of Cabul, with several of the principal buildings, demolished; and the British finally evacuated the country in December 1842. Dost Mahomed was set at liberty, and returned to Afghanistan. Since that period various changes have taken place in that turbulent country, with the details of which we are but little acquainted. (E. T.)

AFIUM, or APPIOM, KARA HISSAR (or *Black Castle of Opium*), a city of Asiatic Turkey, in Anatolia, and the capital of Sanjiack. It stands on a declivity, and is defended by a citadel crowning a high and almost inaccessible rock. The population is estimated at 60,000. Opium in large quantities is produced in its vicinity, and forms the staple article of its commerce; besides which it has manufactories of black felts, carpets, arms, saddlery, &c. Lat. 38. 45. N. Long. 30. 56. E.



AFORT, a hamlet in the department of Seine, France, about five miles from Paris. It is celebrated for its Veterinary College, and also for its botanical garden, which is one of the finest in Europe.

AFRAGOLA, a large manufacturing town in the kingdom of Naples, and in the province of Napoli. It has three parish churches, and contains 12,640 inhabitants, who produce, among other goods, 6000 dozen of hats annually.

AFRANIUS, LUCIUS, a Latin poet, who lived about a century before Christ. He wrote comedies in imitation of Menander; and is commended by Cicero and Quintilian for his acute genius and fluent style. Only some fragments of his works are now extant.

# AFRICA.

Ancient geography of Africa. Egypt.

THE knowledge of this great continent which ancient writers have transmitted to posterity, is of very limited extent, owing principally to its physical construction. The great desert, which in a broad belt stretches quite across the continent, forbade every attempt to pass it until the introduction of the camel by the Arabs. The want of any known great river, except the Nile, that might conduct into the interior, contributed to confine the Greek and Roman colonists to the habitable belt along the northern coast. The Phœnicians are known to have formed establishments on the northern coast of Africa at a very early period of history, probably not less than 3000 years ago; and the conquest of Egypt by Cambyses dates as far back as the year B.C. 525. We may consider, therefore, the coasts of Egypt, of the Red Sea, and of the Mediterranean, to have been settled and well known to the ancient Asiatics, who were constantly passing the narrow isthmus which divided their country from Africa, and led them immediately from parched deserts into a fertile valley, watered by a magnificent river. But whether they were much or little acquainted with the western coast, which bounds the Atlantic, and the eastern coast washed by the Indian Ocean, is a question that has exercised the research and ingenuity of the ablest scholars and geographers, and has not yet been satisfactorily answered.

Western coast.

This question being one of curiosity rather than utility, we shall only state the case, and the results of the several inquiries, without entering into the merits of the arguments advanced by the different parties. We are told by Herodotus, that Necho, king of Egypt, sent out an expedition under the command of certain Phœnician seamen, for the purpose of circumnavigating Africa; and that, on their return, they asserted that they had accomplished this undertaking. Few of the ancient writers give credit to the story; but, among the moderns, the Abbé Paris and Montesquieu have contended that this voyage was actually performed. Isaac Vossius and D'Anville have strong doubts; and Dr Vincent and M. Gosselin maintain that such an expedition, at such a period, exceeds all the means and resources of navigation, then in its infancy. Last of all comes Major Rennell, who in his elucidation of the geography of Herodotus, has done more than all the rest in clearing away the doubts of history; and *he* argues the possibility of such a voyage, from the construction of their ships, with flat bottoms and low masts, enabling them to keep close to the land, and to discover and enter into all the creeks and harbours which any part of the coast might present. At all events, one thing is evident: if such an expedition ever circumnavigated the African continent, the fruits of it have nearly, if not entirely, perished.

About half a century after this supposed expedition, the account of another voyage, down the western coast, is contained in the *Periplus* of Hanno, which has also called forth many learned and elaborate discussions among modern geographers, some of whom would carry Hanno to the Bight of Benin, others only to Sherbro Sound or the river Nun in Lat. 28. N.

Eastern coast.

The extent to which ancient discovery proceeded along the eastern coast of Africa, has divided the opinion of the learned nearly as much as its progress on the western coast. Delisle, Huet, and Bochart, made the discovery of the coast to extend as far south as Mozambique and Madagascar. D'Anville could trace such discovery no farther than to Cape Delgado; and M. Gosselin contends that the ancients never proceeded down the coast beyond Brava. But Dr Vincent, who has entered more profoundly into the subject than any of his predecessors, and brought a great fund of learning to bear on the question, in his *Periplus of the Erythrean Sea*, has with great plausibility extended these boundaries to Mozambique and to the island of Madagascar.

Egypt, under the Ptolemies, the great patrons of science and promoters of discovery, possessing the advantage of the only great river which falls from the African continent into the Mediterranean, made no progress beyond its ancient boundaries; and though the Romans, who subsequently possessed Egypt, penetrated beyond the limits of their own dependencies, they extended their discoveries no further than Fezzan in one direction, and, at a later period, beyond Nubia as far as Abyssinia, and the regions of the Upper Nile.

The Carthaginians.

We know nothing of the progress made by the Carthaginians in the discovery of Interior Africa; but although it has been asserted that their merchants had reached the banks of the interior river, which we call the Kawara or Niger, they have left nothing on record that will warrant such a supposition. The story told by Herodotus, of some Nasamonians crossing the desert, and arriving at a large river, can only be applicable to some western arm of the Nile.

The Arabs.

The people from whom we derive the first information concerning the interior of Northern Africa are the Arabs, who, by means of the camel, were able to penetrate across the great desert to the very centre of the continent, and along the two coasts as far as the Senegal and the Gambia on the west, and to Sofala on the east. On this latter coast, they not only explored to an extent far beyond any supposed limits of ancient discovery, but planted colonies at Sofala, Mombas, Melinda, and at various other places.

The Portuguese. The fifteenth century produced a new era in maritime discovery. The voyages of the Portuguese were the first to give any thing like an accurate outline of the two coasts, and to complete the circumnavigation of Africa. The discovery of America and the West India islands gave rise to that horrid traffic in African negroes which has since been carried on without intermission; and this traffic has been the means of acquiring a more extended and accurate knowledge of that part of the coast which lies between the rivers Senegal and the Cameroons, as well as of the manners and character of the people who inhabit this extended line of coast.

The English and French. With the English and French settlements in Africa began a systematic survey of the coast, and portions of the interior.

Coast surveys. Admiral Sir Francis Beaufort thus sums up the surveys of the coasts of Africa, as far as they were made up to 1848. From the Strait of Gibraltar, the western coast of Africa has been sufficiently surveyed and published as far as Cape Formosa, in the Bight of Benin; but as there is much legitimate traffic in the eastern part of that great Bight, as well as farther to the southward, both it and many of the ports and anchorages on this side of the Cape of Good Hope require a more careful and connected examination. The charts of the whole of the Cape Colony are exceedingly defective, as the numerous wrecks there amply testify, and from thence to the Portuguese settlements of Delagoa we know scarcely anything. From Delagoa to the Red Sea, and the whole contour of Madagascar, are sufficiently represented on our charts for the general purposes of navigation, though many further researches along the former coast might still be profitably made. The Red Sea has been well surveyed by the East India Company. The northern shore of Africa, with the exception of Egypt, has been surveyed by the English and French.

African Association. The uncertainty and confusion that prevailed in the geography of the interior of Africa induced a few learned and scientific individuals to form themselves into an association for promoting the exploration of Inner Africa. This society was formed in London in 1788, and under its auspices important additions were made to the geography of Africa by Houghton, Mungo Park, Hornemann, and Burckhardt. Repeated failures, however, at length discouraged the association from engaging other missionaries, and it subsequently merged in the Royal Geographical Society in 1831.

African discoveries in the 19th century. During the last sixty years more has been done to make us acquainted with the geography of Africa, than during the whole of the 1700 previous years, since Ptolemy, taken together. With Mungo Park, strictly speaking, commences the era of unceasing endeavours to explore the interior.

Mungo Park. Mungo Park proceeded in 1795 from the river Gambia on the west coast, to the Joliba (commonly called Niger), traced this river as far as the town of Silla, explored the intervening countries, determined the southern confines of the Sahara, and returned in 1797. In 1805 this adventurous traveller embarked on a second journey in the same regions, for the purpose of descending down the river Joliba to its mouth. This journey added little to the discoveries already made, and cost the traveller his life. He is ascertained to have passed Timbuktu and to have reached Boussa, where he was killed by the natives.

Hornemann. Hornemann, in 1799, penetrated from Cairo to Murzuk, and transmitted from that place valuable information respecting the countries to the south, especially Bornu. He then proceeded in that direction, but it is supposed that he soon afterwards perished, as no accounts of his further progress have ever reached Europe. In 1816 an expedition was sent out by the English government under the command of Captain Tuckey, to the river Congo, which was at that time believed to be the lower course of the Joliba. This was a disastrous undertaking, and the geographical additions were but slight, the river having been ascended a distance of only 280 miles.

Tuckey.

Lyon and Ritchie. In 1819, Lyon and Ritchie penetrated from Tripoli to Murzuk, and a little distance beyond that place.

Denham, Clapperton, and Oudney. In 1822, Denham, Clapperton, and Oudney, set forth from Tripoli in the same direction, crossed the Great Desert, and reached, on the 4th February 1823, the great Lake Tsad. The surrounding countries were explored as far as Sakatu in the west, and Mandara in the south. This journey was altogether one of the most successful and important into the interior. Oudney died in Bornu, but Clapperton undertook a second journey from the coast of Guinea, crossed the Kawara and arrived at Sakatu, at which place he also died. His servant Richard Lander returned to England after having explored a part of the adjoining regions.

Laing. Major Laing succeeded in reaching Timbuktu from Tripoli, but was murdered on his return, in the desert.

Caillié. In 1827 and 1828, Caillié set out from the Rio Nunez on the western coast, reached Timbuktu and returned from that place through the Great Desert to Marocco.

Landers. The termination of the Joliba, Kawara or Niger, remained in obscurity till 1830, when it was ascertained by Lander and his brother, who succeeded in tracing the river from Yaouri down to its mouth. They embarked on a second expedition, which sailed in 1832, for the purpose of ascending the Kawara as far as Timbuktu. But only Rabba was reached, and the general results of the expedition were most disastrous.

Niger expedition. The great Niger expedition, similar to the foregoing, consisted of three steam-vessels, and was despatched by the government in 1841, under Captain Trotter. It proved a failure, and resulted in a melancholy loss of life.

Duncan. In the region between the Kawara and the coast, Mr Duncan, one of the survivors of the Niger expedition, has made some additions to our geographical knowledge by his journey to Adafoodia, in 1845–46. This enterprising traveller has since met with an untimely death, in a second attempt in the same region for the purpose of reaching Timbuktu.

East-African travellers. The preceding journeys were confined chiefly to the northern and western portions of the continent. A much greater number of travellers explored the regions drained by the Nile, the salubrity of which, particularly of Abyssinia, is so infinitely greater than that of Western Africa, that among the many explorers of the former a very small proportion have died as compared with the immense loss of life in Western Africa. Among the most distinguished of the East-African travellers are Bruce, Brown (who reached Darfur), Burckhardt, Cailliaud, Rüppell, Russegger, Beke, and the Egyptian expeditions up the Nile.

South-African Travellers. Though the Dutch settlement in South Africa was founded as early as 1650, not much information of the interior of that portion of the continent was gained till the end of the 18th century, when a series of journeys was commenced by Sparrmann, and followed up by Vaillant, Barrow, Trotter, Somerville, Lichtenstein, Burchell, Campbell, Thomson, Smith, Alexander, and Harris.

Recent expeditions, some of which are still in progress. Within the last five or six years a number of important discoveries have been made in various parts of Inner Africa, and the present time bids fair to outstrip all previous periods in lifting the veil that has hitherto enveloped Central Africa in impenetrable mystery.

Krapf and Rebmann. The Church Missionary Society established a mission at Mombas, in about 4 deg. south lat., on the east coast of Africa, consisting of the zealous missionaries Krapf and Rebmann. These gentlemen have, ever since 1847, explored the interior from that direction with untiring perseverance. At several hundred miles from the coast they have discovered high mountains covered with perpetual snow, which is the more interesting from their position being so near the equator. The existence of snow on the mountains of Kilimanjaro and Kenia has been disputed, but with little reason. These two remarkable peaks, to judge from the description of the missionaries, seem isolated cones rising out of regions comparatively little elevated and surrounded by plains in the same way as Mount Ararat, Mount Hermon, or the Sierra Nevada de Santa Martha in the equatorial regions of South America.

Livingston, Oswell, Murray, Vardon.

In South Africa also, missionaries have been the pioneers of geographical discovery. Kolobeng (in Lat. 24. 40. S. Long. 25. 55. E.) is, of all the missionary stations in that continent, the furthest inland. It lies on the southern borders of the Kalahari Desert, the Sahara of South Africa, which had frustrated many attempts at proceeding northward, to reach a large lake reported a long time previously to exist in that direction. On the 1st of June 1849, Mr Livingston, the missionary, accompanied by Messrs Oswell and Murray, set out from Kolobeng. After having travelled 300 miles through the desert of Kalahari, they came to a fine river, the Zouga, which issues from the lake. They followed it upwards about 300 miles, when they reached the eastern extremity of that lake, the chief name of which is Ngami, at an elevation of 2825 feet above the sea. Some English traders, who lately reached the lake, succeeded in walking round it, and ascertained it to be about sixty miles in length and about fourteen in breadth.

In 1851, Livingston and Oswell again started for the north, but more in an easterly direction, when they reached the latitude of 17. 25. S., and discovered the Chobé and Sesheké, deep and constantly flowing rivers, supposed to be the feeders of the Zambezi. The Zouga was ascertained to be absorbed in sands and salt-pans. The country through which the former rivers flow is level and very fertile.

Captain Vardon explored the region north-east of Kolobeng, tracing the Limpopo river to a considerable distance.

Gassiot.

In 1851, Gassiot made an interesting journey from Port Natal north-west, through the mountains, keeping along their western slope, and ultimately reaching the Limpopo.

Galton.

During the same year, Mr Galton explored a part of South Africa, from Walfisch Bay, on the west coast, extending from that point as far as 17. 58. S. Lat. in the north, and to 21. E. Long. in the east, and inhabited by the Damara and Ovampo. No very interesting features were discovered, but the whole region was accurately determined; and in this respect this journey is one of the most important yet accomplished between the equator and the tropic of Capricorn.

Plant.

In 1852, a journey was made by Mr Plant, of Natal, from that place to Delagoa Bay, in which he discovered that St Lucia Bay leads into an extensive inlet, hitherto unknown. The preceding journeys are all that have recently been performed south of the equator. In addition to them, may be mentioned a journey across the whole of the continent, from the coast of Zanzibar to Benguela, performed by a caravan of native traders, of which an account has recently been given by the Portuguese. In this journey they crossed Nyassa, the great lake of South Africa.

Richardson, Barth, Overweg, Vogel.

To the north of the equator, the mission to Lake Tsad, originated by Mr James Richardson, promises to exceed in importance all previous expeditions to Central Africa. That gentleman left England in 1849, for the purpose of concluding commercial treaties with the chiefs of Northern Africa, as far as Lake Tsad, by which the legitimate trade with those countries might be extended, and the system of slavery abolished. Upon the proposal of Mr Petermann, Drs Barth and Overweg accompanied Mr Richardson, for the purpose of making scientific observations. The three gentlemen started from Tripoli on the 23d of March 1850, after having minutely surveyed the mountainous region to the south of that place. During the first year the travellers successfully crossed the whole of the Sahara, in a very circuitous westerly direction, and thus explored a great portion of Northern Africa, which had never before been visited by any European. Their route from Ghat to Kano, in particular, leading them through the powerful kingdom of Aïr or Asben, was highly interesting. In the second year the travellers explored a large portion of Sudan in different directions, for which purpose they separated on their arrival at the northern frontiers of that country, each pursuing a different route, their plan being ultimately to meet at Kuka, the capital of Bornu. Barth and Overweg reached that place in safety, but Richardson died on the way, within six days journey of it, in March 1851. The other travellers, nothing daunted, continued their explorations, Barth penetrating 350 miles to the south, as far as Yola, the capital of the kingdom of Adamaua; and Overweg navigating Lake Tsad in a boat, which, with great labour, had been conveyed in pieces, on the backs of camels, from Tripoli across the burning sands of the Sahara. In September 1851, the travellers set out together on a journey to Borgu, a mountainous country lying to the north-east of Lake Tsad, about midway between it and Egypt. They travelled under the protection of a large army of the Sheikh of Bornu, which, however, was attacked at no great distance beyond Lake Tsad, and put to flight so suddenly, that Barth and Overweg saved their lives and instruments only by a quick retreat. Having returned to Kuka, they set out southward with another and a very considerable *ghazzia*, consisting of about 10,000 horse, and the same number of foot soldiers, with innumerable trains of camels and other beasts of burden. On this occasion they explored the country a considerable distance beyond Mandara, the farthest point of Denham's journey, and found it to be one of great fertility. With the beginning of the third year of their explorations, Dr Barth made a journey to Maseña, the capital of the kingdom of Baghermi, to the south-east of Lake Tsad; while Dr Overweg travelled in a south-westerly direction, and reached to within 150 miles of Yacoba, the great town of the Fellatahs. This, alas, was his last journey. On his return to Kuka he was seized with fever, and after a short illness and extreme sufferings, he died, the second victim in that expedition, in September 1852. Dr Barth was about to start for Timbuktu. A reinforcement, consisting of Dr Vogel and two sappers and miners, was despatched to his assistance on the 20th of February last.

Origin of the name of Africa.

The origin and meaning of the name of this great continent has been a fertile subject for conjecture among philologists and antiquaries. By the Greeks it was called Libya, Λιβυη, and by the Romans Africa. Varro believed he had found the etymology of the former in *Libs*, the Greek name of the south wind; and Servius, the scholiast on Virgil, proposed to derive the other from the Latin word *aprica* (sunny), or the Greek word *a-phriké* (without cold). It is more probable that the name Libya was derived by the Greeks from the name of the people whom they found in possession of the country to the westward of Egypt, and who are believed to have been those that are called in the Hebrew Scriptures *Lehabim* or *Lubim*. With respect to the word *Africa*, Suidas tells us, that it was the proper name of that great city which the Romans called *Carthago*, and the Greeks *Karchedon*. It is certain, at least, that it was applied originally to the country in the immediate neighbourhood of Carthage, that part of the continent first known to the Romans, and that it was subsequently extended with

Africa. their increasing knowledge, till it came at last to include the whole continent. Of the meaning of the name, the language of Carthage itself supplies a simple and natural explanation; the word *Afrygah*, signifying a separate establishment, or in other words a colony, as Carthage was of Tyre. So that the Phœnicians of old, at home, may have spoken of their Afrygah, just as we speak of our colonies. Be that as it may, the Arabs of the present day still give the name of Afrygah or Afrikiyah to the territory of Tunis. It may also be remarked, that the name seems not to have been used by the Romans till after the time of the first Punic war, when they became first acquainted with what they afterwards called *Africa Propria*.

Position and extent. Africa lies between the latitudes of 38° north and 35° south, and is of all the continents the most truly tropical. It is, strictly speaking, an enormous peninsula attached to Asia by the isthmus of Suez. The most northern point is the Cape, situated a little to the west of Cabo Blanco, and opposite Sicily, which lies in Lat. 37. 20. 40. N. Long. 9. 41. E. Its southernmost point is Cabo d'Agulhas, in 34. 49. 15. S.; the distance between these two points being 4330 geographical, or about 5000 English miles. The westernmost point is Cabo Verde, in Long. 17. 33. W., its easternmost Cape Jerdaffun, in Long. 51. 21. E. Lat. 10. 25. N., the distance between the two points being about the same as its length. The western coasts are washed by the Atlantic, the northern by the Mediterranean, and the eastern by the Indian Ocean.

Form. The form has been likened to a triangle, or to an oval, but such a comparison is scarcely warranted, it being of an irregular shape, the northern half rounding off, the southern one contracting and terminating in a point.

Superficial extent. The superficial extent of Africa has never been accurately determined, but may be taken at 8,550,000 geographical square miles, exclusive of the islands. It is larger than either Europe or Australia, but smaller than Asia and the New World.

Coast line and indentations. The coast line of Africa is very regular and unbroken, presenting few bays and peninsulas. The chief indentation is formed by the Gulf of Guinea, with its two secondary divisions, the Bight of Benin and the Bight of Biafra. On the northern coast, the Gulf of Sidra and the Gulf of Kabes must be mentioned, and on the eastern coast the Gulf of Arabia.

Physical configuration. The physical configuration may be considered under two heads, the great plain of Northern Africa, and the great table-lands, with their mountain ranges and groups, of Central and Southern Africa. The great plain comprises the Sahara, the Lake Tsad region, and the valley of the Lower Nile. The Sahara is by no means a plain throughout, but for the greater part it rises into table-lands, interspersed with mountain groups of 6000 feet elevation, and probably more, and the term plain can only be applied to it in a general way, to distinguish it from the more elevated region to the south.

The Sahara has often been pictured as a monotonous and immense expanse of sand; but nothing could be more erroneous, as the greatest variety exists in the physical configuration of its surface, as well as in its geological features. Our knowledge is as yet too scanty to enable us to trace its features in every part. On the north, this great desert is fringed with extensive table-lands, which in some places rise abruptly from the Mediterranean, as the table-land of Barca, elevated 1500 feet, and gradually descending towards the Delta of the Nile. This elevated ground is succeeded to the south by a depressed region, which extends from the Great Syrtis or Gulf of Sidra, in a general direction as far as middle Egypt, and comprises the oases of Augila and Siwah. So greatly depressed is this region, that the level of the oasis of Siwah is 100 feet, and in one place (Bahrein) even 167 feet below the level of the sea. This depressed region is again followed by a table-land of considerable extent and width, extending from the Gulf of Kabes in a southerly direction, along the Tripoline shores, and probably traversing, in the same direction, the Lybian Desert, and reaching as far as the Nile, near the first cataract. Its north-western part, as far as Sokna, consists of the Hamadah, a stony, dreary, and extensive table-land, of from 1500 to 2000 feet high, "which seems to be like a broad belt intercepting the progress of commerce, civilisation, and conquest, from the shores of the Mediterranean to Central Africa." Our knowledge of this table-land is only of a recent date, derived as it is, from the expedition under Richardson, Barth, and Overweg, and the journey of Dickson to Ghadamis. Near Sokna, this plateau breaks up and forms what are called the Jebel-es-Soudy, or Black Mountains, a most picturesque group of cliffs; and again, on the route from Murzuk to Egypt, it also breaks into huge cliffs, and bears the name of El-Harouj. The edge of this table-land towards the Tripoline shores is formed by what is generally called the Gharian Mountains; but, strictly speaking, this name applies only to a small portion of that range, situated due south of Tripoli, the western part being called the Yofran or Jebel, the eastern the Tarhonah. This range is not, as is generally supposed, connected with the Atlas Mountains, but is separated from them by a depressed belt, which even sinks below the level of the sea. This depressed region forms the north-western boundary of the Sahara, and extends from the Gulf of Kabes along the southern slope of the Atlas system to the Wady Draa, bordering on the States of Marocco, Algeria, and Tunis. The extensive oasis of Tuat occupies the central portion of that region. From Wady Draa, this great plain extends along the western shore as far as the river Senegal, and probably continues as such to the east towards Timbuktu, and thence to Lake Tsad. To the south of the Hamadah, the kingdom of Fezzan and the oasis of Ghadamis are flat and depressed; and between Fezzan and Lake Tsad, a tract of country intervenes which may also be considered rather a desert plain than a table-land. Thus it appears, that the western half of the Sahara is surrounded by a broad belt of plains and depressions, the central parts being formed by extensive table-lands and mountainous regions, comprising the kingdom of Aïr or Asben, lately explored by Messrs Richardson, Barth, and Overweg. The route of Dr Barth in his journey to Agadez, the capital of that kingdom, was girded by mountain ranges and groups rising to 3000 and 4000 feet, and Mount Dogem, the culminating point in that region, is even between 4000 and 5000 feet high.

The eastern portion of the Sahara appears for the greater part to be a considerably elevated table-land, comprising the mountainous country of Borgu. The summit of Ercherdat-Erner is said to be the highest in the whole region, but the testimony of European eye-witnesses is altogether wanting in treating of its geographical features.

The narrow valley of the Nile forms the eastern boundary of the Great Desert.

To the south of the region just described, Africa may be considered as one connected mass of elevated land, rising more or less above the level of the sea, and comprising the most extensive table-lands, as well as high mountain groups and chains. Some geographers have attempted to trace a system of terraces, which, they maintained, this elevated mass presented on all sides. Such is certainly the case in its southern extremity, where three well-defined terraces are well known to exist, but the same feature cannot be traced throughout; on the contrary, the plateau either gradually slopes down into a plain along the sea-shore, or it rises abruptly almost from out the sea, and presents a deep edge of from 7000 to 8000 feet elevation, as the northern part

Africa.

of the Abyssinian table-land at Massowah. The edge of the table-land, however, is generally from 100 to 300 miles distant from the sea-shore. Little is known at present beyond some parts of this outer fringe, and a few routes across the interior. Commencing at the Cape of Good Hope, and traversing the three aforementioned terraces, an almost uninterrupted table-land has recently been ascertained to extend to the north for at least 1000 geographical miles. The southern portion is formed by the basin of the Orange river, followed by the desert of Kalihari, which is again succeeded by the basin of the River Sesheké and Lake Ngami, with many other rivers, traversing a region which presents a dead level, its elevation at Lake Ngami being 2825 feet. That region probably is in connection with the basin of Zambezi. Farther north the ground ascends to the line of water-parting with the basins of the Congo river and Lake Nyassa; a region very little known, and succeeded by a complete *terra incognita*, extending to the north of the equator. In this region are supposed to be the celebrated "Mountains of the Moon," which have played so exciting a part in the history of African geography, and have given rise to so many curious hypotheses. Since the time of Ptolemæus of Alexandria, geographers have continued to shift these mountains from one latitude to another, from 10° to the north of the equator to 12° to the south of it, but all seem to have agreed in one point, namely, in giving them a direction from west to east. Rennell, one of the ablest geographers of recent times, argued that a very high central chain must cross Africa from east to west in about 10° N. Lat., beginning at Cape Jerdaffun, and ending at Sierra Leone; and in some of the most recent maps this direction is still to be seen. When, therefore, the Egyptian expeditions up the Bahr-el-Abyad, not only advanced as far as the fourth parallel of north latitude, but actually sailed over the alleged site of the Mountains of the Moon, without seeing any elevations whatever which could claim the title of mountains, that favourite hypothesis fell completely to the ground. Dr Beke was the first who, from his own personal researches, combined with extensive studies of the geography of Eastern Africa, propounded the opinion that the Mountains of the Moon have a direction from north to south, and run parallel to the eastern coast, and that they form in fact the southern continuation of the Abyssinian table-land. This direction also agrees much better with what is known of the basin of the Nile. It is a remarkable feature that the most elevated peaks rise on the outer edge of this great table-land, and even between it and the coast as isolated cones. This seems to be the case with the Kenia and Kilimanjaro, which are the only snowy mountains of Africa at present known, and must have for that reason an altitude of at least 20,000 feet. Abba Yared rises out of the northern edge of the Abyssinian table-land to the height of 15,000 feet. Mendif, south of Lake Tsad, another isolated mountain, is probably as high as 10,000 feet; and Alantika, a conspicuous mountain to the south of Yola (in 8. 30. N. Lat. 13. 45. E. Long.), also an isolated peak, was estimated by Barth to be 10,000 feet high; the highest of the Cameroons is 13,760 feet, and the highest known mountain of southern Africa, the Spits Kop, or Compass Berg, attains 10,250 feet.

The system of the Atlas mountains is quite distinct from either of the two divisions described above; it occupies the north-western region of Africa, consists of several ranges, and its highest summits are said to reach an altitude of about 15,000 feet.

Geological features.

Of all the rock formations, those of sandstone and limestone are the most frequent and the most widely distributed in Africa; natron, a rare deposit in other countries, is comparatively abundant; salt is very widely distributed, though in some districts wholly wanting. Metals, although met with in different quarters, seem nowhere abundant; of all the different metals, gold being the most generally distributed. Precious stones, so frequent in other tropical regions, are here of rare occurrence. The African continent is nearly exempt from volcanic action.

Minerals.

Rivers and Lakes.

Africa is emphatically the land of deserts, which are productive of a scarcity of rivers. Many of the smaller rivers and lakes, and not a few of the large ones, present only dry water-courses during certain periods of the year. Even Lake Tsad is said at times to become nearly dry; this large expanse of water has no outlet, and the immense supply of water received during the rainy season is lost again by evaporation. With the rains, floods are prevalent all over the country, even in the desert, as the recent observations made by the expedition under Richardson testify. That traveller relates that when on the borders of the kingdom of "Aïr, in about latitude 19° north, on the 30th September 1850, there was a cry in the encampment, 'The wady is coming.' Going out to look, I saw a broad white sheet of foam advancing from the south between the trees of the valley. In ten minutes after a river of water came pouring along, and spread all around us, converting the place of our encampment into an isle of the valley. The current in its deepest part was very powerful, capable of carrying away sheep and cattle, and of uprooting trees. This is one of the most interesting phenomena I have witnessed during my present tour in Africa. The scene, indeed, was perfectly African. Rain had been observed falling in the south; black clouds and darkness covered that zone of the heavens; and an hour afterwards came pouring down this river of water into the dry parched-up valley. This instance of Wady Tintaghoda explains the Scriptural phrase, "rivers of waters," for here indeed was a river of water, appearing in an instant, and almost without notice." The importance of the floods and inundations of the Nile scarcely requires to be referred to.

Africa is chiefly drained into the Atlantic Ocean, and its branch the Mediterranean Sea, the river system of the Indian Ocean being comparatively inconsiderable.

Nile.

The Nile is the oldest of historical rivers, and afforded the only means of subsistence to the earliest civilised people on earth. Thus renowned from immemorial ages as the gift of the Nile, Egypt issues from the womb of primordial time, with a civilisation already perfected at the very earliest epoch of her history, hieroglyphed on the monuments of the third and fourth dynasties, prior to the 35th century before the Christian era. But the origin of the river itself remains an enigma to this day; and when we moderns, in the quiet of our cabinets, calmly span the chronological interval of above 5000 years, our vain-glorious boastings of the patronage vouchsafed by Europe towards African exploration and discovery, encounter signal reproof from the mute fact that "*caput Nili quærere*" is a task as arduous now-a-days, as fifty-three centuries ago it was to the primeval builders of the Pyramids.

A strange mystery has enshrouded the sources of this river, one of the mightiest of the globe. Its three principal tributaries from the east have, each in succession, claimed the distinction of being the main stream, but that stream remains still to be discovered. The Atbara, called by the Abyssinians Takkazie, the last of the tributaries of the Nile before it disembogues into the sea, was looked upon, in early Christian ages, as the head of the Nile; it rises in the Abyssinian provinces of Lasta and Samen, amid mountains attaining the height of 15,000 feet. From the same lofty regions issues the Abaï, termed formerly the Astapus, which becomes the Bahr-el-Azrek, or "Blue River," at Khartum. The Abyssinians still look upon the Abaï as the Gihon of the Genesis; as did the Portuguese Jesuits in the sixteenth and seventeenth centuries. One hundred and fifty

Africa. years before Bruce, its source in the peninsula of Godjam was visited and far more accurately described by Pedro Paez.

Above the junction of the Astapus with the Bahr-el-Abyad, or "White River," the ancients seem to have known nothing of the course of the Nile, previously to the time of Ptolemy the geographer, except that it came from the west: in this vaguely referring to the Keïlak. Our present knowledge of the upper course of the Bahr-el-Abyad is derived from the three expeditions sent up between 1835 and 1841 by the late Mohammed Ali; from which we learn that on the eastern bank the main stream is joined, in about 9. 20. N. Lat., by the Sobat, otherwise Telfi, or Bahr-el-Habesh, which takes its rise in the same Abyssinian high lands whence issues the Takkazie and the Abaï. Of the head streams of the Sobat, the principal is the Baka, known higher up its course by the names Uma and Godjeb. This last, in the country of the Gallas, is joined by the Gibbe, or Zebee of Father Antonio Fernandez (1613), the Gibbe itself being formed by the union of three rivers all bearing the same name. One of the three, the Gibbe of Enarea, has been singled out by D'Abbadie as the true source of the Nile, but this theory is contradicted by facts. A little beyond the confluence of the Sobat, the main stream of the Nile divides itself into two great arms, the eastern one of which has been ascended to about 4° north of the equator. At the point where the expedition turned back, the river was found still upwards of 1000 feet broad, from which it may be inferred that the sources are several hundred miles beyond; indeed Lakono, the king of Bari,—a country comprising the farthest region reached by the expedition,—stated that the river came from a distance 30 days farther south, a direction which was also corroborated by the direction of the valley. Hence the sources of this river, which is there called the Tubirih, may be looked for either under the equator or south of it, and the prevailing opinion at present is that it forms the true head of the Nile. It is, however, not unlikely that the great western arm of the Nile, the Keïlak, is the principal branch of the Nile, but the present state of our knowledge of that river does not justify any thing but a mere speculation respecting this point. That the basin of the Keïlak extends westward to the basins of Lake Tsad, Kawara, and the Congo, is, however, now pretty well established by the researches of Dr Barth.

The length of the Bahr-el-Azrek, or Blue River, is 2830 English miles, that of the Bahr-el-Abyad, or White River, is :—

| | | |
|---|---|---|
| From the mouth to Khartum | 1780 | English miles. |
| From Khartum to the farthest point reached by the Egyptian expeditions . . | 1300 | „ |
| Thence to the source, probably | 300 | „ |
| | 3380 | |

which is second only to that of the Mississippi-Missouri. The area drained by the Nile is at least 2,000,000 English square miles.

There are no other rivers, of any consideration, along the northern shores of Africa. Proceeding to the western coasts, we first find the Wady Draa, augmented by the Wady Sagis and el Hamra, which runs into the sea opposite the Canary Islands, and is spoken of as a considerable river.

Senegal. The River Senegal has a length of upwards of 1100 miles, and has its sources in the same elevated tract of land as those of the Kawara.

The Gambia and Rio Grande, south of the River Senegal, are also considerable rivers.

Kawara and Tchadda. The Kawara, commonly but erroneously called Niger, is next to the Nile the largest of African rivers. Its sources are like those of the Nile still unknown. It appears to be the Amner, which is said to rise in a high group of mountains east of Liberia. As far as Timbuktu the river is called Joliba, and its course is pretty well known, but from that place to Yaouri it is as yet unexplored. Thence down to its mouth it was first traced by Lander. It is there called Kawara in general, although it has several names in the different languages of the tribes which inhabit its shores. Of the tributaries of the Kawara our knowledge is very scanty. The Tchadda is the most important of these, and rivals the Kawara, if it do not actually surpass it in magnitude; it extends far into the heart of Inner Africa, and was recently explored by Dr Barth in its upper course, where it flows through the kingdom of Adamaua: even there it is half a mile broad, and ten feet deep, and is called Benue. It is highly probable that this splendid river will eventually form the natural and most important line from the west for the spread of commerce and civilisation into the very centre of Africa. The kingdom of Adamaua, situate in the valley of the upper Tchadda, with its pastoral and agricultural population, is spoken of by Dr Barth as the most beautiful country in Central Africa, and as such may probably become the key to the interior of that continent.

The length of the Kawara is about 3000 miles, and the area drained by it may amount to 1,500,000 square miles.

In contradiction to the facts observed by Denham and Clapperton, an hypothesis was started some time ago, that Lake Tsad was drained into the Kawara by means of the Yeou and Tchadda, but their observations have recently been confirmed by Barth and Overweg, who have refuted this hypothesis.

South of the equator, the west coast receives many large rivers which are as yet little explored. Such are, the Zaire Zaire. or Congo, known only for a short distance beyond its mouth; Coanza. the Coanza, which is better known; the Nourse river or Nourse. Cunene, almost unknown. The Swakop has recently been Swakop. explored by Mr Galton.

Orange R. The Orange river is about 1000 miles in length. Its head streams are the Ki Gariep or Vaal river, and the Nu Gariep, which latter again consists of the Caledon and Cradock rivers. The Orange river drains an area of about 350,000 English square miles.

Limpopo. Rounding the southern extremity of Africa, and proceeding up its eastern coast, the Limpopo is the first river requiring notice. Its head streams and its middle course are pretty well known, but whether it disembogues into the sea at Delagoa Bay or at Inhambane, is a matter of doubt. The most trustworthy testimony is that it reaches the sea at the latter place.

Zambezi. The Zambezi is the largest river of the eastern coasts. Its upper course is also shrouded in mystery. It is most probable that the Rivers Sesheké and Chobé, recently discovered by Messrs Livingston and Oswell, form the head streams of the Zambezi; their magnitude is opposed to the hypothesis entertained by some that they are lost in the sands.

Lakes. Tsad. Africa possesses several considerable lakes, among which Lake Tsad is probably the largest and most interesting. It was discovered by Denham and Clapperton, who traced its borders, except on the eastern side; but was first navigated by Overweg, who recently fell a victim in the cause of African exploration. This was done in a boat which had been conveyed from Malta across the Sahara to Lake Tsad, as already mentioned. It was successfully launched on the 18th June 1850; and Dr Overweg embarked in it at Bree, to the east of Kuka. At a distance of twelve miles from the former place he reached the first of the islands, of which there are about one hundred of large size scattered over the lake. They are wooded, and inhabited by the Bidduma, a pagan tribe who have remained independent of the Mahommedan na-

Africa.

tions living around the lake. They have herds of cattle and goats; the shores are infested by numerous crocodiles and hippopotami. The dimensions of the lake were found by Dr Overweg to be considerably smaller than those given by Major Denham; it being from west to east only 60 miles in extent, whereas in Denham's map it is more than double that size. This apparent discrepancy, however, may find its explanation in the remarkable nature of the lake,—it being an immense body of water which is greatly augmented in the rainy season, but in the season of drought evaporates so much that it seems at times to dry up entirely. This was said to have taken place six years previously to the date of Overweg's visit. The average depth of the lake is from ten to fifteen feet, and its waters are *fresh* and clear. Dr Overweg was received with great kindness by the Biddumas on his landing at several of the islands, and during his visits to many of their villages. Lake Tsad has no connection with the Kawara or the Nile, but forms an inland receptacle receiving the waters of some of the most distant regions of Inner Africa. The chief feeder is the Shary or Asu, coming from the south, with its tributary the Loggeme or Serbenel; on the western side it receives the Yeou; on the north-eastern side a river rising in the mountainous district of Borgu.

Fittri.

Lake Fittri, east of Lake Tsad, forms a distinct hydrographical system between it and the Nile, with which it has no connection. It has never been explored by Europeans.

Tsana.

Lake Tsana or Dembea is the chief lake within the basin of the Nile, as far as known. It is situate on the table-land of Abyssinia, at an elevation of 6110 feet, has a length of about 60 miles, and possesses many islands. The Abai flows through it. Other lakes on the Abyssinian table-land are Zuwai, Haik, and Ashangi.

In Inner Africa a number of considerable lakes are reported to exist, but only two are known south of the equator with any degree of certainty. They have various names, but are best known under those of Nyassa and Ngami.

Nyassa.

Nyassa, the great lake or sea in 10° south latitude, is as yet only approximately laid down in the maps, according to native information, and whether it be the feeder of a large river, or merely a recipient lake, is unknown. It is represented as stretching in a general direction of south-east to north-west. Nyassa or Nyassi is the name given to it by the Yao, nations living on its eastern shores, but it is also called Ziwa by the Sawahili, and is farther identified with the Nhanja, and the Murusura, as also with the Maravi and Zambeze of early geographers,—Zembere, Zembre, Zambre being considered corruptions of the latter. Zambeze is probably only the name of the river flowing into the Indian Ocean at Quillimane, a branch of which rises near the south-east extremity of the lake, but by no means issues from it.

Another lake in that region has recently been reported by the natives to Dr Krapf, as being situate west of Mombas, beyond Kilimanjaro, and in the country of Uniamézi.

Ngami.

Lake Ngami was known to exist upwards of twenty years ago, and is alluded to by Philips, Campbell, Harris, and others, and indicated in maps under the name of Mampoor or Mampua; but it was first reached by Europeans in 1849, when Messrs Livingston, Murray, and Oswell, undertook a voyage chiefly for the purpose of its discovery. They only saw its north-eastern extremity, however, which there opened out, like the Firth of Forth, with an unbounded horizon of water towards the south-west. As to its extent, nothing positively could be ascertained from the natives, who said that it took twenty-five days to travel round it; their canoes never cross it, but some coast round and along the shores. It was said to contain hippopotami, alligators, and large fish. The height above the sea was computed by the thermometer to be 2825 feet. The river Zouga, which issues from the lake, is lost in the sands before it reaches the sea.

Lakes Tsad, Nyassa, and Ngami are extensive fresh-water formations. There are, however, numerous small salt and natron lakes in various parts of Africa.

Climate. Temperature.

The following table, compiled from Dove, gives the data for a general view of the distribution of temperature over Africa, namely, the monthly and annual mean.

| | Lat. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algiers, . | 36°. 47'. N. | 52·97 | 54·82 | 55·99 | 59·05 | 66·34 | 71·51 | 75·25 | 76·48 | 73·18 | 68·50 | 61·93 | 55·15 | 64·27 |
| Bona, . | 36. 40. „ | 52·16 | 60·44 | 62·06 | 65·30 | 75·20 | 83·12 | 86·18 | 86·18 | 79·88 | 79·34 | 63·32 | 60·80 | 71·17 |
| Cairo, . | 30. 2. „ | 58·10 | 56·12 | 64·58 | 77·90 | 78·26 | 83·66 | 85·82 | 85·82 | 79·16 | 72·32 | 62·96 | 61·34 | 72·17 |
| Santa Cruz, . | 28. 49. „ | 63·84 | 64·29 | 67·17 | 67·32 | 72·12 | 73·89 | 77·29 | 78·89 | 77·43 | 74·66 | 70·43 | 66·42 | 71·15 |
| Cobbe, . | 14. 11. „ | 67·10 | 67·28 | 80·60 | 86·54 | 87·44 | 87·08 | 87·80 | 87·08 | 86·72 | 83·12 | 78·08 | 72·68 | 80·96 |
| Kuka, . | 13. 10. „ | 75·74 | 83·12 | 88·88 | 92·30 | 91·04 | 89·60 | 83·66 | 80·42 | 83·30 | 85·28 | 79·70 | 70·52 | 83·63 |
| Free-Town, . | 8. 30. „ | 82· | 81· | 80· | 80· | 80· | 78· | 78· | 77· | 78· | 78· | 80· | 80· | 79·33 |
| Christiansborg, | 5. 24. „ | 81·14 | 81·73 | 82·78 | 83·37 | 82·96 | 79· | 77·09 | 75·79 | 77·95 | 80·51 | 81·77 | 81·03 | 80·42 |
| The Niger, . | 5. 9. „ | 86· | 86· | 86· | 87·98 | 87·98 | 89·06 | 80·06 | 87·89 | 88·16 | 89·02 | 80·06 | 80·06 | 85·27 |
| St Helena, . | 15. 55. S. | 63·98 | 65·87 | 66·24 | 65·60 | 63·05 | 60·07 | 57·99 | 57·17 | 57·07 | 58·23 | 59·84 | 61·77 | 61·40 |
| Cape-Town, . | 33. 56. „ | 74·37 | 75·97 | 72·75 | 67·10 | 62·13 | 57·88 | 57·58 | 60·58 | 61·90 | 64·94 | 70·14 | 72·37 | 66·47 |

Africa lies almost entirely in the torrid zone, and is the hottest continent of all. The greatest heat, however, is not found under the equator but to the north of it, in consequence of the northern portion being of greater extent than the southern, and of less elevation. The greatest temperature is found throughout the Sahara, particularly in its eastern portions towards the Red Sea. In Upper Egypt and Nubia eggs may be baked in the hot sands, and the saying of the Arabs is, "in Nubia the soil is like fire and the wind like a flame." The regions along the Mediterranean and Atlantic coasts are rendered more temperate by the influence of the sea. To the south of the Great Desert, where the country becomes more elevated, the temperature decreases, and it is now fully confirmed that some spots, quite near the equator, even reach the altitude of permanent snow. Regular snowfall, however, does not occur even in the most southern or northern regions. The intensity of radiation and its influence upon the temperature are very great in Northern Africa: while in the day time the soil of the Sahara rapidly absorbs the solar rays, during the night it cools so rapidly that the formation of ice has often been known to occur.

Winds.

Africa is not much under the influence of the regular winds, except the monsoons of the Indian Ocean. It will be seen in the next paragraph, that the monsoons, although they extend only to about a third portion of the East-African shores, have an extremely important bearing upon the physical economy of the whole African continent. From hurricanes Africa is nearly exempt, except its south-eastern extremity, to which at times the Mauritius hurricanes extend. Northern Africa is much

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exposed to the hot winds and storms from the Sahara, which are called in Egypt Khamsin, in the Mediterranean, Scirocco, and in the western regions Harmattan. Extreme heat and dryness are the characteristics of these winds, which raising the sand, filling the air with dust, and prodigiously favouring the powers of evaporation, are often fatal to the vegetable and animal creation in the regions visited by them.

Rain.

The supply of rain is, upon the whole, scanty in this continent. The Sahara and also the Kalihari of Southern Africa are almost rainless regions. There seems, however, no part where rain is entirely wanting, even in the middle of the desert. A very striking instance, as related by Mr Richardson, has already been referred to. At sea, between the tropic of Capricorn and the Cape of Good Hope, on both sides of the continent, the transparency of the atmosphere exceeds what is known in any other part of the world; and European astronomers, on first visiting those latitudes, contemplate with astonishment the nocturnal splendour of the heavens, in which the naked eye can perceive stars of considerably less magnitude than it can discern in the northern skies. There Jupiter and Venus shine with startling refulgence, and cause opaque bodies to cast well-defined shadows; the fixed stars Aldebaran, Castor and Pollux, the Corona Australis, and Orion, appear preternaturally brilliant. The littoral regions of Western Africa, from the Kawara to the Senegal, receive copious falls of rain with the south-east trade-winds, so much so that at Sierra Leone 313 inches of rain have been known to fall in one year. But the largest supply of rain appears to be brought to Africa by the summer-monsoon on the east coast. This monsoon, lasting from April to October, extends over the Indian Ocean in a half-circle from south-east to north-east by west. From the latitude of Mozambique to the equator it has a general direction from south-east, and there, in a corresponding manner the chief rainy season is found during April, June, and July. Under the equator the direction of the monsoon changes and becomes south-west. To these winds are to be ascribed the heavy falls of rain that drench the extensive plains and ascending grounds of the east horn of Africa. Farther inland they are broken by the great Abyssinian table-lands, so that they do not extend beyond the strait of Babelmandeb, south-east of which a great fall of rain consequently occurs; to the north-west, on the other hand, scarcely any rain falls. No rain occurs in these regions when the monsoon comes from the opposite direction, namely, from the Asiatic continent. The south-east monsoon does not stop in the coast regions, but continues in a more or less modified direction northwards as far as Lake Tsad and Kordofan, and even the latitude of 22°; in both regions its influences begin to be felt in May, or one month later than on the coast. This is a most important fact, as it evidently shows that no connected equatorial range of high mountains—such as the hypothetical Mountains of the Moon of early geographers—can exist in Central Africa, and the assumption is corroborated by the fact that in the eastern portion, where high mountains are known to exist, the same rainy wind is interrupted so much that it reaches the northern portions of Abyssinia one month later than Lake Tsad and Kordofan. The upper basin of the Nile, being probably not far from the coast, receives the undiminished supply of water with the beginning of the monsoon, and hence, after two months, the Nile begins to rise in Upper Egypt and continues to do so till September. Were the head streams of the Nile surrounded by a high mountain range in the east and south, like the Andes of South America, the monsoon would probably not have the same beneficial influence upon its development.

Plants.

Although Africa belongs almost entirely to the torrid and warm zones, its vegetable productions are essentially different in different parts. Thus, in the extreme north, groves of oranges and olives, plains covered with wheat and barley, thick woods of evergreen-oaks, cork-trees, and sea-pines, intermixed with cypresses, myrtles, arbutus, and fragrant tree-heaths form the principal features of the landscape. On this northern coast the date-palm is first found; but its fruit does not arrive at perfection, and it is chiefly valued as an ornamental object in gardens. Various kinds of grain are cultivated. Beyond this region of the coast and the Atlas chain, with the borders of the Sahara commences a new scene. It is in this region, extending to the borders of Sudan, that the date-tree forms the characteristic feature, it being peculiarly adapted to excessive dryness and high temperature, where few other plants can maintain an existence. Were it not for the fruit of the invaluable date-tree, the inhabitants of the desert would almost entirely depend on the products of other regions for their subsistence. With the southern boundary of the Sahara, the date-tree disappears, the baobab or monkey bread-tree takes its place, and, under the influence of the tropical rains, a new, rich, and highly-developed flora presents itself. These trees, together with huge cotton-trees, oil-palms, sago-palms, and others of the same majestic tribe, determine the aspect of the landscape. The laburnum expands its branches of golden flower, and replaces the senna of the northern regions, and the swamps are often covered with immense quantities of the papyrus plant. Instead of waving fields of corn, the cassava, yam, pigeon-pea, and the ground-nut, form the farinaceous plants. The papaw, the tamarind, the Senegal custard-apple, and others, replace the vine and the fig. In Southern Africa, again, the tropical forms disappear, and in the inland desert-like plains, the fleshy, leafless, contorted, singular, tribes of kapsias, of mesembryanthemums, euphorbias, crassulas, aloes, and other succulent plants, make their appearance. Endless species of heaths are there found in great beauty, and the hills and rocks are scattered over with a remarkable tribe of plants called *cycadaceæ*. Plants of the protea tribe also add to the extraordinary variety in the vegetable physiognomy of that region.

Date-palm.

Of the characteristic African plants, the date-tree is one of the most important, as it is likewise among the nearly one thousand different species of palms. It furnishes, as it were, the bread of the desert, beyond which it occurs only in Western Asia, wherever a similar dry and hot climate prevails. This tree requires a sandy soil, and springs must not be absent. The dates furnish food not only for man, but for the camel and the horse. For the latter purpose the stones are used in many parts, and are said to be more nourishing than the fruit itself. The Arabs make a great variety of dishes of which dates form the chief part. Of the sap of the tree palm-wine is prepared, and the young leaves are eaten like cabbage.

Heaths.

In Southern Africa are the extensive miniature woods of heaths, as characteristic as the groves of date-palms in the north. No less than five hundred species have already been discovered. These plants, of which some reach the height of 12 to 15 feet (*Erica urceolaris*), are covered throughout the greater part of the year with innumerable flowers of beautiful colours, the red being prevalent.

Papyrus.

The papyrus is an aquatic plant, having a stem from 3 to 6 feet high. It inhabits both stagnant waters and running streams, and is common in the countries of the Nile, particularly Egypt and Abyssinia. Its soft, smooth, flower-stem afforded the most ancient material from which paper was prepared, and for this reason it is one of the noticeable African plants. It has, however, also been used for other purposes; its flowering stems and leaves are twisted into ropes; and the roots, which are sweet, are used as food.

Animals.

Africa is distinguished from other continents by the scar-

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Quadrupeds.

city of forests: it has consequently very few of the animals which inhabit forests. Deer are almost entirely wanting; in their place we find antelopes, which occur in greater numbers than in any other country. Peculiar to Africa are the zebras and other striped mammalia of the equine and asinine tribes; the giraffe, and their constant companion the ostrich. The extraordinary swiftness of these animals, which enables them to seek for their food at great distances, is peculiarly adapted to the immense plains of the country. The scarcity of forests further corresponds with that of squirrels, the few that are found being mostly ground-squirrels. Mice are numerous, as are also hares, which prefer steppe-like countries to woodland. The immense quantity of game affords food for plenty of carnivorous animals. Upon the whole, the mammalian fauna of Africa approaches in resemblance much nearer to that of Southern Asia than that of South America. The following table affords a general view of the distribution of mammalia in the different parts of Africa,—the figures denoting the number of species found in each of the divisions, those in parentheses being the number peculiar to Africa.

| Orders. | N. Africa, incl. Barbary & the countries bordering on the Mediterranean | S. Africa. | W. Africa. | Egypt, Nubia. | Abyssinia. | Madagascar. | All Africa. |
|---|---|---|---|---|---|---|---|
| Simiæ | 1 | 5 | 30 | 7 | 6 | 18 | 63 ( 62) |
| Carnivora | 23 | 67 | 34 | 67 | 25 | 21 | 174 (151) |
| Marsupialia | — | — | — | — | — | — | — — |
| Rodentia | 15 | 46 | 20 | 36 | 18 | 3 | 104 ( 94) |
| Edentata | — | 2 | 3 | 2 | — | — | 6 ( 6) |
| Pachydermata | 1 | 9 | 4 | 3 | 5 | 1 | 18 ( 17) |
| Ruminantia | 4 | 27 | 21 | 13 | 11 | — | 65 ( 62) |
| Cetacea | 3 | 11 | 2 | 2 | — | 2 | 16 ( 7) |
| TOTAL | 47 | 167 | 114 | 130 | 65 | 45 | 446 (399) |

Simiæ.

The order *Simiæ* is well represented, more particularly within the tropics, whence they decrease northwards and southwards. In Barbary and Lower Egypt only one ape is found (*Inuus ecaudatus*), and in the southern extremity only two species. In Madagascar, the place of the true monkeys is supplied by the peculiar tribe of the makis. Many species are similar to those of Asia; thus the orang-outang of Borneo is represented in Africa by the chimpanzee. The gibbons and solemn doucs (*Hylobates* and *Semnopithecus*) are entirely wanting.

Carnivora.

Bats are numerous in Africa, but few are peculiar to it: the hedgehog is represented by the *tenrecs* of Madagascar: the shrew peculiar to this continent is the elephant-shrew of the Cape: our mole is represented by the *chryso-chlore*, with iridescent hair, and eyes not perceptible. Of the larger carnivora the bear is almost entirely wanting, and occurs only sparely in Barbary and Abyssinia. The true martens are unknown; but otters occur; and the civets are characteristic types. Of the *Canis* family the shakal (jackal) is characteristic: it differs from the Asiatic species by a paler skin, which approaches the colour of the prevailing deserts. Hyænas are true African tenants. Africa is the chief home of the lion, who there remains undisturbed as king over the animal creation, while in Asia his power is divided with the tiger; he is found all over the continent, except in the north-eastern portions, in the greater part of the Sahara, and where European civilization has taken root. The panther, the leopard, and once, are the other principal representatives of the cat-tribe.

Marsupialia.

The Marsupialia are entirely wanting.

Rodentia.

Of Rodentia the burrowing kinds prevail, both of squirrels and of mice. Hares are unknown in Western Africa, but porcupines extend from the Cape to Barbary.

Edentata.

Of Edentata the six species known to occur in Africa, are also peculiar to it. The aardwark (*Orycteropus capensis*) is essentially burrowing in its habits; and the burrows formed by these animals are the source of frequent danger to the waggons and horses of the Cape colonists.

Pachydermata.

Of wild horses the asinine group is peculiar to Asia, and the hippotigrine group to Africa. The different species are found in large herds. The zebra ranges from Southern Africa northwards to about 10° north latitude. Africa has three peculiar species of rhinoceros, one elephant; and that remarkable animal, the hippopotamus, is one of its most characteristic types, extending from the Orange River to the Nile, Lake Tsad, and the Senegal. In the genus *sus*, the wart-hogs (*Phascochœrus*) belong exclusively to Africa, and the *Hyrax* (wabber, daman, dassie, of the colonists) is also its peculiar inhabitant.

Ruminantia.

Antelopes occur in all parts, and in great varieties and numbers. Dense herds sometimes extend over the far-stretching plains as far as the eye can reach, and, when in the dry season they are forced to approach the colonies, and pay visits to the farmers, they become as destructive as locusts. The most valuable of the African animals is the camel or dromedary, which is believed to have been introduced by the Arabs. It ranges over the Sahara and all Northern Africa, as far as Lake Tsad, and is everywhere domesticated. Lastly, the giraffe, one of the most celebrated and characteristic of African quadrupeds, ranges from the Cape Colony as far as the Sahara and Nubia.

Birds.

The ornithology of Africa presents a close analogy in many of its species to those of Europe and South Asia. Thus, on its northern coasts, there is scarcely a single species to be found which does not also occur in the other countries bordering on the Mediterranean. The ornithology of the region of the Nile and the northern coasts is identified with that of Arabia, Persia, and Spain. The deserts are inhabited by species adapted to its solitudes; while Southern Africa presents different species.

The ostrich, the hugest of birds, which has been described as the feathered camel, or the giraffe among birds, is found in almost every part of Africa. But its chief home is the desert and the open plains; mountainous districts it avoids unless pressed by hunger. The beautiful white feathers, so highly prized by the ladies of Europe, are found in the tail only of the male bird. The chase is not without its difficulties, and it requires the greatest care to get within musket-shot of the bird, owing to its constant vigilance and the great distance to which it can see. The fleetest horse,

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too, will not overtake it, unless stratagem be adopted to tire it out. If followed up too eagerly, the chase of the ostrich is not destitute of danger; for the huntsman has sometimes had his thigh-bone broken by a single stroke from the leg of a wounded bird.

The large messenger or secretary-bird, which preys upon serpents and other reptiles, is one of the most remarkable African birds. It is common near the Cape, and is not seldom domesticated. Of gallinaceous fowls, adapted to the poultry-yard, Africa possesses but a single genus, the guinea-hens, which, however, are found in no other part of the world. These birds, of which there are three or four distinct species, go in large flocks of 400 or 500, and are most frequently found among underwood in the vicinity of ponds and rivers. There are, besides, many species of partridges and quails in different parts of Africa. Water fowl of various species are also abundant on the lakes and rivers, as are likewise various species of owls, falcons, and vultures, the latter of which are highly useful in consuming the offal and carrion, which might otherwise taint the air and produce disease.

Among the smaller birds of Africa are many species remarkable for the gaudiness and brilliancy of their plumage, or the singularity of their manners and economy. Of the former kind may be mentioned the sunbirds, the lamprotornis, the bee-eaters, the rollers, the plantain-eaters, the parrots, the halcyons, and numerous smaller birds that swarm in the forests. Of the latter kind, it will be sufficient to mention the honey-cuckoo (*Cuculus indicator*).

Reptiles.

Though Africa is not exempt from the scourge of venomous or dangerous reptiles, still it has comparatively fewer than other tropical countries, owing to the dryness of the climate. Many of its rivers disappear in the hot season, and forests are scarce, and seldom extensive and large. The reptiles harboured by the desert regions consist chiefly of harmless lizards and serpents of a small size, though often venomous. The frog and tortoise tribes are represented in but few species and numbers.

The most important among the reptiles is the crocodile, which inhabits nearly all the large rivers and lakes within the tropics, and is still abundant in the Nile below the first cataract.

The chameleon is common in Africa. Among the venomous species of snakes are the purple naja, the cerastes or horned viper, the ringed naja, and the darting viper.

Fishes.

The edible fish are found almost everywhere in great variety and quantity. The fresh waters of Egypt produce the gigantic bishir, the coffres, and numerous species of the pimelodes. The greater number of the fish of the Red Sea resemble the saxatiles of the warm seas of Asia. On the west coasts are found the fish belonging to equatorial latitudes, while the shores of the Mediterranean produce those of France and Spain. The seas of the southern extremity possess the species common to the latitudes of the antarctic, south of the three great capes. The fish of the east coast are the same as those of the Indian Sea.

Insects.

Of the insect tribes, Africa also contains many thousand different kinds. The locust has been, from time immemorial, the proverbial scourge of the whole continent; scorpions, scarcely less to be dreaded than the noxious serpents, are everywhere abundant; and the zebub, or fly, one of the instruments employed by the Almighty to punish the Egyptians of old, is still the plague of the low and cultivated districts. In the interior of Africa, a venomous fly has recently been discovered, which is fatal to nearly all domestic animals. It is called tsetse (*Glossina morsitans*), and its size is almost that of the common blue fly which settles on meat; but the wings are larger. On the existence of this insect greatly depended the success of recent explorers in that quarter, as, where it occurred, their cattle infallibly fell victims to its bite. There are large tribes which cannot keep either cattle or sheep, because the tsetse abounds in their country. Its bite is not, however, dangerous to man; wild animals, likewise, are undisturbed by it. The termites or white ants are likewise a scourge to the country where they occur in great numbers. This destructive creature devours everything in the shape of wood, leather, cloth, &c. that falls in its way; and they march together in such swarms, that the devastation they commit is almost incredible.

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Zoophytes.

Of the class of zoophytes, the brilliant polypi of every variety, and madrepores, abound on the coasts of Africa. The shores of the Mediterranean produce the finest coral, and those of the Red Sea bristle with extensive reefs of the same mollusca.

Man.

From the shores of the Mediterranean to about the latitude of 20° north, the population of Africa consists largely of tribes not originally native to the soil, but of Arabs and Turks, planted by conquest, with a considerable number of Jews, the children of dispersion; and the recently introduced French. The Berbers of the Atlas region, the Tuaricks and Tibbus of the Sahara, and the Copts of Egypt, may be viewed as the descendants of the primitive stock, while those to whom the general name of Moors is applied, are perhaps of mixed descent, native and foreign. From the latitude stated, to the Cape colony, tribes commonly classed together under the title of the Ethiopic or negro family are found, though many depart very widely from the peculiar physiognomy of the negro, which is most apparent in the natives of the Guinea coast. In the Cape Colony, and on its borders, the Hottentots form a distinct variety in the population of Africa, most closely resembling the Mongolian races of Asia.

The Copts, or as they are correctly pronounced either Ckoobt or Ckibt, are considered to be the descendants of the ancient Egyptians. They do not now compose more than one-sixteenth part of the population of Egypt, their number not exceeding 150,000, about 10,000 of whom reside at Cairo. Conversions to the Mahometan faith, and intermarriages with the Moslems, have occasioned this decrease in their numbers; to which may be added the persecutions which they endured from their Arabic invaders and subsequent rulers. They were forced to adopt distinctions of dress, and they still wear a turban of a black or blue, or a grayish or light brown colour, in contradistinction to the red or white turban. In some parts of Upper Egypt, there are villages exclusively inhabited by the Copts. Their complexion is somewhat darker than that of the Arabs, their foreheads flat, and their hair of a soft and woolly character; their noses short, but not flat; mouths wide, and lips thick; the eyes large, and bent upwards in an angle like those of the Mongols; their cheek-bones high, and their beards thin. They are not an unmixed race, their ancestors in the earlier ages of Christianity having intermarried with Greeks, Nubians, and Abyssinians. With the exception of a small proportion, the Copts are Christians of the sect called Jacobites, Eutychians, Monophysites, and Monothelites, whose creed was condemned by the council of Chalcedon, A.D. 451. They are extremely bigoted, and bear a bitter hatred to all other Christians; they are of a sullen temper, extremely avaricious, great dissemblers, ignorant, and faithless. They frequently indulge in excessive drinking; but in their meals, their mode of eating, and the manner in which they pass their hours of leisure, which is chiefly in smoking their pipes and drinking coffee, they resemble the other inhabitants of the country. Most of the Copts in Cairo are employed as secretaries and accountants, or tradesmen; they are chiefly engaged in the government offices; and as mer-

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chants, goldsmiths, silversmiths, jewellers, architects, builders, and carpenters, they are generally considered more skilful than the Moslems. The Coptic language is now understood by few persons, and the Arabic being employed in its stead, it may be considered as a dead language.

Nubians.

The countries above Egypt are inhabited by two tribes of people resembling each other in physical characters, but of distinct language and origin. One is, perhaps, the aboriginal or native, the other a foreign tribe. Dr Prichard terms them Eastern Nubians, or Nubians of the Red Sea, and Nubians of the Nile, or Berberines. All these tribes are people of a red-brown complexion, their colour in some instances approaching to black, but still different from the ebony hue of the Eastern negroes. Their hair is often frizzled and thick, and is described to be even woolly; yet it is not precisely similar to the hair of the negroes of Guinea. The Eastern Nubians are tribes of roving people who inhabit the country between the Nile and the Red Sea; the northern division of this race are the Ababdeh, who reach northward in the eastern desert as far as Kosseir, and towards the parallel of Deir border on the Bishari. The Bishari reach thence towards the confines of Abyssinia. The latter are extremely savage and inhospitable; they are said to drink the warm blood of living animals: they are for the most part nomadic, and live on flesh and milk. They are described as a handsome people, with beautiful features, fine expressive eyes, of slender and elegant forms; their complexion is said to be a dark brown, or a dark chocolate colour. The Barâbra or Berberines are a people well known in Egypt, whither they resort as labourers from the higher country of the Nile. They inhabit the valley of that name from the southern limit of Egypt to Sennaar. They are a people distinct from the Arabs and all the surrounding nations. They live on the banks of the Nile; and wherever there is any soil, they plant date-trees, set up wheels for irrigation, and sow durra and some leguminous plants. At Cairo, whither many of this race resort, they are esteemed for their honesty. They profess Islam. The Barâbra are divided into three sections by their dialects, which are those of the Nuba, the Kenous, and the Dongolawi. According to Dr Prichard, it is probable that the Berberines may be an offset from the original stock which first peopled Egypt and Nubia.

Tibbus.

The country of the Nubians is limited on the west by that of the Tibbus, who are spread over the eastern portions of the Sahara, as far as Fezzan and Lake Tsad. Dr Latham considers it probable that their language belongs to the Nubian class. They inhabit the locality of the ancient Libyans or *Libyes*. Their colour is not uniform. In some it is quite black, but many have copper-coloured faces. They are slim and well made, have high cheek-bones, the nose sometimes flat like that of the negro, and sometimes aquiline. Their mouth is, in general, large, but their teeth fine. Their lips are frequently formed like those of Europeans, their eyes are expressive, and their hair, though curled, not woolly. The females are especially distinguished by a light and elegant form, and in their walk and erect manner of carrying themselves are very striking. Their feet and ankles are delicately formed, and not loaded with a mass of brass or iron, as is the practice in other countries of Northern Africa, but have merely a light anklet of polished silver or copper, sufficient to show their jetty skin to more advantage; and they also wear neat red slippers. The Tibbus are chiefly a pastoral people. They keep horses, cattle, sheep, and goats, but camels constitute their principal riches. The villages of the Tibbus are very regularly built in a square, with a space left on the north and south faces of the quadrangle for the use of the cattle. The huts are entirely of mats, which exclude the sun, yet admit both the light and the air. The interior of these habitations is singularly neat: clean wooden bowls for the preservation of milk, each with a cover of basket-work, are hung against their walls. They are greatly exposed to the predatory incursions into their country by the enemies who surround them. They carry on a considerable traffic in slaves between Sudan, Fezzan, and Tripoli.

The Berber group.

"All that is not Arabic in the kingdom of Marocco," says Dr Latham, "all that is not Arabic in the French provinces of Algeria, and all that is not Arabic in Tunis, Tripoli, and Fezzan, is Berber. The language, also, of the ancient Cyrenaica, indeed the whole country bordering the Mediterranean, between Tripoli and Egypt, is Berber. The extinct language of the Canary Isles was Berber; and, finally, the language of the Sahara is Berber. The Berber languages, in their present geographical localities, are essentially inland languages. As a general rule, the Arabic is the language for the whole of the sea-coast, from the Delta of the Nile to the Straits of Gibraltar, and from the Straits of Gibraltar to the mouth of the Senegal." The Berber nation is one of great antiquity, and, from the times of the earliest history, has been spread over the same extent of country as at present: the ancient Numidian and Mauritanian names of Sallust, and other writers, have a meaning in the Modern Berber. It has affinities with the Semitic languages. In the northern parts of Atlas, these people are called Berbers; in the southern tracts, they are the Shuluh, or Shelhas. In the hilly country belonging to Tunis, the Kabyles, in Mount Auress, the Showiah, and in the Desert the Tuarick,—all belong to the same group. The mountains of Atlas are said to be inhabited by more than twenty different tribes, carrying on perpetual warfare against each other. They are very poor, and make plundering excursions in quest of the means of supporting life. They are described as an athletic, strong-featured people, accustomed to hardships and fatigue. Their only covering is a woollen garment without sleeves, fastened round the waste by a belt.

The Shuluh, who are the mountaineers of the Northern Atlas, live in villages of houses made of stone and mud, with slate roofs, occasionally in tents, and even in caves. They are chiefly huntsmen, but cultivate the ground and rear bees. They are described as lively, intelligent, well-formed athletic men, not tall, without marked features, and with light complexions. The Kabyles, or Kabaily, of the Algerian and Tunisian territories, are the most industrious inhabitants of the Barbary States, and, besides tillage, work the mines contained in their mountains, and obtain lead, iron, and copper. They live in huts made of the branches of trees, and covered with clay, which resemble the *magalia* of the old Numidians, spread in little groups over the sides of the mountains, and preserve the grain, the legumes, and other fruits, which are the produce of their husbandry, in *mattoures*, or conical excavations in the ground. They are of middle stature; their complexion is brown, and sometimes nearly black.

The Tuarick are a people spread in various tribes through the greater portion of the Sahara. The expedition under Richardson, Barth, and Overweg, who traversed and explored a great portion of the Tuarick territories, has greatly added to our knowledge of these people. The following are the names and localities of the principal tribes:—

1. Tanelkum, located in Fezzan.
2. Azghers, { Ouraghen, family of Shafou, / Emanghasatan, „ of Hateetah, / Amana, „ of Jabour, } located at Ghat.
3. Aheethanaran, the tribe of Janet.
4. Hagar (Ahagar), pure Hagars and Maghatah. They occupy the tract between Ghat, Tuat, and Timbuktu.
5. Sagamaram, located on the route from Aisou to Tuat.

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6. Kailouees, including the Kailouees proper, the Kaltadak, and the Kalfadaï.

7. Kilgris, including the Kilgris proper, the Iteesan, and the Ashraf. These and the tribes under the preceding head inhabit the kingdom of Ahir.

8. Oulimad, tribes surrounding Timbuktu in great numbers. This, probably identical with the Sorghou, is the largest and most powerful tribe, while the Tanelkums are the smallest and weakest.

The various tribes are very different in their characters, but they are all fine men, tall, straight, and handsome. They exact a tribute from all the caravans traversing their country, which chiefly furnishes them with the means of subsistence. They are most abstemious, their food consisting principally of coarse brown bread, dates, olives, and water. Even on the heated desert, where the thermometer generally is from 90° to 120°, they are clothed from head to foot, and cover the face up to the eyes with a black or coloured handkerchief.

Moors. The Moors who inhabit large portions of the empire of Marocco, and are spread all along the Mediterranean coast, are a mixed race, grafted upon the ancient Mauritanian stock; whence their name. After the conquest of Africa by the Arabs, they became mixed with Arabs; and having conquered Spain in their turn, they intermarried with the natives of that country, whence, after a possession of seven centuries, they were driven back to Mauritania. They are a handsome race, having much more resemblance to Europeans and western Asiatics, than to Arabs or Berbers; although their language is Arabic, that is, the Mogrebin dialect, which differs considerably from the Arabic in Arabia, and even in Egypt. They are an intellectual people, and not altogether unlettered; but they are cruel, revengeful, and blood-thirsty, exhibiting but very few traces of that nobility of mind and delicacy of feeling and taste which graced their ancestors in Spain. The history of the throne of Marocco, of the dynastic revolutions at Algiers, Tunis, and Tripoli, is written with blood; and among the pirates who infested the Mediterranean they were the worst. Their religion is the Mahometan. They are temperate in their diet, and simple in their dress, except the richer classes in the principal towns, where the ladies literally cover themselves with silk, gold, and jewels, while the men indulge to excess their love of fine horses and splendid arms. They generally lead a settled life as merchants, mechanics, or agriculturists, but there are also many wandering tribes. They exhibit considerable skill and taste in dyeing, and in the manufacture of swords, saddlery, leathern-ware, gold and silver ornaments. At the Great Exhibition in London in 1851, the Moorish department contained several articles which were greatly admired. The Moors, along the coast of Marocco, still carry on piracy by means of armed boats.

Arabs. At two different periods, separated from each other by perhaps a thousand years, Africa was invaded by Arabic tribes which took a lasting possession of the districts they conquered, and whose descendants form no inconsiderable portion of the population of North and Central Africa, while their language has superseded all others as that of civilisation and religion. Of the first invasion, more has been said under the head *Abyssinians*. The second was that effected by the first successors of Mahomet, who conquered Egypt, and subsequently the whole north of Africa as far as the shores of the Atlantic, in the course of the first century of the Hegira, or the seventh of the Christian era. As regards language, Egypt is now an entirely Arabic country, although in many other respects the Fellahs are totally different from the peasants in Arabia. But there are also several tribes of true Arabic descent scattered about from the highlands of Abyssinia down over Nubia and Egypt, and westward over the central provinces of Kordofan, Darfur, Waday, and Bornu. Others wander in the Libyan deserts and the Great Sahara, as well as in the states of Tripoli, Tunis, and Algiers, leading a similar life with the Kabyles, but constituting a totally distinct race. Others, again, dwell in the empire of Marocco, among whom those along the shores of the Atlantic are notorious for their predatory habits and ferocious character. In many places Arabic adventurers have succeeded in subduing native tribes of every nationality, over which they rule as sovereign lords; and on the coast of Zanzibar resides an Arabic royal dynasty. Many of the smaller islands to the north of Madagascar are inhabited by Arabs, and traces of them have been discovered in Madagascar itself. The African Arabs are not all alike in features and colour of skin, the differences being attributable to some of them having intermarried with natives, while others preserved the purity of their blood.

Jews. The early settlements of the Jews in Egypt are facts universally known. Under the Ptolemies, large numbers of them settled at Alexandria and in Cyrenaica, and after the destruction of Jerusalem they rapidly spread over the whole of the Roman possessions in Africa; many also took refuge in Abyssinia. King Philip II. having driven them out of Spain, many thousands of families took refuge on the opposite coast of Africa. They are now numerous in all the larger towns in the north, where they carry on the occupation of merchants, brokers, &c., the trade with Europe being mostly in their hands. They live in a state of great degradation, except in Algiers, where the French restored them to freedom and independence. They have acquired much wealth, and, although compelled to hide their riches from the cupidity of their rulers, they lose no opportunity of showing them whenever they can do so without risk of being plundered, fear and vanity being characteristic features of their character. The Jewesses in Marocco and Algiers are of remarkable beauty.

Turks. Ever since the conquest of Egypt by Sultan Selim, and the establishment of Turkish pashalics in Tripoli, Tunis, and Algiers, Turks have settled in the north of Africa; and as they were the rulers of the country, whose numbers were always on the increase, on account of the incessant arrivals of Turkish soldiers and officials, the Turkish became, and still is, the language of the different governments. Properly speaking, however, they are not settled, but only encamped in Africa, and hardly deserve a place among the African nations.

Abyssinians. Not all the inhabitants of the country called Abyssinia are Abyssinians in ethnology; nor are the real Abyssinians all of the same origin, being a mixed race, to the formation of which several distinct nations have contributed. The primitive stock is of Ethiopian origin, but, as their language clearly shows, was at an early period mixed with a tribe of the Himyarites from the opposite coast of Arabia, who, in their turn, were ethnologically much more closely connected with the Hebrews than with the Joctanides, or the Arabs properly speaking. In the age of the Egyptian Ptolemies, and after the destruction of Jerusalem, Jews settled in Abyssinia in such numbers, that not only their religion spread among the inhabitants, but the Hebrew language became mixed with the Abyssinian as it then was. Hence the surprising analogy between the principal Abyssinian languages, viz., the Gheez in Tigré, and the Amharic in Amhara, with the Hebrew. The uninterrupted intercourse with Arabia, and the immigration of several Arabic tribes, also contributed towards the apparently Semitic aspect of the present Abyssinian language. A large portion of Abyssinia having been occupied by Galla and other tribes, we shall here only dwell on the original Abyssinians. They inhabit a large tract extending from the upper course of the Blue River, north as far as the Red Sea, and some isolated districts in the south

Africa.

and south-east. To the west of them are the Agau Abyssinians, a different tribe, whose idiom, however, is the common language of the lower classes in Tigré and Amhara also. Abyssinia was once a large and powerful kingdom, but the Galla having conquered the whole south of it, it gradually declined until the king or emperor became a mere shadow, in whose name several vassal princes exercise an unlimited power each in his own territory. Owing to their jealousy and mutual fears, war seldom ceases among the inhabitants. The Christian religion was introduced into Abyssinia in the first centuries after Christ; but whatever its condition might have been in former times, it now presents a degraded mixture of Christian dogmas and rites, Jewish observances, and heathenish superstition. Yet of Judaism, which was once so powerful, but feeble traces are extant, while the Mahometan religion is visibly on the increase. European missionaries have been and still are very active among them, but their efforts have been crowned only with partial success. The Abyssinians, the Gallas being excluded from that denomination, are a fine strong race, of a copper hue more or less dark, and altogether different from the Negroes, with whom, however, they have frequently been confounded because they were called a black people. Their noses are nearly straight, their eyes beautifully clear, yet languishing, and their hair is black and crisp, but not woolly. They are on the whole a barbarous people, addicted to the grossest sensual pleasures; and their priests, among whom marriage is customary, are little better than the common herd of the people. They live in huts, a large assemblage of which forms a so-called town, and although they possess some solid constructions of stone, such as churches and bridges, it appears that they were built by the Portuguese, the ruins at Axum and other places belonging to a much earlier period, when the country undoubtedly enjoyed a higher civilisation than at present. Owing to influence exercised upon them during the last thirty years by European missionaries and travellers, their conduct towards strangers is less rude than it used to be at the time of Bruce. It is a remarkable fact that, notwithstanding the low state of their religion, the Christians in Abyssinia are not allowed to keep slaves, although they may purchase them for the purpose of selling them again.

The Ethiopic race.

This extensive race comprehends by far the greater number of African nations, extending over the whole of Middle and South Africa, except its southernmost projection towards the Cape of Good Hope. A line drawn from the mouth of the Senegal in the west to Cape Jerdaffun in the east, forms its northern limits almost with geometrical accuracy, few Ethiopic tribes being found to the north of it. All the members of this race, however, are not Negroes. The latter are only one of its numerous offshoots, but between the receding forehead, the projecting cheek-bones, the thick lips of the Negro of Guinea, and the more straight configuration of the head of a Galla in Abyssinia, there are still many striking analogies; and modern philology having traced still greater analogies, denoting a common origin, among the only apparently disconnected languages of so many thousands of tribes, whose colour presents all the hues between the deepest black and the yellow brown, it is no longer doubtful that the Negro, the Galla, the Somali and the Kaffre, all belong to the same ethnological stock. Owing to our most imperfect knowledge of the central parts inhabited by that race, a classification of all its numerous members must always remain imperfect, a circumstance which cannot fail to give interest to the following scientific classification of the Negro tribes according to their various languages.[1]

I. *North-west Atlantic Languages.* 1st Group.—Fulup, Filham. 2d.—Bola, Sarar, Pepel. 3d.—Biafada, Padsade. 4th.—Baga, Timne, Bulom, Mampua, Kisi.

II. *North-west High Sudan or Mandengo Languages.* 1st.—Mande or Mandengo dialects. 2d.—Bambara. 3d. Kono. 4th.—Vei. 5th.—Soso. 6th.—Tene. 7th.—Gbandi. 8th.—Landoro. 9th.—Mande. 10th.—Gbese. 11th.—Toma. 12th.—Mano. 13th.—Gio.

III. *Upper Guinea Languages.* A. *Liberian or Kru* (Kroo). 1st.—Dewoi or De. 2d.—Basa. 3.—Kra or Kru. 4th.—Krebo. 5th.—Gbe.

B. *Dahomean or Slave Coast.* 1st.—Adampe. 2d.—Anfue. 3d.—Hwida. 4th.—Dahome. 5th.—Mahi.

C. *Aku-Igalu.* 1st Group.—Aku proper, Ota, Egba, Idsesa, Yoruba, Yagba, Ki or Eki, Dsumu, Oworo, Dsebu, Ife, Ondo or Doko, Dsekiri. 2d.—Igala dialects.

IV. *North-east High Sudan Languages.* 1st Group.—Mose or Gurmaka or Bembe, Dselana, Guren, Gurma. 2d.—Legba, Kaure, Kiamba or Dsamba or Tem. 3d.—Koama, Bagbalan. 4th.—Kasem, Yula.

V. *Niger-Delta Languages.* 1st Group or Ibo dialects.—Isoama, Isiele, Abadsa, Aro, Mbofia. 2d.—Sobo, Egbele, Bini, Ihewe or Isewe, Oloma. 3d.—Okuloma, Udso.

VI. *Niger-Chadda or Nupe Languages.* Nupe, Kupa, Esitako, Musu, Goali, Basa, Ebe, Opanda, Egbira Hima.

VII. *Central African Languages.* 1st Group of Languages.—Buduma, Bornu dialects. 2d.—Pika, Karekare. 3d.—Bode dialects.

*South African Languages*—distinguished by an initial inflection.

VIII. *Atam Languages.* 1st Group.—Ekamtulufu, Udom, Mbofon, Eafen. 2d.—Basa, Kamuku.

IX. *Moko Languages.* 1st.—Isuwu, Diwala, Orungu, Bayon, Kum or Bakum, Bagba, Balu, Mom or Bamom, Ngoala, Momenya or Bamenya, Papiah, Param. 2d.—Ngotan, Melon, Nhalemoe, Seke.

X. *Kongo-Ngola Languages* (in Kongo, Angola, and further inland). 1st Group. Kabenda, Mimboma, Ntere or Nteke or Betera, Mutsaya, Musentandu or Besentandu, Mbamba, Kanyika. 2d.—Babuma, Bumbete, Kasands, Nyombe, Sunde. 3d.—Ngola (Angola), Pangela (Benguela), Lubalo, Ruunda or Luonda or Muola, Songo, Kisama.

XI. *South-east Languages.* Muntu or Adsawa, Kiriman, Marawi, Meto, Matatan, Nyamban.

XII. *Unclassified and isolated Languages.* A. *In North-western Sudan.* Wolof or Yolof, Gadsaga, Bidsogo, Gura, all distinguished by final inflection; and Banyun, Nalu, Bulanda, Limba and Landoma, distinguished by initial inflection.

B. *In High Sudan.* Asante, Barba, Boko.

C. *In Central Africa.* Kandin, Timbuktu, Baghermi, Houssa, Pulo dialects.

D. *In the delta of the Niger.* Yala.

E. *In South Africa.* Anan, Dsuka, Dsarawa, Koro, Ham, Akurakura, Okam, Yasgua, Nki, Kambali, Alege, Penin, Bute, Murundo, Undaza, Ndob, Nkele, Konguan, Mbarike, Tiwi, Abadsa, Boritsu, Afudu, Mfut, Mbe, Nso.

These divisions, however, are merely linguistic. The principal Negro nations, as we know them, are the *Mandingoes*, who are numerous, powerful, and not uncivilised, in Senegambia, and farther inland, around the head waters of the Kawara, where they have established a great number of kingdoms and smaller sovereignties. The inland trade is chiefly in their hands. They are black, with a mixture of yellow, and their hair is completely woolly. The *Wolofs* or *Yolofs*, whose language is totally different from those of

[1] Extracted from a MS. of the Rev. Mr Koelle of the Church Missionary Society, on the Negro Languages, which the author, who has just returned from his labours at Sierra Leone, kindly allowed the writer to avail himself of for the *Encyclopædia Britannica*.

Africa. their neighbours, are the handsomest and blackest of all Negroes, although they live at a greater distance from the equator than most of the other black tribes, their principal dwelling-places being between the Senegal and the Gambia along the coast of the Atlantic. They are a mild and social people. The *Foulahs* or *Fellatahs* occupy the central parts of Sudan, situated in the crescent formed by the course of the Kawara, and also large tracts to the south-east as far as the equator west to the Senegal, and east till beyond Lake Tsad. Their colour is black, with a striking copper hue, some of them being hardly more dark than gipsies. They are one of the most remarkable nations in Africa, very industrious, live in commodious and clean habitations, and are mostly Mahometans. A distinction was formerly made between the Foulahs of Senegambia and the Fellatahs of Central Africa, but it has since been ascertained that they belong to the same stock, and speak the same language. The hair of the Foulahs is much less woolly than that of other Negroes. Of the principal nations in Guinea, among whom the true Negro type is particularly distinct, especially around the Bight of Benin, are the Feloops, near the Casamanca, very black, yet handsome; and the Ashanti, of the Amina race, who surpass all their neighbours in civilisation, and the cast of whose features differs so much from the Negro type that they are said to be more like Indians than Africans; although this is perhaps only true of the higher orders. They are still in possession of a powerful kingdom. The country behind the Slave Coast is occupied by tribes akin to the Dahomeh on the coast. In South Guinea we meet three principal races, namely, the Congo, the Abunda, and the Benguela Negroes, who are divided into a variety of smaller tribes, with whom we are much less acquainted than with the northern Negroes, although the Portuguese have occupied this coast for upwards of three centuries. The next great branch of the Ethiopic race comprehends the Galla, who occupy an immense tract in Eastern Africa from Abyssinia as far as the inland portions of the Portuguese possessions in Mozambique to the south of the equator. Our knowledge of them is chiefly confined to those Gallas who conquered Abyssinia. With regard to their physical conformation, they stand between the Negro of Guinea and the Arab and Berber. Their countenances are rounder than those of the Arabs, their noses are almost straight, and their hair, though strongly frizzled, is not so woolly as that of the Negro, nor are their lips quite so thick. Their eyes are small (in which they again differ from the Abyssinians), deeply set, but very lively. They are a strong, large, almost bulky people, whose colour varies between black and brownish, some of their women being remarkably fair, considering the race they belong to.

Galla.

Somali. An interesting tribe of them has lately been brought to the knowledge of Europeans, the Somali, a widely-scattered nation which leads a pastoral life on the uplands, and also nearer to the coast of the Indian Ocean from Cape Jerdaffun southward for a considerable distance. They seem to be of a mild and peaceful disposition, while on the contrary the other Galla are a warlike race, which has been pressing upon its neighbours during the last three hundred years, and are much feared by all those who are obliged to come near them.

Kaffres. The Kaffres, who, together with the tribes most akin to them, occupy the greater portion of South Africa, especially the eastern portions, have some analogy with Europeans in their features; but they are woolly haired, and while some are almost black, others are comparatively fair, although some of their tribes might have been mixed with the Eastern Negroes. They have been very wrongly classed with the Negroes. They are a strong, muscular, active people, addicted to plunder and warfare. The Eastern Kaffres, among whom the Amakosah and Amazulah are best known to us on account of their frequent invasions of the Cape Colony, are much more savage than the western and northern, or the Bechuana and Sichuana tribes. All Kaffres are pastoral, keeping large herds of cattle, but the last-named tribes inhabit large towns, well-built houses, cultivate the ground carefully, and exhibit every appearance of being capable of entire civilisation. The word Kaffre or Kafir, as it ought to be written, is Arabic, and was first applied by the Europeans to the inhabitants of the coast of Mozambique, because they were so called by the Mahometans, in whose eyes they were *Kafirs*, that is infidels. Africa.

Hottentots. We conclude this sketch with the Hottentot race, which is entirely different from all the other races of Africa. Where they originally came from, and how they happened to be hemmed in and confined entirely to this remote corner of the earth, is a problem not likely to be ever satisfactorily solved. The only people to whom the Hottentot has been thought to bear a resemblance, are the Chinese or Malays, or their original stock the Mongols. Like these people, they have the broad forehead, the high cheek-bones, the oblique eye, the thin beard, and the dull yellow tint of complexion, resembling the colour of a dried tobacco leaf; but there is a difference with regard to the hair, which grows in small tufts, harsh, and rather wiry, covering the scalp somewhat like the hard pellets of a shoe-brush. The women, too, have a peculiarity in their physical conformation, which, though occasionally to be met with in other nations, is not universal, as among the Hottentots. Their constitutional "bustles" sometimes grow to three times the size of those artificial stuffings, with which our fashionable ladies have disfigured themselves. Even the females of the diminutive Bosjesmen Hottentots, who frequently perish of hunger in the barren mountains, and are reduced to skeletons, have the same protuberances as the Hottentots of the plains. It is not known even whence the name of Hottentot proceeds, as it is none of their own. It has been conjectured that *hot* and *tot* frequently occurring in their singular language, in which the monosyllables are enunciated with a palatic clacking with the tongue, like that of a hen, may have given rise to the name, and that the early Dutch settlers named them *hot-en-tot*. They call themselves *qui-quæ*, pronounced with a clack. They are a lively, cheerful, good-humoured people, and by no means wanting in intellect; but they have met with nothing but harsh treatment since their first connection with Europeans. Neither Bartholomew Diaz, who first discovered, nor Vasco de Gama, who first doubled, the Cape of Good Hope, nor any of the subsequent Portuguese navigators, down to 1509, had much communication with the natives of this southern angle of Africa; but in the year above mentioned, Francisco d'Almeyda, viceroy of India, having landed on his return, at Saldanha (now Table) Bay, was killed, with about twenty of his people, in a scuffle with the natives. To avenge his death, a Portuguese captain, about three years afterwards, is said to have landed a piece of ordnance loaded with grape shot, as a pretended present to the Hottentots. Two ropes were attached to this fatal engine; the Hottentots poured down in swarms. Men, women, and children flocked round the deadly machine, as the Trojans did round the wooden horse, "*funemque manu contingere gaudent.*" The brutal Portuguese fired off the piece, and viewed with savage delight the mangled carcasses of the deluded people. The Dutch effected their ruin by gratifying their propensity for brandy and tobacco, at the expense of their herds of cattle, on which they subsisted. Under the British sway they have received protection, and shown themselves not unworthy of it. They now possess property, and enjoy it in security. One of the most beautiful villages, and the neatest and best-cultivated gardens, Africa. belong to a large community of Hottentots, under the instruction and guidance of a few Moravian missionaries.

Bushmen. These forlorn people are of Hottentot origin. Of them also several tribes have been discovered much farther north, and intelligence has lately reached Europe, that between the Portuguese possessions, in the very centre of South Africa, there is a nation of dwarfish appearance who possess large herds, and who seem to belong to the original Bushmen stock.

Malays. The island of Madagascar is inhabited by a race of Malay origin, exhibiting traces of Negro and Arabic mixture.

Population The total population of Africa is vaguely estimated, according to the most recent researches, at 100,000,000.

Occupation Strictly nomadic habits are not extensively prevalent. The great majority of the native tribes are distributed in towns or villages, occupy permanent dwellings and cling to their rude habitations with home attachment; while even the wild tenants of the desert, who roam far and wide in search of plunder, have selected oases, or watered valleys, as the sites of permanent abode. Except in the immediate neighbourhood of the Mediterranean, and of European settlements, society has remained in a barbarian state.

*Agriculture* is conducted with little art. The natural fertility of the soil in the well-watered districts supersedes the need of skill, while the production of the simplest manufactures is alone requisite, where the range of personal wants embraces few objects, and those of the humblest class.

*Wars*, cruel and incessant, waged not for the sake of territory, but for the capture of slaves, form one of the most marked and deplorable features in the social condition of the African races. This practice, though not of foreign introduction, has been largely promoted by the cupidity of the Europeans and transatlantic nations; and, unhappily, the efforts of private philanthropy, and the political arrangements of various governments, have not availed to terminate the hideous traffic in mankind, or abate the suffering entailed upon its victims.

Religion. In *Religion*, Christianity is professed in Abyssinia, and in Egypt by the Copts, but its doctrines and precepts are little understood and obeyed. Mahometanism prevails in all the northern countries; but the native mind, generally, is surrendered to superstitions of indefinite number and character. The labours of Christian missionaries have, however, done much, especially in South Africa, towards turning the benighted Africans from idols to the living God.

Political Divisions. In describing the political divisions of Africa, we shall proceed from north to south.

Northern Africa; Barbary. The country included under the general name of Barbary extends from the borders of Egypt on the east, to the Atlantic on the west, and is bounded by the Mediterranean on the north, and by the Sahara on the south. It comprises the states of Marocco, Algeria, Tunis, and Tripoli.

Marocco. Marocco, the most westerly state of Barbary, is thus named by the Europeans, but by the Arabs themselves Mogr'-eb-el-Aksa, or "the extreme west." The eastern boundary was determined in the treaty with the French of 18th March 1845, by a line which, in the south, commences east of the oasis Figueg, intersecting the desert of Angad, and reaching the Mediterranean at a point about 30 miles west of the Franch port Nemours. It comprehends an area of about 170,000 geographical square miles, and a population of 8,500,000. But for some time the power of the government of Marocco has been diminishing, and at present the greater portion of the empire may be said to be independent, particularly that to the south of the Atlas chain. See Marocco.

Algeria extends from Marocco in the west, to Tunis in the east, and closely answers in its limits to the ancient kingdom of Numidia. The eastern and southern boundaries are not very definite, falling, as they do, within the boundless plains of the desert. The area is estimated at 100,000 square miles, the population at 3,000,000. See Algiers. Africa.

Tunis is the smallest of the Barbary states. The area may be estimated at 40,000 square miles, and the population between 2,000,000 and 3,000,000. Tunis.

The configuration of the surface is similar to that of Algeria, the northern part being mountainous, the southern and eastern consisting of lowlands and plains. The highest peaks range between 4000 and 5000 feet. The southern plains comprise the land of dates (Belad-el-Jerid), and several extensive salt lakes. Tunis possesses but few rivers and streams, and springs are plentiful only in the mountainous regions.

The climate is, upon the whole, salubrious, and is not of the same excessive character as that of Algeria; regular sea-breezes exercise an ameliorating influence both in summer and winter; frost is almost unknown, and snow never falls. During summer occasional winds from the south render the atmosphere exceedingly dry and hot.

The natural productions of the country are somewhat similar to those of the other Barbary states, but dates of the finest quality are more largely produced. The horses and camels are of excellent breed, and the former are eagerly sought for the French army in Algeria. Bees are reared in great quantity, and coral fisheries are carried on, especially at Tabarka. Of minerals, lead, salt, and saltpetre, are the most noticeable.

The population consists chiefly of Moors and Arabs: the former have attained a higher degree of industry and civilisation than their brethren elsewhere; those of the latter who inhabit the central mountainous regions are nearly independent.

The government is vested in a hereditary bey, and has been conducted in peace and security for a number of years. The present ruler, Bey Mushir Pasha, abolished the slave trade in 1842, and has otherwise endeavoured to govern the country on an enlightened system.

The commerce of Tunis is considerable, but agriculture is in a backward state. The exports consist chiefly of wool, olive-oil, wax, honey, hides, dates, grain, coral, &c.

The principal town is Tunis, situated on a shallow lake on the north coast. It is the most important commercial place on the southern shores of the Mediterranean after Alexandria, and has a population of about 100,000. The site of the ancient Carthage is thirteen miles from Tunis in the direction of Cape Bon.

Tripoli, a Turkish province, extends from Tunis to Egypt, along the shores of the Mediterranean. Politically, it includes the pashalics of Fezzan and Ghadamis, countries which, in a physical point of view, are included in the Sahara. The area is estimated at 200,000 square miles, and the population at 1,500,000. Tripoli.

Tripoli is the least favoured by nature of the Barbary states, possessing a great extent of sterile surface. Mr Richardson graphically describes the physiognomy of the country between the towns of Tripoli and Murzuk in eight zones: 1, the plain along the sea-shore, with the date-palm plantations and the sandhills; 2, the Gharian mountains, with their olive and fig plantations, more favoured with rains than the other regions; 3, the limestone hills and broad valleys between the town of Kalubah and Ghareeah, gradually assuming the aridity of the Sahara as you proceed southward; 4, the Hamadah, an immense desert plateau, separating Tripoli from Fezzan; 5, the sandy valleys and limestone rocks between El-Hessi and Es-Shaty, where herbage and trees are found; 6, the sand between Shiaty and El-Wady, piled in masses or heaps, and extending in undulating plains; 7, the sandy valleys of El-Wady, covered with forests of date-palms; 8, the plateau of Murzuk, consisting of shallow valleys, ridges of low sandstone hills, and naked plains. These

Africa.

zones extend parallel with the Mediterranean shores through the greater portion of the country. Mount Tekut, almost due south of Tripoli, 2800 feet high, is supposed to be the culminating point of the regency. Rivers exist only periodically, and springs are exceedingly scarce.

The climate is somewhat more excessive than that of Tunis, especially in the interior, where extreme heat is followed by a considerable degree of cold. As far south as Sokna, snow occasionally falls. The climate of Murzuk is very unhealthy, and frequently fatal to Europeans.

The natural products are very much like those of Tunis. Oxen and horses are small, but of good quality; the mules are of excellent breed. Locusts and scorpions are among the most noxious animals. Salt and sulphur are the chief minerals.

The population is very thin. Arabs are the prominent race, besides which are Turks, Berbers, Jews, Tibbus, and Negroes. The country is governed by a pasha, subject to the Ottoman empire. The military force by which the Turks hold possession of this vast but thinly-peopled territory amounts only to 632 men.

The commerce is not inconsiderable, and the inhabitants of Tripoli trade with almost every part of the Sahara, as well as the Sudan. At Murzuk there is a large annual market, which lasts from October to January. The exports of Tripoli are gum-arabic, wool, senna, hides, and dates.

Tripoli is the capital of the regency, and the largest town; it lies on the Mediterranean, surrounded by a fertile plain; the number of inhabitants is from 15,000 to 20,000. Bengazi is the second important town on the coast, and has about 10,000 inhabitants. Murzuk, the capital of Fezzan, has a mixed population of only 2000 souls, that of the whole pashalic being 26,000. The town of Ghadamis has about 1000 inhabitants.

North-western or Nilotic countries; Egypt.

Egypt occupies the north-eastern corner of Africa, and comprises about 100,000 square miles with 2,000,000 inhabitants. It is remarkable for its ancient and sacred associations, and its wonderful monuments of human art.

Egypt is a vast desert, the cultivable and fertile portions being confined to the Delta of the Nile and its narrow valley, a region celebrated in the most ancient historic documents for its singular fertility, and still pouring an annual surplus of grain into the markets of Europe. By the annual inundation of the Nile this region is laid under water, and upon its retirement the grain crops are sown in the layer of mud left behind it. Barren ranges of hills and elevated tracts occupy the land on both sides of the Nile, which is the only river of the country. The amount of its rise is a matter of extreme solicitude to the people, for should it pass its customary bounds a few feet, cattle are drowned, houses are swept away, and immense injury ensues; a falling short of the ordinary height, on the other hand, causes dearth and famine, according to its extent. The water of the Nile is renowned for its agreeable taste and wholesome quality. In connection with the Nile is the Birket-el-Kerun, a salt lake.

The climate is very hot and dry. Rain falls but seldom along the coasts, but the dews are very copious. The hot and oppressive winds called khamsin and simooms are a frequent scourge to the country; but the climate is, upon the whole, more salubrious than that of many other tropical countries.

The natural products are not of great variety. The wild plants are but few and scanty, while those cultivated include all the more important kinds adapted to tropical countries: rice, wheat, sugar, cotton, indigo, are cultivated for export; dates, figs, pomegranates, lemons, and olives, are likewise grown. The doum-palm, which appears in Upper Egypt, is characteristic, as also the papyrus. The fauna is characterised by an immense number of waterfowl, flamingoes, pelicans, &c. The hippopotamus and crocodile, the two primeval inhabitants of the Nile, seem to be banished from the Delta, the latter being still sometimes seen in Upper Egypt. The cattle are of excellent breed. Large beasts of prey are wanting; but the ichneumon of the ancients still exists. Bees, silkworms, and corals are noticeable. Minerals are scarce, natron, salt, and sulphur being the principal.

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Since the last century the inhabitants, then amounting to four millions, have considerably diminished in number. In 1840 their total number was calculated at 2,895,500. The native Egyptians of Arab descent amounted to 2,600,000 souls, composing the great bulk of the people. Next in number, though comparatively few (150,000) are the Copts, descended from the old inhabitants of the country, the ancient Egyptians, but far from being an unmixed race. The Arabic Bedouin tribes were calculated in 1840 at 70,000, the Negroes at 20,000, the European Christians at 9500, the Jews at 7000, and the dominant Turks at only 12,000.

Egypt is formally a Turkish pashalic, but the hereditary pasha, by whom the government is conducted, and whose authority is absolute, is practically an independent prince. The government of Nubia and Kordofan is also conducted by the Pasha of Egypt.

The agriculture of Egypt has always been considerable; there being three harvests in the year. The industry is limited: one peculiar branch is the artificial hatching of eggs in ovens heated to the requisite temperature, a process which has been handed down from antiquity, and is now chiefly carried on by the Copts. Floating bee-hives are also peculiar to the Nile. The commerce is extensive and important: the exports to Europe consist chiefly of cotton, flax, indigo, gum-arabic, ostrich-feathers, ivory, senna, and gold.

Egypt is divided into three sub-pashalics; Bahari or Lower Egypt, Vostani or Middle Egypt, and Said or Upper Egypt. Cairo, on the east bank of the Nile, is the capital of Egypt, and is the largest town of Africa, containing about 300,000 inhabitants in 30,000 houses: it has 400 mosques, and upwards of 130 minarets, some of them of rich and graceful architecture, presenting at a distance an appearance singularly imposing. Alexandria, on the coast, is the emporium of the commerce with Europe, and has 60,000 inhabitants, among whom are 12,000 Europeans. Suez, on the northern extremity of the Red Sea, is a small, ill-built town, but has assumed importance as a good port since the establishment of the overland route to India.

Nubia.

Nubia extends along the Red Sea, from Egypt to Abyssinia, comprising the middle course of the Nile. The total population amounts to 1,000,000 at the least.

The natural features of this country are varied; the northern portion consisting of a burning sterile wilderness, while the southern, lying within the range of the tropical rains, and watered by the Abyssinian affluents of the Nile, exhibits vegetation in its tropical glory, forests of arborescent grasses, timber-trees, and parasitical plants largely clothing the country. This latter territory, which may be called Upper Nubia, includes the region of ancient Meroe, situated in the peninsula formed by the Nile proper, the Blue River, and the Atbara, and comprises, further south, the recently extinguished modern kingdom of Sennaar.

Nubia forms the link between the plain of Egypt and the high table-lands of Abyssinia; its general physical character is that of a slightly ascending region. The lowest parts in Upper Nubia scarcely exceed an altitude of 1500 feet; Khartum, at the confluence of the Blue and White Rivers, being 1525 feet above the level of the sea. A chain of mountains and elevated land rises abruptly along the shores of the Red Sea, gradually sloping down to the valley of the Nile; the intermediate region being intersected by smaller ranges, groups of hills, and numerous wadies filled with sand. Jebel Olba, a prominent summit of that range, is upwards of 7000

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feet high. The spurs of the Abyssinian table-land, extending within the southern confines of Nubia, reach a height of 3000 feet; Mount Akaro, in Tasokl, being 3300 feet high. Besides the Nile, the country is watered by two other large rivers, its tributaries, the Bahr-el-Azrek, or Blue River, and the Atbara or Takkazie, both being much alike in magnitude, and having their head-streams on the Abyssinian table-land.

The climate of Nubia is tropical throughout, and the heat in the deserts of its central portions is not exceeded by that of any other part of the globe. The southern half of the country is within the influence of the tropical rains, the northern partakes the character of the almost rainless Sahara; and while the latter is generally very salubrious, the former is a land of dangerous fevers, particularly in the plains subject to inundations. Such is the Kolla, a marshy and swampy region of great extent, situated along the foot of the Abyssinian Mountains, between the Blue River and the Takkazie.

The northern region is poor in natural productions, but in the south the vegetation is most luxuriant; palms form a prominent feature, and the monkey bread-tree attains its most colossal dimensions. The date-tree, dourra, cotton, and indigo, are cultivated. The date-palm does not extend beyond the south of Abou-Egli, in Lat. 18. 36.

The elephant is native to this region, and is seen in herds of several hundreds; also the rhinoceros, lion, and giraffe. The waters are inhabited by crocodiles more ferocious than those of Egypt, and by huge hippopotami. The young hippopotamus brought to the zoological gardens, Regent's Park, in 1850, was captured in Nubia, in an island of the Nile, about 1800 miles above Cairo: no living specimen had been seen in Europe since the period when they were exhibited by the third Gordian in the Colosseum at Rome. Monkeys and antelopes are found in great numbers. The camel does not extend beyond the twelfth degree of latitude to the south. Ostriches roam over the deserts; and among the reptiles, besides the crocodile, are large serpents of the python species, and tortoises. Of the numerous insects, the most remarkable is the scarabaeus of the ancient Egyptians, still found in Sennaar. Of minerals. Nubia possesses gold, silver, copper, iron, salt.

In the inhabitants two principal varieties are recognised, the pure original population, and their descendants mixed with other nations. The Berberines, amounting to upwards of 100,000, inhabit the northern part, and the Bisharis, to about 200,000, the desert regions; the latter are the genuine Nubians, finely moulded and dark complexioned, supposed by some to agree more closely with the ancient Egyptians than the Copts, usually deemed their representatives. In the south-eastern part, the true negro element appears.

Nubia, now a province under the pashalic of Egypt, consisted formerly of a number of small and independent kingdoms. The Turkish conquest lasted from 1813 to 1822: in the latter years it was invaded and mercilessly ravaged by the army of Mahomet Ali, under his second son Ismayl, whose dreadful atrocities entailed a fearful fate upon himself, having been surprised when attending a nocturnal banquet at some distance from his camp, and burned to death.

The country is favourable for agriculture, which, however, is only carried on to a limited extent, by the women. Cattle are abundant, and the camels of the Bisharin and Ababde are famous for their enduring powers. Commerce has diminished through the oppressive policy of Mahomet Ali. Salt is largely exported from the shores of the Red Sea to India, and ivory, with other products of tropical Africa, forms a principal article of trade.

Khartum, the capital of Nubia, the headquarters of the Egyptian government, and the chief seat of commerce, contains 20,000 inhabitants. It is a newly-created town, having been founded in 1821, and lies in a dry, flat, and unhealthy country.

Kordofan.

Kordofan, on the western side of Nubia, lies between the parallels of 12° and 16°, and between the meridians 29° and 32°, containing about 30,000 square miles. It is a flat country interspersed with a few hills, presenting in the dry season a desert with little appearance of vegetation, and in the rainy season a prairie, covered with luxuriant grass and other plants. The general elevation of the country is 2000 feet, and some of the hills attain a height of 3000. The altitude of El Obeid is 2150 feet. There are no permanent rivers in the country, and the natural products are similar to those of the adjoining regions of Nubia.

The population consists of Negroes. This country was, simultaneously with Nubia, made tributary to Egypt. The commerce consists of gum-arabic, ivory, and gold, and is not inconsiderable. El Obeid, the chief town, is composed of several villages of mud-built houses thatched with straw, containing about 20,000 inhabitants.

Abyssinia.

The boundaries of Abyssinia are somewhat uncertain; but, confining it to the provinces actually under the government of Christian or Mahometan princes, it may be described as extending from about 9° to 16° north Latitude, and from 35° to 41° east Longitude, and as having a superficial area of about 150,000 square miles. The population has been estimated at from 4,000,000 to 5,000,000, which is probably too high. See ABYSSINIA.

Saharan countries.

The Saharan countries extend from the Atlantic in the west, to the Nilotic countries in the east, from the Barbary States in the north, to the basins of the Rivers Senegal and Kawara, and Lake Tsad in the south. The area of this large space amounts to at least 2,000,000 square miles, or upwards of one-half of that of the whole of Europe. It is very scantily populated, but from our present defective knowledge of that region, the number of its inhabitants cannot even be estimated.

The physical configuration of the Sahara has already been indicated in the general introductory remarks of this article. Notwithstanding the proverbial heat, which is almost insupportable by day, there is often great cold at night, owing to the excessive radiation, promoted by the purity of the sky. Rain is nearly, though not entirely absent, in this desolate region. It appears that when nature has poured her bounty over the adjoining regions in the south, and has little more left to bestow, she sends a few smart showers of rain to the desert, parched by the long prevalence of the perpendicular rays of the sun. The prevailing winds blow during three months from the west, and nine months from the east. When the wind increases into a storm, it frequently raises the loose sand in such quantities that a layer of nearly equal portions of sand and air, and rising about 20 feet above the surface of the ground, divides the purer atmosphere from the solid earth. This sand, when agitated by whirlwinds, sometimes overwhelms caravans with destruction, and, even when not fatal, involves them in the greatest confusion and danger.

The natural products correspond with the physical features of the country. Vegetation and animal life exist only sparingly in the oases or valleys where springs occur, and where the soil is not utterly unfit to nourish certain plants. Amongst the few trees, the most important is the date-palm, which is peculiarly suited to the dryness of the climate. This useful tree flourishes best in the eastern part of the desert, inhabited by the Tibbus. The doum-palm is likewise a native of the same part, and seems entirely absent in the western Sahara: its northernmost limit is on the southern borders of Fezzan and Tegerry, in Lat. 24. 4. N. Acacias are found in the extreme west towards Senegambia, furnishing the so-called gum-arabic. In many parts of the desert, a thorny evergreen plant occurs, about

18 inches high. It is eagerly eaten by the camels, and is almost the only plant which supplies them with food while thus traversing the desert. The cultivation of grains to a small extent is limited to the western oases of Tuat and others, a little barley, rice, beans, and gussub, being there grown. In the kingdom of Aïr, there are some fields of maize and other grains; but upon the whole, the population depend for these products on Sudan and other regions. There are but a few specimens of wild animals in these wildernesses; lions and panthers are found only on its borders. Gazelles and antelopes are abundant, hares and foxes but scarce. Ostriches are very numerous, and vultures and ravens are also met with. In approaching Sudan, animal and vegetable life becomes more varied and abundant. Of reptiles only the smaller kinds are found, mostly harmless lizards and a few species of snakes. Of domestic animals, the most important is the camel, but horses and goats are not wanting, and in the country of the Tuaricks an excellent breed of sheep is found, while in that of the Tibbus a large and fine variety of the ass is valuable to the inhabitants. Of minerals, salt is the chief production, which occurs chiefly near Bilma.

The habitable portions of the Sahara are possessed by three different nations. In the extreme western portion are Moors and Arabs. They live in tents, which they remove from one place to another; and their residences consist of similar encampments, formed of from twenty to a hundred of such tents, where they are governed by a sheik of their own body; each encampment constituting, as it were, a particular tribe. They are a daring set of people, and not restrained by any scruple in plundering, ill-treating, and even killing persons who are not of their own faith; but to such as are, they are hospitable and benevolent. The boldest of these children of the desert are the Tuaricks, who occupy the middle of the wilderness, where it is widest. The form of their bodies, and their language, prove that they belong to the aboriginal inhabitants of Northern Africa, who are known by the name of Berbers. They are a fine race of men, tall, straight, and handsome, with an air of independence which is very imposing. They live chiefly upon the tribute they exact from all caravans traversing their country. They render themselves formidable to all their neighbours, with whom they are nearly always in a state of enmity, making predatory incursions into the neighbouring countries. The third division of Saharan people are the Tibbus, who inhabit the eastern portion, comprising one of the best parts of the desert. In some of their features they resemble the Negroes. They are an agricultural and pastoral nation, live mostly in fixed abodes, and are in this respect greatly different from their western neighbours. Their country is as yet little explored by Europeans. The Tibbus are in part Pagans, while the other inhabitants of the Sahara are Mahometans.

The commerce of the Sahara consists chiefly of gold, slaves, ivory, iron, and salt.

Western Africa.

Western Africa comprehends the west coast of Africa, from the borders of the Sahara, in about Lat. 17. north to Nourse River, in about the same latitude south, with a considerable space of inland territory, varying in its extent from the shores, and, in fact, completely undefined in its interior limits.

Senegambia.

Senegambia, the country of the Senegal and Gambia, extends from the Sahara in the north to Lat. 10. in the south, and may be considered as extending inland to the sources of the waters which flow through it to the Atlantic.

The western portion is very flat, and its contiguity to the great desert is frequently evidenced by dry hot winds, an atmosphere loaded with fine sand, and clouds of locusts. The eastern portion is occupied with hills and elevated land. Under the 10th parallel the hills approach quite close to the coast. There the Sangari Mountains attain an elevation of from 4000 to 5000 feet. The country possesses a great number of rivers, among which the Senegal, Gambia, and Rio Grande are the most important. Senegambia ranges, in point of heat, with the Sahara and Nubia. The atmosphere is most oppressive in the rainy season, which lasts from June to November, when an enormous amount of rain drenches the country. The prevailing winds in that period are southwest, whereas in the dry season they are from the east. The climate is, upon the whole, most unhealthy, and too generally proves fatal to Europeans.

The vegetation is most luxuriant and vigorous. The baobab (monkey bread-tree), the most enormous tree on the face of the globe, is eminently characteristic of Senegambia. It attains to no great height, but the circumference of the trunk is frequently 60 to 75 feet, and has been found to measure 112 feet; its fruit, the monkey-bread, is a principal article of food with the natives. Bombaceae (cotton-trees) are likewise numerous, and they are among the loftiest in the world. Acacias, which furnish the gum-arabic, are most abundant, while the shores are lined with mangrove trees. The vegetation is similar to that of Nubia, as also the animal world. Gold and iron are the chief metals.

The inhabitants consist of various Negro nations, the chief of which are the Wolof.

The gum trade is the most important traffic on the Senegal; bees-wax, ivory, bark, and hides, forming the chief exports from the Gambia.

Of European settlements are: The French possessions on the Senegal; the capital of which is St Louis, built about the year 1626, on an island at the mouth of the river. The total population of the settlement amounted, in 1846, to 17,976 coloured people, and 1170 Europeans.

The British settlement is on the Gambia, and has 4851 inhabitants. Bathurst is the chief town.

The Portuguese settlement consists of small factories south of the Gambia, at Bissao, Cacheo, and some other points.

The Guinea coast.

The West coast of Africa, from Senegambia to the Nourse River, is commonly comprised by the general denomination Guinea Coast, a term of Portuguese origin.

The coast is mostly so very low, as to be visible to navigators only within a very short distance, the trees being their only sailing marks. North of the equator, in the Bight of Benin, the coast forms an exception, being high and bold, with the Cameroon Mountains behind; as also at Sierra Leone, which has received its name (Lion Mountain) in consequence. The coast presents a dead level often for thirty to fifty miles inland. It has numerous rivers, some of which extend to the furthest recesses of Inner Africa.

The climate, notoriously fatal to European life, is rendered pestilential by the muddy creeks and inlets, the putrid swamps, and the mangrove jungles that cover the banks of the rivers. There are two seasons in the year, the rainy and the dry season. The former commences in the southern portion in March, but at Sierra Leone and other northern parts, a month later.

Vegetation is exceedingly luxuriant and varied. One of the most important trees is the *Elais guineensis*, a species of palm, from the covering of whose seed or nut is extracted the palm oil, so well known to English commerce and manufacture: several thousand tons are annually brought into the ports of Liverpool, London, and Bristol. The palm-oil tree is indigenous and abundant from the river Gambia to the Congo; but the oil is manufactured in large quantities chiefly in the country of the Gold and Slave Coasts. The former comprises nearly all the more remarkable of African animals: particularly abundant are elephants, hippopotami, monkeys, lions, leopards, crocodiles, serpents, parrots. The domestic animals are mostly of an inferior quality. The principal minerals are gold and iron. The population consists, besides a few European colonists, of a vast variety of Negro nations, similar in their physical qualities and prevailing customs, but differing considerably in their dispositions and morals.

The chief articles of commerce are palm-oil, ivory, gold, wax, various kinds of timber, spices, gums, and rice.

The divisions of Northern or Upper Guinea, are mostly founded on the productions characteristic of the different parts, and are still popularly retained.

**Sierra Leone.** The British colony of Sierra Leone extends from Rokelle River in the north, to Kater River in the south, and about twenty miles inland. The population, consisting chiefly of liberated slaves, amounted in 1847 to 41,735. Freetown, the capital, has 10,580 inhabitants, and is, after St Louis, the most considerable European town on the western coast of Africa.

**Grain coast.** The Malaghetta or Grain Coast extends from Sierra Leone to Cape Palmas. Malaghetta is a species of pepper yielded by a parasitical plant of this region. It is sometimes styled the Windy or Windward Coast, from the frequency of short but furious tornadoes, throughout the year. **Liberia.** The republic of Liberia, a settlement of the American Colonization Society, founded in 1822, for the purpose of removing free people of colour from the United States, occupies a considerable extent of the coast, and has for its capital Monrovia, a town named after the president, Mr Monro. The population amounts to from 10,000 to 15,000 native inhabitants, and 3200 liberated Negroes from America.

**Ivory coast.** The Ivory Coast extends from Cape Palmas to Cape Three Points, and obtained its name from the quantity of the article supplied by its numerous elephants.

**Gold coast.** The Gold Coast stretches from Cape Three Points to the River Volta, and has been long frequented for gold-dust and other products. The Dutch have several trading ports, of which Elmina, a town of 12,000 inhabitants, is the principal and oldest of the European stations, founded by the Portuguese in 1411. The British possess Cape Coast Castle, a spacious fortress, and James' Fort, near Accra. The Danish settlements of Christiansburg and Friedensburg were ceded to the English in 1849.

**Slave coast.** The Slave Coast extends from the River Volta to the Calabar River, and is, as its name implies, the chief scene of the most disgraceful traffic that blots the history of mankind. Eko, or Lagos, one of the chief towns of the coast, was destroyed in 1852.

The kingdoms of Ashanti, Dahomey, Yoruba and others, occupy the interior country of the Guinea coast.

The coast from the Old Calabar River to the Portuguese possessions is inhabited by various tribes. Duke's Town, on the former river, is a large town of 30,000 to 40,000 inhabitants, with considerable trade in palm-oil, ivory, and timber.

On the Gabun river, close to the equator, are a French settlement and American missionary stations. At the equator, Southern or Lower Guinea begins, where the only European settlements are those of the Portuguese.

**Loango.** Loango is reckoned from the equator to the Zaïre or Congo river. Its chief town is Boally, called Loango by the Europeans.

**Congo.** Congo extends south of the Zaïre, comprising a very fertile region, with veins of copper and iron. Banza Congo or St Salvador is the capital.

**Angola and Benguela.** Angola comprises the two districts of Angola proper and Benguela. In these regions the Portuguese settlements extend farther inland than in the two preceding districts, namely, about 200 miles. The population of the settlements is about 400,000, comprising only 1830 Europeans. The capital St Paolo de Loando, contains 1600 Europeans and 4000 native inhabitants, and has a fine harbour. St Felipe de Benguela is situated in a picturesque but very marshy and most unhealthy spot.

**South Africa.** The coast from Benguela to the Cape Colony may, in a general arrangement like this, be included either within West Africa or South Africa. The whole coast is little visited or known, being of a most barren and desolate description, and possessing few harbours. From Walfich Bay, as has been already stated, Mr Galton recently penetrated nearly 400 miles into the interior towards Lake Ngami, and explored the country inhabited by the Ovaherero or Damaras, and other tribes.

**Cape Colony.** Under South Africa the Cape Colony only is generally comprised. It takes its name from the Cape of Good Hope, and extends from thence to the Orange River in the north, and to the Tugela River in the east. A large proportion of the territory included within these limits, especially in the north, is either unoccupied, or, excepting missionary stations, entirely in the hands of the aborigines.

Apart from the shores, the country consists of high lands, forming parallel mountainous ridges, with elevated plains or terraces of varying extent between. The loftiest range, styled in different parts of its course Sneuw-bergen, Winter-bergen, Nieuveld-bergen, and Roggenveld-bergen, names originated by the Dutch, is the third and last encountered on proceeding into the interior from the south coast. The most elevated summit, Spitzkop or Compass-berg, in the district of Graafreynet, attains the height of 10,250 feet. This and the other chains are deeply cut by the transverse valleys called kloofs, which serve as passes across them, and appear as if produced by some sudden convulsion of nature, subsequently widened by the action of the atmosphere and running water.

The high plains or terraces are remarkable for their extraordinary change of aspect in the succession of the seasons. During the summer heats they are perfect deserts, answering to the term applied to them, karroos, signifying, in the Hottentot language, "dry" or "arid." But the sandy soil being pervaded with the roots and fibres of various plants, is spontaneously clothed with the richest verdure after the rains, and becomes transformed for a time into a vast garden of gorgeous flowers, yielding the most fragrant odours. Adapted thus to the support of graminivorous animals, the karroos are the resort of antelopes, zebras, quaggas, and gnus in countless herds, and of the carnivorous beasts that prey upon them, the lion, hyæna, leopard, and panther. These quadrupeds, however, with the elephant, rhinoceros, hippopotamus, giraffe, buffalo, and ostrich, have been largely banished from their old haunts by the advanced footsteps of civilised man, and are only found in the more secluded parts of the interior. The country has a singular and superb flora, but it comprises few native plants useful to man: many such have been now introduced. Heaths of varied species and great beauty abound; and geraniums are treated as common weeds. Many highly productive districts occur; corn, wines, and fruit, being the chief objects of cultivation in the neighbourhood of the Cape, while the more inland settlements are grazing farms. Some fine natural forests clothe the sides of the mountains; but in general the colony is deficient in timber-trees, as well as in navigable streams, perennial springs, and regular rain. A great deposit of rich copper ore occurs near the mouth of the Gariep; and salt is obtained for consumption and sale from salt lakes.

The climate is exceedingly fine and salubrious. There are two seasons, characterised by the prevalence of certain winds. During the summer, which lasts from September to April, the winds blow from southeast, cold and dry; during the winter, namely from May to September, northwest winds prevail. In the most elevated regions the winters are occasionally severe, and snow and ice occur.

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The population of Cape Colony amounted in 1847 to 178,300 souls. The chief native tribes within the British territory are the Kaffres, Hottentots, and Bechuanas. No manufacture is conducted at the Cape except the making of wine, of which 8000 pipes are annually exported to England. Various articles of provision are supplied to ships sailing between Europe and the East Indies.

Cape Town is the capital of the colony, and contains 22,600 inhabitants. Its commerce is considerable, and the port is frequented by 500 to 600 vessels every year.

The Orange River sovereignty, added to the British territories in 1849, extends north of the Orange River as far as the Ky Gariep or Vaal River.

Natal. Natal, or Victoria, a district on the east coast, and separated from the Cape Colony by Kaffraria, is a recently formed British settlement, containing an area of about 18,000 square miles. It is highly favoured in those respects in which the Cape is most deficient, having abundance of wood and water, with coal and various metallic ores, a fine alluvial soil, and a climate adapted to the cultivation of the products for which the home demand is large and constant—cotton, silk, and indigo. Pietermaritzburg, the capital of the settlement, lies 50 miles from the coast. Port Natal, now D'Urban, seated on a fine lake-like bay, is the only harbour.

East Africa. East Africa extends from Natal northwards to the Red Sea, comprising Sofala, Mozambique, Zanzibar, and the Somali country. But little is known of that region beyond the shores. Sofala. The Sofala coast, extending from Delagoa Bay to the Zambezi River, is flat, sandy, and marshy, gradually ascending towards the interior. It abounds with rivers, which cause yearly inundations. The soil is very fertile, and produces chiefly rice. In the interior, gold and other metals, as well as precious stones, are found. The Portuguese have settlements at Sofala, in an unhealthy spot, abounding with salt-marshes; it consists of only eighteen huts, a church, and a fort in ruins. Inhambane, near the Tropic of Capricorn, has an excellent harbour.

Mozambique. Mozambique extends from the Zambezi to Cape Delgado, and is similar, in its natural features, to the Sofala coast. The country is inhabited by the large and powerful tribe of the Macuas. The principal river is the Zambezi. The principal settlement of the Portuguese is at Quillimane, which is situated in a very unhealthy position, surrounded with mangrove trees. It has 130 free inhabitants, comprising only 12 Portuguese, and 5000 or 6000 slaves.

Zanzibar. The Zanzibar or Sawahili coast extends from Cape Delgado to the River Jub, near the Equator. The coast is generally low, and has but few bays or harbours: its northern portion is rendered dangerous by a line of coral reefs extending along it. The region possesses a great number of rivers, but none of them attain a first-rate magnitude. The principal are the Livuma, Lufigi, Ruvu, Pangani, and Dana; the two latter rising in the snowy mountains of Kilimanjaro and Kenia. The climate is similar to that of other tropical coasts of Africa, hot and unhealthy in general: in some portions, however, the elevated ground, and with it a more temperate and healthy climate, approaches the shores to within a short distance. The vegetation is luxuriant, and cocoa-nut, palms, maize, rice, and olives, are the chief articles of cultivation. The fauna comprises all the more characteristic African species.

The chief inhabitants are the Sawahili, but the coasts are under the Arab dominion of the Imaum of Muscat, by whose efforts commerce with the nations of the interior has greatly increased.

The island of Zanzibar (Unguja of the Sawahili) is the residence of the Imaum of Muscat, and the seat of extensive commerce. Mombas, on a small island close to the main shore, possesses the finest harbour on that coast, and has recently become famous as the seat of an important missionary station.

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Somali country. The Somali country comprises the eastern horn of Africa, from the equator northward to the Bay of Tadjurra, near the entrance into the Red Sea. The coast is generally bold and rocky, in some places covered with sand; and the extensive region it encloses, presents a slightly ascending plain, traversed by large valleys of great fertility, among which the Wady Nogal is prominent. Along the Arabian Gulf the coast is very abrupt, and girded with a range of mountains, the highest summit of which, Jebel Ahl, reaches an elevation of 6500 feet. This country is not so well watered as the region to the south, and some of its rivers are periodical.

The Somali country is famous for its aromatic productions and gums of various kinds; and it is supposed that the spices and incense consumed in such large quantities by the ancient people of Egypt, Greece, Syria, and Rome, were derived from this part of Africa, and not from Arabia.

The Somali, the inhabitants of this region, belong to the Galla tribe. The commerce is considerable, and is partly in the hands of the Arabs. Zeïla and Berbera, on the northern coast, are the chief trading ports: the permanent population of the former is about 750, while the latter may be said to exist only during the winter, when no less than 20,000 strangers, at an average, arrive to pitch their tents, and thus create a great market place. Hurrur is the chief place in the interior, with 17,000 inhabitants, who are Mahometans.

Central Africa. Central Africa comprises the regions which extend from the southern borders of the Sahara in the north to Cape Colony in the south, and from Senegambia in the west to the territory of the Egyptian pashalic on the east. It comprehends the central basins of Lake Tsad, Nyassa, and others, and the greater part of the basins of the Kawara, Zaïre, Nile, and Zambezi. Even the Sahara may well be included in this general denomination. So little is yet known of this vast region that the general features of some portions only can be indicated. The greater portion seems to be densely peopled with numerous tribes, and to possess inexhaustible natural resources. The portion north of the equator, under the name Sudan or Nigritia, comprises a great number of states, among which the principal are Bambarra, Timbuktu, and Houssa in the west; Bornu, Baghermi, and Waday, around Lake Tsad; Darfur in the east; and Adamaua in the south. The inhabitants are Negro races, with many Arabs, Moors, and Berbers.

Bambarra. Bambarra occupies part of the basin of the Joliba, or upper source of the Kawara. The dominant inhabitants are the Mandingoes and Foulahs, who have embraced Islamism, and are much more advanced in civilisation than the other negro tribes. The country comprises extensive and excellent pastures, with abundance of domestic animals, as horned cattle, sheep, goats, and horses of a fine breed. Among the vegetable products the most remarkable is the butter-tree, which furnishes an important article of agricultural industry and trade.

Sego, the capital, is situated on the Joliba, and contains 30,000 inhabitants. It was here that Mungo Park first caught sight of the long-sought river.

Timbuktu. Timbuktu, or Jennie, comprises the basin of the Joliba below Bambarra, and lies partly within the Great Sahara. Timbuktu, a few miles from the banks of the Joliba, and situated amid sands and deserts, is a celebrated centre of the North African caravan trade. It contains from 12,000 to 15,000 inhabitants.

Houssa. Houssa is an extensive country extending to the Sahara in the north, to the Joliba or Kawara on the west, to Bornu on the east, and to about 10. north Lat. on the south. The dominant race are the Foulahs, but the mass of the popula-

Africa.

tion are Negroes. It is a very fertile and beautiful country, but the climate is insalubrious, and in many parts fatal to Europeans. The inhabitants are engaged in pastoral, as well as in agricultural and commercial pursuits.

The capital, Sakatu, is one of the largest cities in Negroland; it is situated in a fertile but marshy plain. Kano, another large town, containing 30,000 to 40,000 inhabitants, is the great emporium of trade in Houssa: there the English merchandise coming from the north through the Sahara, meets with American goods coming from the Bight of Benin. The manufactures of Kano consist chiefly of cloth, for the dyeing of which that town is famed all over Central Africa.

Bornu.

Bornu is one of the most powerful states of Negroland; extending on the west to the 10th degree of Long., on the east to Lake Tsad and the kingdom of Baghermi, and on the south as far as Mandara and Adamaua, in about 11. north Lat. Kanem, on the northern side of Lake Tsad, has recently been conquered and brought under Bornuese sovereignty.

The general character of Bornu is that of a plain, subject to inundations, particularly near Lake Tsad. It is very fertile, and cotton and indigo attain a high degree of excellence. The original Bornuese are an agricultural people.

Kuka, the capital and residence of the Sheik of Bornu, has only 8000 inhabitants, while Angornu, south of it, has 30,000.

Baghermi.

Baghermi, another powerful kingdom, is situated east of Bornu. The boundaries, according to Dr Barth, who first visited this country and penetrated as far as Maseña, the capital, are on the west the river Loggeme, a tributary of the Shary or Asu, by which it is divided from Bornu and Adamaua; on the north its limits are in about $12\frac{1}{2}°$ north Lat., and on the east in $19\frac{1}{2}°$ east Long., both lines dividing it from Waday: the southern boundary is in about $8\frac{1}{2}°$ north Lat. Baghermi is an extensive plain or valley formed by the river Shary or Asu and its tributaries. The inhabitants are very warlike, and frequently engage in slave marauding expeditions into the neighbouring states to the south.

Maseña, the capital, lies in 11.40. north Lat., and 17.20. east Long.

Waday.

Waday, or Dar Saley, lies east of Baghermi, and reaches as far as Darfur. It comprises an extensive region, stretching as far as the basin of the Nile. Lake Fittri, situated in the western portion, forms a basin, unconnected with that of Lake Tsad, and by which the country as far as Darfur is drained. It has never been explored by Europeans. The population comprises a great variety of tribes and different languages.

Wara, the capital, is placed by Dr Barth in 14° north Lat., and 22° east Long.

Darfur.

Darfur, east of Waday, extends as far as Kordofan. The country rises towards the west into a range of hills called Jebel Marrah. It is drained into the Nile. A great portion of the country is Saharan in its character, while others are fertile and diversified. Browne, in 1793, estimated the whole population at 200,000. It has an extensive trade with Egypt.

Cobbeïh, the capital, is a merchant town, and contains about 6000 inhabitants.

Adamaua.

Fumbina or Adamaua is an extensive country south of Houssa and Bornu, under Foulah dominion. It consists of a large, fertile, and highly-cultivated valley, formed by the River Benue, which is the upper course of the Tchadda. Near Yola, the capital, the Benue receives the Faro, a large tributary coming from the south-west in the direction of the Cameroon Mountains. The waters in the rainy season, namely, from June to September, rise 40 to 50 feet. This country was first visited by Dr Barth in 1851.

Yola, the capital, lies in 8.50. north Lat., and 13.30. east Longitude.

Africa.

Islands of Africa in the Atlantic Ocean.

To Africa belong a considerable number of islands. The Madeiras, belonging to Portugal, lie off the north-west coast of Africa, at a distance of about 360 miles. Madeira, the chief island, is about 100 miles in circuit, and has long been famed for its picturesque beauty, rich fruits, and fine climate, which renders it a favourite resort of invalids. Wine is the staple produce. Funchal, the chief town, with nearly 30,000 inhabitants, is a regular station for the West India mail steam-packets from Southampton, and the Brazilian sailing-packets from Falmouth.

The Canaries, belonging to Spain, the supposed Fortunate Islands of the ancients, are situated about 300 miles south of Madeira. They are 13 in number, all of volcanic origin, Teneriffe being the largest. The latter is remarkable for its peak, which rises as a vast pyramidal mass to the height of 12,172 feet.

The Cape Verde Islands, subject to Portugal, are a numerous group about 80 miles from Cape Verde. They obtained their name from the profusion of sea-weed found by the discoverers in the neighbouring ocean, giving it the appearance of a green meadow. They are also of volcanic origin.

Fernando Po, a very mountainous island, is in the Bight of Biafra. Formerly a British settlement, it was abandoned owing to its unhealthiness, and is now only inhabited by a few negroes and mulattoes.

St Thomas, immediately under the equator, is a Portuguese settlement; as also Prince's Island, 2° north of the line.

Annobom, in 2. south Lat., belongs to the Spaniards.

Ascension, a small, arid, volcanic islet, was made a British port on the arrival of Napoleon Bonaparte at St Helena, and since retained as a station, at which ships may touch for stores. Green Hill, the summit of the island, rises to the height of 2840 feet.

St Helena is a huge dark mass of rock, rising abruptly from the ocean to the height of 2692 feet. James' Town is the only town and port, containing 5300 inhabitants.

Islands of Africa in the Indian Ocean.

Madagascar, the largest island of Africa, and one of the largest in the world, is separated from the Mozambique coast by a channel of that name, about 250 miles wide. The area exceeds that of France, comprising 225,000 square miles, and the population is estimated at 4,000,000.

It has an atmosphere so pestilential, in particular localities, that to breathe it for a short duration is generally, and very quickly fatal. But other parts are not insalubrious. The lemurs, an interesting tribe of animals, are peculiar to Madagascar and the Comoro Archipelago.

The inhabitants are diverse races of Negro, Arab, and Malay origin. The Ovahs, a people of the central provinces, are now dominant. The principal town, Tananarivu, has 8000 inhabitants.

The Comoro isles, four in number, are in the north part of the Mozambique Channel, and inhabited by Arab tribes.

Bourbon, 400 miles east of Madagascar, is a colony of France, producing for export, coffee, sugar, cocoa, spices, and timber.

Mauritius, ceded to the British by the French in 1814, is 90 miles north-east of Bourbon. The sugar-cane is chiefly cultivated. Port Louis, the capital, beautifully situated, has 26,000 inhabitants. Within the jurisdiction of the Governor of the Mauritius, are the islands of Rodriguez, the Seychelles, and the Amirante islands.

Socotra, a large island, east of Cape Jerdaffun, with an Arab population, has been known from early times; it is now a British possession. This island was long celebrated as producing the finest aloetic drug: a few years ago this was denied; but now it is found still to produce a fine kind of aloe, though much of what passed as Socotrine aloes really came from India.

AFRICANUS, John Leo. See Leo.

Africanus, Sex. Julius, of Emmaus in Palestine, a learned Christian historian of the third century, who wrote a chronicle extending from the date of the creation to A. D. 221, of which copious extracts exist in the Chronicon of Eusebius, besides many fragments in Syncellus, Cedrenus, and the Paschale Chronicon. Eusebius has also given some extracts of his letter to Aristides reconciling the apparent discrepancy of St Matthew and St Luke in the genealogy of Christ. His letter to Origen, impugning the authority of the book of Susanna, and Origen's answer, are both extant. To Africanus is also ascribed a work entitled Κεστοι, treating of medicine, agriculture, natural history, the military art, &c., of which extracts have been published, and some of the books are said to exist still in MS.

AFRIQUE, St, a French town in the department of Aveyron, in Lat. 43. 57. N. Long. 2. 51. E. with a population of 6000 persons.

AFSLAGERS, persons appointed by the burgomasters of Amsterdam to preside over the public sales made in that city. They must always have a clerk of the secretary's office with them, to take an account of the sale. They correspond to our brokers, or auctioneers.

AFT, in the sea language, the same with Abaft.

AFTER-GUARD, in the navy, the men stationed on the poop to work the aftersails, &c.

AFTERMATH, in *Husbandry*, signifies the grass which springs or grows up after mowing.

AFWESTAD, or Avestad, a market-town of Sweden, in the district of Fahlun, on the Dal-Elf. Pop. 900. It has iron and copper works, and the copper coin of the country was formerly struck here.

AGA, in the Turkish language, signifies a great lord or commander. Hence the aga of the janizaries is the commander-in-chief of that corps; as the general of horse is denominated *spachiclar aga*. The aga of the janizaries is an officer of great importance. He is the only person who is allowed to appear before the grand signior without his arms across his breast in the posture of a slave. Eunuchs at Constantinople are in possession of most of the principal posts of the seraglio: the title *aga* is given to them all, whether in or out of employment. This title is also given to all rich men without employ, and especially to wealthy landholders.

We find also *agas* in other countries. The chief officers under the khan of Tartary are called by this name; and among the Algerines we read of *agas* chosen from among the *boluk bashis* (the first rank of military officers), and sent to govern in the chief towns and garrisons of that state. The *aga* of Algiers is the president of the divan or senate. For some years the *aga* was the supreme officer, and governed the state in place of the bashaw, whose power dwindled to a shadow. But the soldiery rising against the *boluk bashis* or *agas*, massacred most of them, and transferred the sovereign power to the caliph with the title of *Dey* or King.

AGADIR, or Santa Cruz, a seaport on the western coast of Marocco, in Lat. 30. 26. 35. N. Long. 9. 35. 56. W. It was, when possessed by the Portuguese, a strong fortress; but it was captured by the Moors in 1536, and since that time has decayed, and its former trade has been transferred to Mogadore.

AGALMATA, in *Antiquity*, a term originally used to signify any kind of ornaments in a temple, but afterwards applied only to the statues, which were most conspicuous.

AGAMEMNON, the son of Plisthenes and Aërope, and grandson of Atreus, or according to Homer, the son of Atreus and grandson of Pelops. He was king of Mycenæ in Argos, and married Clytemnestra daughter of Tyndarus king of Sparta. On the abduction of Helen the wife of his brother Menelaus, by Paris, Agamemnon, as the most powerful prince in Greece, was chosen captain-general of the expedition against Troy. While the fleet lay at Aulis, Agamemnon chanced in hunting to kill a stag sacred to the goddess Diana, who punished the offence by sending a pestilence among the troops, and a dead calm, which retarded the further progress of the expedition. The oracle, on being consulted, demanded the sacrifice of Agamemnon's daughter Iphigenia, as the only expiation of the crime. While the king was in the act of slaying his child, the goddess intervened, and carried her away to Tauris. Another victim was substituted, and the fleet pursued its course to Troy. Agamemnon's quarrel with Achilles and its consequences form the subject of the Iliad. After the taking of Troy, Agamemnon returned home, carrying with him Cassandra daughter of Priam, whom he had received as his prize. During his absence Clytemnestra had formed an unlawful connection with Ægisthus, who now sat on the throne of Mycenæ. Agamemnon was received into his palace by the adulterers, and assassinated by their own hands. This horrible tragedy forms the subject of the *Agamemnon* of Æschylus.



AGANIPPE, in *Antiquity*, a fountain of Bœotia, at Mount Helicon, on the borders between Phocis and Bœotia, sacred to the Muses, and running into the river Permessus. Ovid seems to make *Aganippe* and *Hippocrene* the same. Serenus more truly distinguishes them, and ascribes the blending of them to poetical license. From this fountain the Muses derived their designation of *Aganippides*.

AGAPE, in *Ecclesiastical History*, the love-feast, or feast of charity, in use among the primitive Christians, when a liberal contribution was made by the rich to feed the poor. The word is Greek, and signifies *love*. St Chrysostom gives the following account of this feast, which he derives from the apostolical practice. He says, "The first Christians had all things in common, as we read in the Acts of the Apostles; but when that equality of possessions ceased, as it did even in the apostles' time, the *agape* or love-feast was substituted in the room of it. Upon certain days, after partaking of the Lord's Supper, they met at a common feast; the rich bringing provisions, and the poor who had nothing being invited." It was always attended with receiving the holy sacrament; but there is some difference between the ancient and modern interpreters as to the circumstance of time, viz. whether this feast was held before or after the communion. St Chrysostom is of the latter opinion; the learned Dr Cave of the former. These love-feasts, during the first three centuries, were held in the church without scandal or offence; but in after times the heathens began to tax them with impurity. This gave occasion to a reformation of these *agapæ*. The kiss of charity, with which the ceremony used to end, was no longer given between different sexes; and it was expressly forbidden to have any beds or couches for the conveniency of those who should be disposed to eat more at their ease. Notwithstanding these precautions, the abuses committed in them became so notorious, that the holding of them (in churches at least) was solemnly condemned, at the Council of Carthage, in the year 307.

AGAPETÆ, in *Ecclesiastical History*, a name given to certain virgins and widows, who, in the ancient church, associated themselves with and attended on ecclesiastics, out of a motive of piety and charity.

In the primitive days there were women instituted deaconesses, who, devoting themselves to the service of the church, took up their abode with the ministers, and assisted them in their functions. In the fervour of the primitive piety, there was nothing scandalous in these societies; but they afterwards degenerated into libertinism; insomuch that St Jerome asks, with indignation, *unde agapetarum pestis* *in ecclesias introiit?* This gave occasion for councils to suppress them. St Athanasius mentions a priest, named Leontius, who, to remove all occasion of suspicion, offered to mutilate himself, to preserve his beloved companion.

AGAPETUS, deacon of the church at Constantinople, A. D. 527, was the author of a work on the *Duties of Princes*, which he presented to the emperor Justinian, who had been his pupil. This work, known as the *Charta Regia*, caused him to be ranked among the best writers of his age. It was translated into English by Thos. Paynell in 1550.

AGARD, ARTHUR, a learned English antiquary, born at Foston, in Derbyshire, in the year 1540. His fondness for English antiquities induced him to make many large collections; and his office as deputy-chamberlain of the exchequer, which he held 45 years, gave him great opportunities of acquiring skill in that study. Similarity of taste brought him into acquaintance with Sir Robert Cotton and other learned men, who associated themselves under the name of *The Society of Antiquaries*, of which society Mr Agard was a conspicuous member. He made the Domesday book his peculiar study, and composed a work purposely to explain it, under the title of *Tractatus de Usu et obscurioribus Verbis libri de Domesday*. He also compiled a book for the service of his successors in office, which he deposited with the officers of the king's receipt, as a proper index for succeeding officers. All the rest of his collections, containing at least 20 volumes, he bequeathed to Sir Robert Cotton. He died in 1615.

AGARIC MINERAL, a marly earth, resembling the vegetable of that name in colour and texture.

AGARICUS, a genus of mushroom, a cryptogamian plant. Some of the genus are excellent articles of food, as the common mushroom, *A. campestris*, *A. pratensis*, &c.; others are poisonous, as *A. necator*, *A. acris*, *A. semiglobosus*, &c.

AGASIAS, son of Dositheus, was a famous sculptor of Ephesus, whose celebrated work, known under the erroneous title of the Borghese *Gladiator*, is now in the Louvre. He probably lived not earlier than the fourth century.

AGATE, or ACHAT (among the Greeks and Latins Αχατης and *Achates*, from a river in Sicily, on the banks of which it was first found), a name applied by mineralogists to a siliceous stone of the quartz family, generally occurring in rounded nodules, or in veins in trap rocks. The number of agate balls in the rock often give it the character of amygdaloid; and when such a rock decomposes by the elements, the agates drop out, and are found in the beds of streams descending from such mountains; or they may be obtained in quarrying. Immense quantities are obtained from Oberstein and Idar, in Germany, and many are brought from India and Brazil. Very large masses of chalcedony, a variety of agate, are brought from Iceland, Feroe, and Brazil, which often have a mammillated surface, and are very uniform in colour. A large quantity of agate is found in Scotland; whence the stone is familiarly known to our lapidaries as *Scotch Pebble*. Agate chiefly consists of chalcedony, with mixtures of common quartz, and occasional patches of jasper and opal. The colour delineations are often in concentric rings of varying forms and intensity, or in straight parallel layers or bands. The colours are chiefly gray, white, yellow, or brownish-red. The composition of agate is not uniform; but it usually contains from 70 to 96 per cent. of silica, with varying proportions of alumina, coloured by oxide of iron or manganese. The principal varieties are—

1. *Chalcedony*. In this the colours are in parallel bands. Notwithstanding the compact structure of agate, it is now known to be porous, though the eye cannot detect the cavities; and this has given rise to a beautiful and important process for heightening the natural colours of the stone artificially. This has been long secretly practised at Oberstein and Idar, the seats of the great agate manufactories of Europe, and probably has been long known in India, especially for the production of the finely coloured *Carnelians* and *Mochas* of that country. The stones best suited for this purpose are such as when recently fractured most readily imbibe moisture from the tongue; and a rude guess is made of the value of the specimen, by the quickness with which the moisture disappears.



The stone is first dried without heat, and is then immersed in a mixture of a quarter of a pound of honey in a pint of water; the whole is placed in an oven heated below the boiling point, where it should remain for two or three weeks, constantly covered with the liquid. At the end of this time the stones are washed, dried, and introduced into an earthenware vessel, containing sufficient sulphuric acid to cover the stones; this vessel, covered with a lid, is next placed in the oven, for a space varying from one to twelve hours, according to the hardness of the stone. The agates are now removed from the vessel, washed, and thoroughly dried; after which they are kept in oil for twenty-four hours; the oil is removed by rubbing them with bran. The stones are now cut and polished. In the best specimens, the gray streaks are increased in intensity; some exhibit brown streaks approaching to black, while white impenetrable parts assume a brighter hue by the contrast. This is the process employed to convert the veined chalcedony or agate into *onyx*, for the purposes of the lapidary, especially in the production of *cameos* and *intaglios*, in imitation of the antique sculptured gems; of which most admirable specimens have descended to us, and are found in the cabinets of the curious, especially in the Florentine Museum. In those minute but exquisite works, the ancient Greeks especially excelled; and curious specimens of the art are still found among the tombs of Egypt, Assyria, and Etruria. Among the moderns the Romans are the most successful imitators of antiquity; and the name of Pickler was long mentioned as almost a rival of the ancient engravers of gems. In such works the figures, whether in relief or intaglio, appear of a different colour from the ground.

A beautiful clear yellow is given to agate by digestion in hydrochloric acid for two or three weeks, at a moderate heat. The stone is first dried for two days in an oven, and immersed, when hot, in the acid; the jar is lined with clay, and placed in an oven for the requisite time. When examined, the muddy-brown streaks will be found of a rich yellow. The change that takes place is probably on the oxide of iron. Chalcedony has also been coloured, so as to imitate the Turquoise; but the process is not divulged. It is perhaps effected by immersing it in a solution of copper, which is the colouring matter of Turquoise.

2. *Carnelian*, or red chalcedony, when found, is almost always brownish or muddy. Both this sort and the yellowish-brown varieties are converted into a rich red by *roasting*, so as to rival the Indian carnelian, which probably also has its colour heightened artificially. The following process is employed at Oberstein, when the pale red stone becomes of a bright full red, and the muddy yellow of a rich full *carnelian* hue. Such stones are first kept in an oven for two or three weeks to dissipate moisture; they are then dipped in sulphuric acid, and immediately exposed in a covered earthenware crucible to a red heat: the whole is allowed to cool slowly; the stones are removed when cold, and washed. The hydroxide of iron they naturally contained has lost its water, and is more highly oxidated, and thus the full colour is produced.

3. *Mocha stones*, originally brought from the East, are clear grayish chalcedonies, with clouds and dashes of rich brown of various shades. They probably owe their colour chiefly to art.

4. *Moss-agates* are such as contain arborizations, or *dendrites* of oxide of iron: these seem in some instances to be produced on real vegetable forms, as petrifactions; but some of them are imitative forms that oxide of iron and manganese are known to assume.

5. *Jasp-agate* and *Opal-agate*, are mixtures of agate with these minerals.

6. *Plasma*, a substance found in engraved stones in the ruins of Rome, also on the Schwartzwald near Baden, and on Mount Olympus, appears to be chalcedony, coloured by oxide of iron, as it occurs in *green-earth*.

7. *Chrysoprase* is now considered as a quartz, or agate, coloured by oxide of nickel.

Agates have been described with representations of men, animals, or inanimate natural objects; but we can now have no hesitation in considering them as productions of art, or ingenious deceptions. Velschius had in his custody a flesh-coloured agate, on one side of which appeared a half-moon in great perfection, represented by a milky semicircle; on the other side, the phases of *vesper*, or the evening star; whence he denominated it an *aphrodisian agate*. An agate is mentioned by Kircher,[1] on which was the representation of a heroine armed; and one in the church of St Mark in Venice has the representation of a king's head adorned with a diadem. On another, in the museum of the Prince of Gonzaga, was represented the body of a man with all his clothes, in a running attitude. A still more curious one is mentioned by De Boot,[2] wherein appears a circle struck in brown, as exactly as if done with a pair of compasses, and in the middle of the circle the exact figure of a bishop with a mitre on; but inverting the stone a little, another figure appears; and if it is turned yet farther, two others appear, the one of a man, and the other of a woman. But the most celebrated agate of this kind was that of Pyrrhus, wherein were represented the nine Muses, with their proper attributes, and Apollo in the middle playing on the harp.[3] We have also seen accounts of an oriental agate, of such size as to be fashioned into a cup, with a diameter of an ell abating two inches. In the cavity is found delineated in black specks, B. XRISTOR. S. XXX. Other agates have also been found, representing the numbers 4191, 191; whence they were called *arithmetical* agates, as those representing men or women have obtained the name of *anthropomorphous*.

[1] *Ephem. German.* dec. i. an. 1. obs. 151.

[2] *De Gem.* l. ii. c. 95.

[3] *Pliny*, l. xxxvii. c. 3.

The agate is used for making cups, rings, seals, handles for knives and forks, hilts for swords and hangers, rosary beads, and a great variety of trinkets; being cut or sawed with no great difficulty. (T. S. T.)

AGATE, among *Antiquaries*, denotes a stone of this kind engraven by art.

AGATE is also the name of an instrument used by gold-wire drawers; so called from the agate in the middle of it, which forms its principal part.

AGATHARCHUS, a Greek painter, commemorated by Vitruvius for having first applied the laws of perspective to architectural painting, which he successfully used in painting scenery for the plays of Æschylus. He flourished about 480 years B.C.

AGATHARCIDES, a celebrated geographer, who flourished about 140 years B.C., was born at Cnidos. His works are lost, except those passges quoted by Diodorus Siculus, and other authors, for his descriptions especially of the gold mines of Upper Egypt, and his philosphical explanation of the inundations of the Nile, which he ascribed to the rains on the mountains of Ethiopia.—Hudson's *Greek Geographers*.

AGATHERMUS, a Greek geographer of the third century, of whose works we only possess brief outlines.—Hudson's *Greek Geographers*.

AGATHIAS, or, as he calls himself in his epigrams, AGATHIUS, distinguished by the title of *Scholasticus*, a Greek historian in the sixth century, in the reign of Justinian. He was born at Myrina, a colony of the ancient Æolians, in Asia the Less, at the mouth of the river Phythicus. He was an advocate at Constantinople. Though he had a taste for poetry, he was yet more famous for his history, which begins with the 26th year of Justinian's reign, where Procopius ends. It was printed in Greek and Latin by Vulcanius, at Leyden, 1594, in 4to. The best edition is that of Niebuhr, Bonn, 1828.



AGATHO, the Athenian, a tragic and comic poet, was the disciple of Prodicus and Socrates, and applauded by Plato, in his Dialogues, for his virtue and beauty. His first tragedy obtained the prize; and he was crowned, in the presence of upwards of 30,000 persons, in the fourth year of the 90th Olympiad. There are no remains of his works, excepting a few quotations in Aristotle, Athenæus, and others.

AGATHOCLES, the famous tyrant of Sicily, was the son of a potter at Reggio. By his singular vigour and abilities, he raised himself through various gradations of rank, till he finally made himself tyrant of Syracuse, and then of all Sicily. He defeated the armies of the Carthaginians several times, both in Sicily and Africa. But meeting at length with a reverse, and being in arrears with his soldiers, they mutinied, forced him to fly his camp, and murdered his sons. Recovering himself, he relieved Corfu, which was besieged by Cassander; burnt the Macedonian fleet; and revenged the death of his children by putting the murderers, with their wives and families, to the sword. After ravaging the sea-coast of Italy he took the city of Hipponium. He was at length poisoned by his grandson Archagathus, in the 72d year of his age, B.C. 290, having reigned 28 years.

AGATHYRNA or AGATHYRNUM, AGATHYRSA or AGATHYRSUM, a town of Sicily, now *St Marco*, as old as the war of Troy, having been built by Agathyrnus, son of Æolus. The gentilitious name is *Agathyrnæus;* or, according to the Roman idiom, *Agathyrnensis*.

AGBARUS. See ABGARUS.

AGAVE, a botanical genus, of the natural order of *Bromeliaceæ*, including the *American aloe*. The principal species is *A. americana*, a plant now naturalised in Spain, where it forms very secure fences. It sends up a lofty spike of very rapid growth, bearing a bunch of yellow flowers. The leaves are fleshy, long, and strong, carrying a formidable spine at their extremity. The fermented juice of the stem is the *pulque* of the native Mexican tribes. The fibres of the leaf afford a very good material for cordage.

AGDE, a city of France, in the department of Herault. It is seated on the river Herault between two and three miles from its mouth, where it falls into the Gulf of Lyons, and where there is a fort built to guard its entrance. The greater part of the inhabitants are merchants or seamen. The city is extended along the river where it forms a little port wherein ships of 200 tons may enter. Pop. in 1846, 8321.

AGE, in its most common acceptation, implies the whole space of time through which anything has existed; but the term is frequently used in other senses too vague and figurative to be included under any general definition.

The age of this habitable globe has been much disputed. Cuvier, Dolomieu, Deluc, and Greenough, concur in thinking that not more than 5000 or 6000 years have elapsed since the creation of man.—Cuvier's *Theory of the Earth*.

Josephus estimates the period that elapsed from the creation of man to the deluge at 2256 years. The antediluvian or obscure age was succeeded by the fabulous or heroic age, in which the exploits of the gods and heroes of the ancients were supposed to have been performed, extending down to the first Olympiad, B.C. 776. To this succeeded the historic age, terminating with the destruction of Carthage by the Romans in B.C. 146. The period immediately following has been denominated the Roman age, which extended down to the fall of the Roman Empire in the West, A.D. 476. The middle age is defined by some writers as that period extending from the time of Constantine in the fourth century to the capture of Constantinople by the Turks, A.D. 1453; but it is more usually defined as dating from the division of the empire of Theodosius, A.D. 395, down to the time of the emperor Maximilian I., in the beginning of the sixteenth century, when the Germanic Empire was first divided into circles. It has also been termed the barbarous age, and is commonly divided into two periods; the first extending from the sixth to the ninth century, when learning was almost extinct in Europe; the second dating from the ninth century, when letters again began to flourish.

The term age has been applied metaphorically to supposed epochs in human civilisation: thus, in the mythology of the Greek and Roman poets, there were four ages, distinguished as the Golden, the Silver, the Brazen, and the Iron; the three latter being successively a farther declension from the first or pristine state of purity and bliss. In the first, mankind were supposed to have subsisted on the spontaneous productions of nature, in a state of innocence and happiness, without the necessity of laws or civil government. In the second, the earth no longer yielded its fruits untilled, and the human heart first began to be corrupted. In the third, emulation and discord arose, men grew more and more selfish, and laws became necessary to restrain human depravity. In the fourth, Astræa, the last of the celestial sojourners on earth, withdrew from the contemplation of human wickedness, and abandoned the world to violence, the scourge of wars, and desolation. The propriety of inverting the order of these four ages has been urged, on the ground that civilisation has been steadily progressive from the earliest times down to the present. However this may be, the universal tradition of a golden age, or primeval state of bliss, seems to favour the opinion that the light of revealed religion was never wholly extinguished, but may be traced exerting a remote influence on the human mind, long after the source whence it was derived was lost to the heathen world.

The term age is often used to denote any period that has been distinguished by the occurrence of remarkable events, or by the appearance of eminent persons; *e. g.* the age of the crusades, of chivalry, of the reformation; or, the age of Pericles, of Alexander, of Augustus, of Trajan, of Alfred, of Chaucer, the Elizabethan age,—the age of Shakspeare, of Newton, &c. The reign of Queen Anne has sometimes been styled the Augustan age of English literature, from its supposed resemblance to that illustrious period in the literary history of Rome.

The several ages at which, with us, individuals become legally qualified for certain ends, may be stated shortly as follows, commencing with the earliest age so cognisable. An infant under $10\frac{1}{2}$ years of age is not amenable to the laws; but above that age, the offender, without distinction of sex, is responsible, if found to be *capax doli*, or competent to distinguish between right and wrong: and although 14 is fixed by the civil law as the age of criminal responsibility, capital punishment has once been inflicted, for an artfully-concealed murder (in 1629), at the early age of 8 years. After 12, the oath of allegiance may be taken. The age of puberty in either sex is 14, when each may choose guardians; and formerly, if their discretion was proved, a male at 14, and a female at 12, could execute a valid testament of personal property, though not of lands: but by Vict. 1, c. 26, it is enacted that no person can execute any valid will under 21 years of age. The nubile age was fixed by the Roman law at 14 for males, and 12 for females, which are the respective legal ages with us, when either sex may consent to marriage, with the approval of guardians; yet it may be observed, that many minors contract marriages without such sanction. In France, by the *Code-Napoleon*, the nubile age is 18 for males, and 15 for females, under similar restriction. At 17, a person of either sex may be an executor or executrix. The sovereignty of this realm is assumed at 18; though the law, according to Blackstone, recognises no minority in the heir to the throne. The age of majority, which gives to both sexes the free disposal of themselves and their property, personal and real, is 21; at which age a man is capable of enjoying most civil privileges. In France the age of majority is the same. Among the Romans, minority did not cease until the completion of the 25th year. A seat in the British Parliament may be taken at 21: in the American House of Representatives at 25, and in the Senate at 30. In France, the requisite age for an elector was 25: for a seat in the Chamber of Deputies, 30; and in the Chamber of Peers it was 25, though no member of that Assembly could vote till 30. At Rome, during the time of the republic, 32 was probably the senatorial age; but it was fixed by Augustus at 25, and so it continued during the time of the empire. It appears that previous to the year B.C. 179, a citizen was eligible to most offices in Rome after the completion of his 27th year: but at that time it was enacted that the earliest age for the quæstorship should be 31; for the ædileship, 36; for the prætorship, 40; and for the consulate, 43,—though the law respecting this last was frequently infringed, especially by Julius Cæsar. The age for admission to the Spartan *Gerusia*, or Council of Elders, was 60. In the Church of England, a candidate for holy orders may become a deacon at 23; be ordained a priest at 24; and at 30 is eligible to a bishopric. A licentiate of the Church of Scotland must not be under 21 years of age. The same is the age for admission to the English or Scottish Bar, and for receiving the degree of Doctor of Medicine in the University of Edinburgh, and in most other colleges.

*Age of Man.*—We learn from the oldest and most authentic record of our race that the age of man has greatly diminished from his first creation. The antediluvians attained an age nearly approaching one thousand years; and during all the period from the creation of man to the deluge, his age did not diminish, seeing that the last of the antediluvians, Noah, lived 950 years, or twenty years longer than Adam. From the period of the deluge however, the age of man was suddenly shortened; none born after that event reached the age of 500 years, and even that age was lessened by a-half, and again gradually shortened during succeeding generations, till in the days of Moses it had reached that standard from which it has not since departed. "The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow."

As the most remarkable instance of longevity in modern times we may notice Petratsch Czartan, a Hungarian peasant, who was born in 1537, and died in 1722, at the patriarchal age of 185 years. See Longevity.

As applied to man the term age is often used to express the duration of a generation. The ancients in using the term in this sense intended to express a period of thirty years. Thus Nestor is said to have lived three ages when he was ninety years old. It is a remarkable instance of the correct observation of the ancients, that the statistics of the countries of Europe at present show that thirty years is the mean term of the life of a generation. In our more favourable isle this mean age or mean duration of a generation is somewhat higher, being for London about thirty-one years, and for England and Wales thirty-three years;—residence in the

Age. country being more favourable to health and longevity than residence in towns. As a general rule, when the population is rapidly increasing, as in America, the mean age or mean duration of a generation is lower than in an old country where the population is nearly stationary.

The age of man has been variously divided into four, six, and seven stages:—The latter being not only the poetical, but the most correct physiologically. These seven stages are, 1. Infancy; 2. Childhood; 3. Boy or Girlhood; 4. Adolescence; 5. Manhood or Womanhood; 6. Age; 7. Old Age or second childhood. These different periods are more or less distinctly marked. Infancy is attended with peculiar dangers, and extends to about the end of the second year of life, by which time the first dentition is completed. Childhood extends from this period to about the seventh year, the termination of this period being marked by the dropping out of the middle incisors, and the appearance of the second set of teeth. Boyhood extends from the seventh to about the fourteenth year, and during this period all the first or milk set of teeth are replaced by the permanent ones. Adolescence, youth, or puberty, generally commences somewhat earlier in the female than in the male; and extends in both from about the fourteenth to the twenty-first year of life. It commences with the evolution of the generative system; and during this period the body attains its full height. Womanhood lasts distinctly from the 21st to the 45th or 50th year, most generally to about the latter, at which period the female ceases to be capable of procreation, and her constitution undergoes a complete change. Though less attention has been paid to the duration of this stage in the male, it is an unquestionable fact that about the 49th or 50th year of life the male constitution also undergoes a change, and fully justifies the notion of the ancients as to climacteric periods of life. The period of life we have termed age, extending generally from the 49th to the 63d year of life, has been too commonly, but most erroneously, confounded with the next stage, viz. old age. During the earlier portion of this period, the body, instead of tending to decay, tends rather to obesity. The maturity and strength of intellect too, continue for the most part undiminished during all this stage. In old age, the last stage of all, the body begins to shrink, the muscles lose their tone, and not being able to sustain the weight of the body, allow the limbs to bend more or less. The hair becomes white; the teeth drop out; all the senses are blunted; the intellect is feeble; the circulation becomes weaker; and death naturally closes the scene.

*Age of Animals.*—Comparatively few observations have been made on the ages of animals. From observations founded on some of the domestic animals, it has been stated that the duration of the life of an animal is usually seven or eight times longer than the period it takes to arrive at its full growth. This rule applies pretty well to horses, oxen, sheep, dogs, the camel, and even the elephant, but is quite inapplicable to man, to many quadrupeds, birds, reptiles, or fishes. Even were the rule applicable to animals, it would not enable us from an examination of the animal to find out its age; hence other means have been devised for determining the age with a greater degree of certainty. Thus the age of the horse may be pretty accurately determined by the examination of the incisive teeth or nippers, but even these lose mark at ten years, and the age of the horse after that period cannot be accurately ascertained. (See Horse.) In horned cattle and deer, the age may, for a certain period of their life, be pretty accurately guessed at by the appearance of the horns. All deer shed their horns annually, and, in the males of many species, each successive year adds one more branch to the horns, till they attain a certain size, beyond which they do not increase. Thus the common stag during the first year of its life has a simple horn, called a pricket. This falls off during the second year of its life, and is replaced by a horn with one branch or antler. This in its turn falls off during the third year, to be replaced by a horn with two antlers; and so on till the eighth year of life, when the horns cease to acquire additional antlers, so that the future age of the animal cannot be ascertained. The horns of oxen, sheep, goats, and antelopes, being permanent, are simple, and grow in a different manner. As a general rule, for a certain number of years, a ring is added annually to the base of the horn, and by this mark their age may be pretty accurately ascertained. In sheep and goats the horn which grows the first year of life is smooth; but every year after this a ring more or less wrinkled is added to the base of the horn, and indicates their age. It is probable that the same law prevails with the antelopes. In oxen, again, the horn continues smooth for the first three years of life, but every year thereafter, a wrinkled ring is added to the base of the horns. By counting the number of these rings, therefore, and adding three for the first years when the horns are smooth, the age may be pretty accurately known.

No sure indications exist by which the ages of birds, reptiles, or fishes, may be known.

Several curious facts, however, have been collected relative to the age attained by various animals. The Indians believe that the elephant lives three centuries; and authentic instances are on record of their having been kept in captivity for 130 years, their age being unknown at the period of their being taken captive. Camels live from 40 to 50 years; horses from 25 to 30 years, if not overworked; oxen about 20 years; sheep 8 or 9 years; dogs 12 to 14 years.

The longevity of some birds appears to be very great. The swan has been known to live 100 years. Birds of prey, and especially the eagle, have survived a century; and several instances are on record of the raven having exceeded that period. Parrots have been known to live 60 and 80 years. The gallinaceous birds, as domestic poultry and pheasants, have short lives, rarely exceeding 12 or 15 years.

Of reptiles, so far as known, the tortoise seems to attain the greatest age. One was placed in the archiepiscopal garden at Lambeth in the year 1633 during the life of Archbishop Laud, and it survived till the year 1753, when it perished from accident rather than old age. The toad is know to live about 15 years. Nothing, however, is known relative to the age of the gigantic boas or other serpents.

Of fishes, the carp has been known to attain the age of 200 years. We have seen the common river trout confined in a well, one 30 years, the other upwards of 50 years, and both still living. Rzaczynski mentions a pike which lived in a pond a period of 90 years. Gesner relates that in 1497 an enormous pike was caught in a lake near Haillerun in Suabia, with a brazen ring attached to it, bearing that it was put into the lake in the year 1230; which ring is still preserved at Mannheim. This pike, therefore, appears to have reached the patriarchal age of 267 years at least.

Of the ages of the lower animals little is known. That of insects has received most attention, and it is instructive to note that, though the first period of life of many of these animals (the caterpillar or grub) extends through a period of several months, or even years, the great majority live but a few days or weeks after they attain their perfect form. The ephemera does not enjoy the pleasures of its aerial life above a few hours; the same day which brings it into perfect being seeing it die.

It may be observed, as a general law of nature applicable to all organised beings, that early maturity indicates shortness of life, and that they are usually prolific in the inverse ratio of their duration.

*Age of Plants and Trees.*—The great majority of plants which adorn the face of the earth are annual and biennial—

that is, spring from the seed, blossom, ripen their seeds, and die, in one or in two years. Most of those, however, which rise to the stature of shrubs or trees attain considerable age. Of the palm trees it is very questionable whether any attain a greater age than 200 years. As this class of plants, after attaining a certain diameter, shoots up a straight stem which never increases in diameter, and all the new wood which every leaf necessarily produces insinuates its fibres into the centre of the trunk, this trunk or stem necessarily becomes more and more condensed, so that at last life or vegetation ceases, from the fibres and vessels being too much compressed to conduct the sap to the growing top. Exogenous trees, or those which grow by the addition of an annual layer of wood superimposed or encircling those already formed, may continue growing for an indefinite length of time, and several of the trees which exist on the surface of the globe may have witnessed the Noachian deluge. Of this class is the Baobab tree of Senegal, with a girth of nearly 300 feet, reckoned by Adanson to be 5150 years old; the gigantic *Dracœna draco* at Orotava, in Teneriffe, which Humboldt classes with the Baobab as "the oldest habitants of our planet;" the deciduous cypress at Chapultepec in Mexico, supposed by the younger De Candolle to be of equal antiquity with the two former; the chestnut trees on Mount Ætna, of which one is 180 feet in circumference, another 70 feet, and another 64 feet; and the oriental plane tree, in the valley of Bujukdere, near Constantinople, which measures 150 feet in circumference. Of trees of known age are the eight olive trees which still exist in the garden on the Mount of Olives at Jerusalem, and which historical documents prove to have existed prior to the taking of that city by the Turks. These trees, consequently, exceed 800 years in age. The yew tree is proverbial for the great age it sometimes attains. The yews at Fountains Abbey in Yorkshire were considered old trees when the Abbey was erected in 1132, and are probably more than 1200 years old. The old yew formerly in Fortingal churchyard, in Perthshire, was probably double that age, and was 56½ feet in circumference. At Ankerwyke House, near Staines, is the yew tree known as a tree of note before the day of Runnymede (5th June 1215); and many other instances might be adduced. Oaks have frequently been cut down in the New Forest which presented 300 and 400 concentric rings, each of which indicated a year's growth. But many oaks exist of much larger dimensions, and consequently of much greater age, probably exceeding 1200 years. Thus, an oak was felled at Norburg, as is related by Dr Plott, of the enormous circumference of 45 feet, and the Boddington oak, in the vale of Gloucester, was 54 feet in circumference. Damory's oak in Dorsetshire was 68 feet in circumference, and, according to the common calculation, was 2000 years of age. Wallace's oak at Ellersley, near Paisley, must be at least 700 years old, but its age is trifling as compared with the forementioned giants. The cypress has been known to attain the age of 800 years. A lime tree in the Grisons, measuring 51 feet in circumference, is known to be upwards of 580 years old. It is doubtful whether the elm ever reaches the age of 300 years. One planted by Henry IV. was standing at the Luxembourg, at the commencement of the French Revolution. Bacon's elms in Gray's Inn Walks, planted in 1600, decayed prematurely in 1720; and the elms in the Long Walk at Windsor, planted in the beginning of the last century, are evidently past their prime, though still noble trees.

AGEDA, Synod of, an assembly of Jewish doctors in the year 1650, who met in the plain of this name, about thirty leagues distant from Buda, for the purpose of debating whether the Messiah had appeared. The meeting was attended by more than 300 rabbis, and many other Jews of different nations, and the question was decided in the negative. Some ecclesiastics from Rome were present, but the multitude refused to hear them.



AGELA, in *Antiquity*, an assembly of the sons of the noblest families in Crete, who lived together from their eighteenth year, and were instructed in manly exercises at the expense of the state until the time of their nuptials, which were solemnized simultaneously. The Agelæ were exclusively aristocratic. At Sparta, seven was the age for entering the Βοῦαι.

AGELADAS, an eminent statuary of Argos, and the instructor of the three great sculptors, Phidias, Myron, and Polycletus.

AGELNOTH, Egelnoth, or Æthelnoth, in Latin *Achelnotus*, archbishop of Canterbury in the reign of Canute the Great, succeeded Livingus in that see in the year 1020. This prelate, surnamed the *Good*, was son of Earl Agilmer, and at the time of his election, dean of Canterbury. After his promotion he went to Rome, and received his pall from Pope Benedict VIII. On his way thither, as he passed through Pavia, he purchased, for a hundred talents of silver and one of gold, St Augustin's arm, which was kept there as a relic, and sent it over to England as a present to Leofric, earl of Coventry. Upon his return, he is said to have raised the see of Canterbury to its former dignity. He was much in favour with King Canute, and employed his interest with that monarch to good purposes. By his advice the king sent over large sums of money for the support of the foreign churches; and William of Malmesbury observes, that this prince was prompted to acts of piety, and restrained from excesses, by the regard he had for the archbishop. Agelnoth, after he had sat 17 years in the see of Canterbury, died October 29, 1038, and was succeeded by Eadsius, King Harold's chaplain. He was the author of, 1. A panegyric on the blessed Virgin Mary; 2. A Letter to Earl Leofric concerning St Augustin; 3. Letters to several persons.

AGEMA, in *Macedonian Antiquity*, was a body of soldiers, not unlike the Roman legion.

AGEN, an arrondissement in the department of Lot and Garonne, containing 9 cantons, 72 communes, and 85,149 inhabitants. The chief town of the same name is situate on the right bank of the Garonne, about 75 miles south-east of Bordeaux. It has a sail-cloth manufactory, a college, several literary institutions, and is the seat of a bishop and a royal court of justice. Here is a fine bridge of 11 arches over the Garonne. In this neighbourhood some meteoric stones fell in July 1790. In 1846 the population was 14,091.

AGENDA, among *Philosophers* and *Divines*, signifies the duties which a man lies under an obligation to perform. Thus we meet with the *agenda* of a Christian, or the duties he ought to perform; in opposition to the *credenda*, or things he is to believe.

Agenda, among *Merchants*, a term sometimes used for a memorandum-book, in which is set down all the business to be transacted during the day, either at home or abroad.

Agenda, among *Ecclesiastical Writers* denotes the service or office of the church. We meet with *agenda matutina et vespertina*, the morning and evening prayers; *agenda diei*, the office of the day, whether feast or fast; *agenda mortuorum*, called also simply, *agenda*, the service of the dead.

Agenda is also applied to certain church-books, compiled by public authority, prescribing the order and manner to be observed by the ministers and people in the principal ceremonies and devotions of the church; in which sense *agenda* amounts to the same with what is otherwise called *ritual*, *liturgy*, *acolouthia*, *missal*, *formulary*, *directory*, *&c.*

AGENHINE, in our old writers, signifies a guest that has lodged at an inn for three nights, after which time he was accounted one of the family; and if he offended the king's peace, his host was answerable for him. It is also written Hogenhine and Hogenhyne.

AGENOIS, a country of France, in the department of the Garonne, formerly the province of Guienne. It contained about one hundred and twenty square leagues, was fertile and healthful, and, according to Cæsar, was inhabited by the Nitiobriges. It constituted part of the kingdom of Aquitania: was held by the counts of Toulouse, and successively by the English and French.

AGENT, in a general sense, denotes any active power or cause. Agents are either natural or moral. Natural agents are such inanimate powers as act upon other bodies in a certain and determinate manner: as gravity, fire, &c. Moral agents, on the contrary, are rational creatures, capable of regulating their actions by a certain rule.

Agent, in *Diplomacy*, *Commerce*, and *Jurisprudence*.—This word applies generally to any person who acts for another. It has probably been adopted from France, as its function in modern civil law was otherwise expressed in Roman jurisprudence. Ducange tells us that in the eastern empire the important officers who collected the grain in the provinces for the troops and the household, and afterwards extended their functions so as to include those of government postmasters, came to be called *agentes in rebus*, though their earlier name was *frumentarii*.

In *Diplomacy*, a class of semi-ambassadors termed agents have been employed generally between states of unequal power. The small community might send an agent to propitiate some powerful government, and secure its protection. A great power would, on the other hand, distribute its agents among the petty states which it kept in clientage, to see that no counteracting influence was at work among them. In this shape our Indian government keep agencies in the protected and other neighbouring states. In countries within the operation of the laws of diplomacy, an agent has the privilege of personal protection, and sometimes that of exemption from direct taxes, but he has not the ambassador's prerogative of communicating directly with the sovereign. See Ambassador; Diplomacy.

The law of principal and agent is one of those which have arisen in common practice regulated by jurisprudential theory. It involves nice and subtle distinctions, which are not merely theoretical, but have been found of eminent practical utility in the affairs of active life, for the service of which they have been created from time to time, by sagacious jurists. They had their origin in the subtleties of the law of mandate among the Romans, whence they spread through the different countries of Europe. It is perhaps fortunate that in England the spirit of the Justinian system thus pervades this branch, and that it is but little affected by the conventional peculiarities of the common law. This renders the law of agency almost alike throughout the whole British empire, and produces the farther result, that a branch of the British commercial code, in which it is of great importance that different nations should understand each other's system, differs only slightly from the corresponding branch of the law throughout the rest of Europe. The main features of a general view of the law of agency involve the adjustment of the rights and duties of the principal, the agent, and the public. The agent should not do what he has no authority for, yet if he be seen to have authority, those with whom he deals should not be injured by secret and unusual conditions. The employer is bound by what his agent does in his name, but the public are not entitled to take advantage of obligations which are known to be unauthorised and unusual. The agent is entitled to demand performance by the principal of the obligations undertaken by him within the bounds of his commission, but he is not entitled to pledge him with a recklessness which he would certainly avoid in the management of his own affairs. It is in the regulation of these powers and corresponding checks in such a manner that the legal principle shall apply to daily practice, that the niceties of this branch of the law consist.



Agents are of different kinds, according to their stipulated or consuetudinary powers. The main restraint in the possible powers of an agent is in the old maxim, *delegatus non potest delegare*, designed to check the complexity that might be created by inquiries into repeatedly deputed responsibility. But in practice this principle is modified. The agent cannot delegate his commission, or put another in his own place; but it is often a part of his function that he is to employ, for the accomplishment of certain objects, persons who are themselves agents. Thus, there is nothing to prevent a commercial agent from sending a portion of the goods entrusted by him to his own agent for disposal. In the general case, the authority may pass from the principal to the agent, either verbally or in writing. The English statute of frauds requires an agent to have authority in writing for the purposes of its 1st, 2d, and 3d clauses relating to leases. "And it is a general rule, that an agent who has to execute a deed, or to take or give livery or seisin, must be appointed by deed for that purpose. Moreover, as a corporation aggregate can in general act only by deed, its agent must be so appointed, though it would seem that some trifling agencies, even for corporations, may be appointed without one; and there is one case in which it was considered that a corporation might, without deed, empower an agent to do acts in the common course of its corporate business, or to make notes for a banking corporation." (Smith's *Commercial Law*, B. I. chap. v.) It is a general rule, that those obligations which can only be undertaken by solemn formalities cannot be entered on by a delegate who has not received his authority in writing. Agency is, however, often constituted, at the same time that its extent is defined, by mere appointment to some mandatory function—as where one is appointed agent for a banking establishment, factor for a merchant, broker, supercargo, traveller, or attorney. In these cases, usage defines pretty strictly the powers granted to the agent; and the employer will not readily be subjected to obligations going beyond the usual functions of the office; nor will the public dealing with the agent be bound by private instructions inconsistent with its usual character. While, however, the public, ignorant of such secret limitations, are not bound to respect them, the agent himself is liable for the consequences of transgressing them. There is another method by which agency may either be created or enlarged—*implication*. What the agent has done with his principal's consent, the public are justified in believing him authorised to continue doing. Thus, as a familiar instance, the servant who has continued to purchase goods for his master at a particular shop on credit, is presumed to retain authority and trust, and pledges his master's credit in farther purchases, though he should apply the articles to his own uses. The law is ever jealous in admitting as accessories of a general appointment to any particular agency the power to borrow money in the principal's name, to give his name to bill transactions, and to pledge him to guaranties; but all these acts may be authorised by implication, or by being the continuation of a series of transactions, to the precedents of which the principal has given his sanction. Thus an employer may, by the previous sanction of such operations, be liable for the bills or notes drawn, indorsed, and accepted by his clerk, or other mandatory; nay, may be responsible for the obligations thus incurred after the mandatory's dismissal, if the party dealing with him knew that he was countenanced in such transactions, and had no reason to suppose that he was dismissed. The unpleasant responsibilities thus created have often suggested the propriety of some system of publishing the cessation of agency, after the manner in which dissolutions of partnerships are gazetted. It is true that every principal has the means of specially warning the public not to confide in the agent he has ceased to employ, but the merely occasional use of precaution makes it invidious, and sometimes cruel.

The law of principal and agent, though of a purely consuetudinary character, has, by the sound foresight of great lawyers, been so well adjusted on the whole to the exigencies of society, that parliament has only found it necessary to interfere in one department of it. The law applicable to a mercantile agent's power to pledge, or otherwise dispose of the goods entrusted to him being in an unsatisfactory state, a statutory remedy was applied to it by an act of 1825 (6th Geo. IV. c. 94), which required amendment in 1842 (5th and 6th Vict. c. 39). It is to be regretted that these statutes, intended to regulate merchants in the transaction of their business, should have been framed with all the worst technicalities and elaborate complexities, which are never necessary, but would be less mischievous in acts for the guidance of professional or official men.

The general object of these measures is, to make transactions with an agent in possessions of goods as safe as dealing with the owner, to all who treat with him as purchasers or otherwise, in good faith, and in ignorance of his want of ownership. Thus, when an agent ships goods in his own name, the consignee is entitled to a lien on them for any advances to the agent, or liabilities on bills or notes. The presumption in such cases is ownership; and the burden of disproving it, as well as of showing that the consignee was aware of the mere agency, falls on the person questioning the validity. By the statutes, the person in possession of a bill of lading, dock warrant, warehouse-keeper's certificate, wharfinger's certificate, or other delivery warrant, is held the owner of the goods it represents, so as to render valid any transaction for their sale or other disposal to parties ignorant of the limited ownership. Besides their effect in rendering valid, in this more comprehensive manner, operations conducted under the appearance and supposition of absolute ownership, the acts have separate provisions for the security of those who deal with agents knowing them to be such. Any purchase from the agent, or payment of price to him, is declared to be effective against the principal, "provided such contract and payment be made in the usual and ordinary course of business," and that the party, when he made the purchase, or paid the price, was not specially warned, that the agent had no authority to sell or receive money for his principal. By the earlier act, the extent to which an impledgment by an agent was made effective, was only to the extent of covering the amount of his own claims against the principal. The act of Victoria, in the preamble, that advances on goods and delivery orders are part of the usual and ordinary course of business, enlarges the freedom of disposal, and provides that the agent is to be held as owner, to the effect of affording validity "to any contract or agreement by way of pledge, lien, or security, *bona fide* made by any person with such agent;" although it be known that he is merely an agent, provided it be not also known that he is acting fraudulently, and without authority. The interest of the principal is fortified by severe penal provisions against agents acting fraudulently; but it is provided that no agent is to be held fraudulent, who pledges merely for the amount due to him by his principal, or for which he has rendered himself liable by acceptances.

This necessarily very brief outline applies to the constitution of agency, which, as involving those questions where not only the two parties to the contract but the rest of the public, are concerned, is by far the most important branch of the subject. The others, which may be more briefly noticed, comprehend the mutual and reciprocal rights and obligations of the principal and agent. These can always be regulated by agreement. The obligations on the principal are, to pay the agent's remuneration, and honour the obligations lawfully undertaken for him. The responsibilities of the agent involve greater niceties. He is responsible for the possession of the proper skill and means for carrying out the functions which he undertakes. He must devote to the interests of his employer such care and attention as a man of ordinary prudence bestows on his own—a duty capable of no more certain definition, the application of it as a fixed rule being the function of a jury. In some instances the law interposes to remove him from temptation to sacrifice his employer's interests to his own: Thus, when he is employed to buy, he must not be the seller; and when employed to sell, he must not be the purchaser. He ought only to deal with persons in good credit, but he is not responsible for their absolute solvency unless he guarantee them. A mercantile agent guaranteeing the payments he treats for is said to hold a *del credere* commission. Doubtful questions often arise as to the extent to which an agent may save expense to his employer, and take credit for the amount. Thus, it used to be said that an agent cannot take credit for home customs or excise dues which he has evaded, but that he may for foreign; but, at the present day, certainly neither claim could be supported.

In Scotland, the procurators or solicitors who act in the preparation of cases in the various law-courts, and all who take out the attorney-license are called agents. See ATTORNEY.

In France, the *Agents de Change* were formerly the class generally licensed for conducting all negotiations, as they were termed, whether in commerce or the money market. Of late the term has been practically limited to those who conduct, like our stockbrokers, transactions in public stock; and it is understood that it is rather as speculators than as agents that the majority of them adopt the profession. The laws and regulations as to *courtiers*, or those whose functions were more distinctly confined to transactions in merchandise, have been mixed up with those applicable to *agents de change*. Down to the year 1572, both functions were free; but at that period, partly for financial reasons, a system of licensing was adopted at the suggestion of the Chancellor l'Hôpital. Among the other revolutionary measures of the year 1791, the professions of agent and courtier were again opened to the public. Many of the financial convulsions of the ensuing years, which were due to more serious causes, were attributed to this indiscriminate removal of restrictions, and they were re-imposed in 1801. From that period regulations have been made from time to time as to the qualifications of agents, the security to be found by them, and the like. (J. H. B.)

AGER, in *Roman Antiquity*, a certain portion of land allowed to each citizen.

AGER PICENUS, or PICENUM, in *Ancient Geography*, a territory of Italy, to the south-east of Umbria, reaching from the Apennines to the Adriatic. The people are called *Picentes* (Cicero, Livy), distinct from the Picentini on the Tuscan Sea, though called by Greek writers Πικεντινοί. This name is said to be derived from the bird *picus*, under whose conduct they removed from the Sabines, of whom they were a colony.

AGESILAUS II., king of the Lacedemonians, son of Archidamus II., was raised to the throne in opposition to the superior claim of his nephew Leotychides. Immediately on his accession, he advised the Lacedemonians to anticipate the king of Persia, who was making great preparations for war, and to attack him in his own dominions. He was himself chosen for this expedition, and gained so many advantages over the enemy, that if the league which the Athenians and the Thebans formed against the Lacedemonians had not obliged him to return home, he would have carried his victorious arms into the very heart of the Persian empire. He gave up, however, all these triumphs readily, to come to the succour of his country, which he happily relieved by his victory over the allies in Bœotia. He obtained another near Corinth; but, to his great mortification, the Thebans afterwards gained several over the Lacedemonians. These misfortunes at first raised a clamour against him. He had been sick during the first advantages which the enemy gained; but as soon as he was able to act in person, his valour and prudence prevented the Thebans from reaping the advantages of their victories; so that it was generally believed, had he been in health at the beginning, the Lacedemonians would have sustained no losses, and that without him all would have been lost. It cannot be denied, however, that his fondness for war occasioned many losses to his countrymen, and led them into enterprises which in the end contributed much to weaken their power. He died in the third year of the 103d Olympiad, being the 84th year of his age and 38th of his reign, and was succeeded by his son Archidamus. Agesilaus would never suffer any picture or sculpture to be made of him, and prohibited it also by his will. This he is supposed to have done from a consciousness of his own deformity; for he was of short stature, and lame of one foot, so that strangers used to despise him at the first sight. Agesilaus was extremely fond of his children, and would often amuse himself by joining in their diversions. One day when he was surprised riding upon a stick with them, he said to a person who had seen him in this posture, "Forbear talking of it till you are a father."

AGGER, in the *Ancient Military Art*, a work of fortification, used both for the defence and the attack of towns, camps, &c.; in which sense it is the same with what was otherwise called *vallum*, and in later times *aggestum;* and, among the moderns, *lines*, sometimes *cavaliers, terrasses*, &c. The agger was usually a bank or elevation of earth or other matter, bound and supported with timber; having sometimes turrets on the top, wherein the workmen, engineers, and soldiery were placed. It was also accompanied with a ditch, which served as its chief defence.

The height of the agger was frequently equal to that of the wall of the place. Cæsar tells us of one he made which was 30 feet high and 330 feet broad. Besides the use of aggers before towns, the generals used to fortify their camps with such works.

AGGER, in *Ancient Writers*, likewise denotes the middle part of a military road, raised into a ridge, with a gentle slope on either side, to make a drain for the water, and keep the way dry.—The term is also used for the whole road or military way. Where highways were to be made in low grounds, as between two hills, the Romans used to raise them above the adjacent land, so as to make them on a level with the hills. These banks they called *aggeres*. Bergier mentions several in Gallia Belgica, which were thus raised, ten, fifteen, or twenty feet above ground.

AGGERHUUS, one of the provinces or dioceses into which the kingdom of Norway is divided. It extends over 31,050 square miles, with a population, in December 1845, of 519,890 inhabitants. It is a very mountainous and most romantic district, abounding in woods, rivers, cascades, and lakes, with some moderately fruitful spots in the narrow valleys. The climate is raw and cold, and the frosts usually continue till May. The corn is scarcely sufficient for the consumption, though fish and potatoes are extensively used as food. The chief trade is in deals, pitch, and tar, with some iron, butter, tallow, and hides. The inhabitants all speak the peculiar language of Norway, a dialect of the Teutonic mixed with the Celtic. They are all of the Lutheran confession, and have 307 parish churches and chapels.



AGGERHUUS, a bailiwick in the see of the same name, in Norway. It is in the middle of the see, near the lake of Christiania, and comprehends 2 cities, 5 market towns, 22 parishes, and 109,432 inhabitants.

AGGLUTINANTS, in *Pharmacy*, a general name for all medicines of a glutinous or viscid nature; which, by adhering to the solids, were supposed to contribute to repair their loss.

AGGREGATION, in *Physics*, a species of union, whereby several things which have no natural dependence or connection with one another are collected together, so as in some sense to constitute one. Thus, a heap of sand, or a mass of ruins, is a body by aggregation.

AGHORI, a fraternity that infests almost every town in the upper provinces of Hindostan, especially Behar. Their religion teaches them to act in almost every thing contrary to the rules of caste, which they altogether despise; and, going to the opposite extreme, they eat all kinds of food, such even as those who do not respect caste abhor.

AGHRIM, or AUGHRIM, in Galway, a small village, about 95 miles from Dublin, and rendered memorable by a decisive battle fought there and at Kilcommodon-hill on the 12th of July 1691, between General Ginkell and Monsieur St Ruth, who commanded respectively under King William III. and James II. St Ruth was slain, with 7000 of his men: the loss of the English was only 700. The victory was the more brilliant, as the English army consisted of no more than 18,000 men, whereas the Irish were computed at 20,000 foot and 5000 horse and dragoons. They lost likewise nine pieces of brass cannon; all their ammunition, tents, and baggage; and most of their small-arms, which they threw away to expedite their flight; with 11 standards, and 32 pair of colours.

AGINCOURT, a French village in the department of the Pas de Calais, situate in N. Lat. 50. 35. E. Long. 2. 10. famous on account of the victory obtained there by Henry V. of England over the French.

On the morning of Friday the memorable 25th of October, A.D. 1415, the day of Crispin and Crispianus, the English and French armies were ranged in order of battle, each in three lines, with bodies of cavalry on each wing. The Constable d'Albert, who commanded the French army, fell into the snare that was laid for him, by drawing up his army in the narrow plain between the two woods. This deprived him, in a great measure, of the advantage he should have derived from the prodigious superiority of his numbers; obliged him to make his lines unnecessarily deep, about thirty men in file; to crowd his troops, particularly his cavalry, so close together, that they could hardly move or use their arms; and, in a word, was the chief cause of all the disasters that followed. The French, it is said, had a considerable number of cannon of different sizes in the field; but we do not hear that they did any execution, probably for want of room. The numbers of the French are differently stated, the estimates varying from 50,000 to 150,000 men. The first line was commanded by the Constable d'Albert, the Dukes of Orleans and Bourbon, and many other nobles; the Dukes of Alençon, Brabant, and Bar, &c. conducted the second line; and the Earls of Marle, Damartine, Fauconberg, &c. were at the head of the third line. The King of England employed various arts to supply

Agio.

his defect of numbers. He placed 200 of his best archers in ambush, in a low meadow, on the flank of the first line of the French. His own first line consisted wholly of archers, four in file, each of whom, besides his bow and arrows, had a battle-axe, a sword, and a stake pointed with iron at both ends, which he fixed before him in the ground, the point inclining outwards, to protect him from cavalry. This was a new invention, and had a happy effect. That he might not be encumbered, he dismissed all his prisoners on their word of honour to surrender themselves at Calais if he obtained the victory, and lodged all his baggage near the village of Maisoncelle, in his rear, under a slender guard. The main body of the English army, consisting of men-at-arms, was commanded by Henry in person; the vanguard, committed to Edward Duke of York, at his particular request, was posted as a wing to the right; and the rearguard, commanded by Lord Camois, as a wing on the left. The archers were placed between the wings, in the form of a wedge. The lines being formed, the king, in shining armour, with a crown of gold adorned with precious stones on his helmet, mounted on a fine white horse, rode along them, and addressed each corps with a cheerful countenance and animating speeches. To inflame their resentment against their enemies, he told them that the French had determined to cut off three fingers of the right hand of every prisoner; and to rouse their love of honour, he declared, that every soldier in that army who behaved well should from henceforth be deemed a gentleman, and entitled to bear coat armour.

When the two armies were drawn up in this manner, they stood a considerable time gazing at one another in solemn silence. But the king, dreading that the French would discover the danger of their situation, and decline a battle, commanded the charge to be sounded, about ten o'clock in the forenoon. At that instant the first line of the English kneeled down and kissed the ground; and then starting up, discharged a flight of arrows, which did great execution among the crowded ranks of the French. Immediately after, upon a signal being given, the archers in ambush arose, and discharged their arrows on the flank of the French line, and threw it into some disorder. The battle now became general, and raged with uncommon fury. The English archers, having expended all their arrows, threw away their bows, and rushing forward, made dreadful havock with their swords and battle-axes. The first line of the enemy was by these means defeated, its leaders being either killed or taken prisoners. The second line, commanded by the Duke d'Alençon (who had made a vow either to kill or take the King of England, or to perish in the attempt), now advanced to the charge, and was encountered by the second line of the English, conducted by the King. This conflict was more close and furious than the former. The Duke of Gloucester, wounded and unhorsed, was protected by his royal brother till he was carried off the field. The Duke d'Alençon forced his way to the king, and assaulted him with great fury; but that prince brought him to the ground, where he was instantly despatched. Discouraged by this disaster, the second line made no more resistance, and the third fled without striking a blow; yielding a complete and glorious victory to the English, after a violent struggle of three hours' duration.—Henry's *Britain*; and *Battle of Agincourt*, by Sir H. Nicolas.

AGIO, a term used in *Commerce*, to denote the difference between the real and the nominal value of money. In some states the coinage is so debased, that the real is greatly reduced below the nominal value. Sometimes this is owing to abrasion, and the wear of circulation. Where this reduction amounts, *e. g.* to 5 per cent., if 100 sovereigns were offered as payment of a debt in England, while such sovereigns were current at their nominal value, they would be received as just payment; but if they were offered as payment of the same amount of debt in a foreign state, they would be received only at their intrinsic value of L.95, the additional L.5 constituting the *Agio*. The same principle is applied to the paper currency of a country, when reduced below the bullion value which it professes to represent. According to the respective demand for gold or paper money for the purposes of commerce, it becomes necessary, in order to procure the one or other, as the case may require, to pay a premium for it, which is called the *Agio*.

Agiosymandrum || Agis.

AGIOSYMANDRUM, a wooden instrument used by the Greek and other churches, under the dominion of the Turks, to call together assemblies of the people. The *agiosymandrum* was introduced in the place of bells, which the Turks prohibited their Christian subjects the use of, lest they should make them subservient to sedition.

AGIS. Four kings of this name reigned at different periods in Sparta. The first of the name was the son of Eurysthenes, and is supposed to have reigned about 1032 B.C. The designation of *Helots*, is said to have had its rise in his time, from the unsuccessful revolt and final enthralment of the inhabitants of Helos by the Spartans.

Agis II. succeeded his father Archidamus, and reigned from 427 to 399 B.C. He was an able and successful general, and headed the Spartans at the great and decisive battle of Mantineia.

Agis II. succeeded his father Archidamus VI. B.C. 338. He took an active part in the league of the Grecian states against Alexander the Great, and at the head of their forces defeated a Macedonian army under Corragus. He was slain about 331 B.C., in a battle with Antipater, under the walls of Megalopolis.

Agis IV., son of Eudamidas II., and lineally descended from Agesilaus II., succeeded his father B.C. 244, and reigned four years. The degenerate state of the Spartan commonwealth moved him to attempt a reformation by restoring the institutions of Lycurgus, and, in the spirit of a true reformer, he set the example in his own person and household. His excellent intentions were seconded by all the younger and poorer portion of the community; but the rich and luxurious were vehemently opposed to measures which threatened to interfere so seriously with their influence and pleasures. His colleague, Leonidas, headed the opposition, and busily propagated the suspicion that Agis aspired to tyranny, by levelling the just distinctions of society, and increasing the power of the multitude. Agis was supported by the influence of his uncle Agesilaus, who, being deeply in debt, was highly favourable to the proposed changes. Lysander and Mandroclides, two of the ephori, were also strenuous promoters of the reform. When the time came for Agis to propose in the senate a general discharge of debts, and a new division of lands, the measure was lost by a minority of one. The triumph of Leonidas, however, was short. Being accused by Lysander of having violated the laws, he took refuge in the temple of Minerva, and refusing to appear in his own defence, was degraded from his dignity, and banished to Tegæa. His son-in-law, Cleombrotus, was elected in his stead. The next election of ephori proved unfavourable to the party of Agis. Lysander and Mandroclides were tried for innovation, but succeeded in persuading the two kings to eject the new magistrates out of office, which was effected in the midst of much tumult. The reformation might now have been established, but for the intrigues of Agesilaus, whose selfish schemes counteracted the good intentions of the two kings. At this time the Achaians sent to Sparta for assistance in the war with the Ætolians, which was granted. Agis received the command of the troops, and conducted the campaign with much reputation. On his return, he found that the misconduct of Agesilaus had resulted in a revolution, and the recal of Leonidas. He took refuge in the temple of Minerva, Cleombrotus in that of Neptune. Leonidas contented himself with banishing his son-in-law, but resolved on the ruin of Agis. The unfortunate king was accordingly seized and cast into prison, whence he was brought to trial and sentenced to be strangled. His mother and grandmother in vain entreated to gain him a public hearing: they were insidiously permitted to visit him in prison, where they immediately after shared his fate.

Agis, a Greek poet of Argos, who accompanied Alexander the Great to Asia, and celebrated the praises of his patron in verses of the most contemptible quality. Q. Curtius, viii. 5.

AGISTMENT, Agistage, or Agistation, in *Law*, the taking in of other people's cattle to graze at so much per week. The term is peculiarly used for the taking of cattle to feed in the king's forests, as well as for the profits arising from that practice. It is also used, in a metaphorical sense, for any tax, burden, or charge; thus, the tax levied for repairing the banks of Romney Marsh was called *agistamentum*.

*Tythe of Agistment*, or the tithe of cattle and other produce of grass lands, is a small tithe in England paid to the vicar or rector by the occupier of the land, and not by the person who may put his cattle there to graze at a certain rate per head. This tithe was abolished in Ireland by the act of Union; but for a long time previously it had been very irregularly paid. After the Reformation, while the lands were chiefly in the possession of Catholics, the clergy received thankfully whatever they could get; but subsequently to the capitulation of Limerick, when almost all the benefices fell into the hands of Protestant rectors, they gradually began to reassume their constitutional rights. Accordingly, about the year 1720, they formally demanded payment of the tithe of agistment, to which their right was as indisputable as to the tithe of tillage lands; but it was vehemently resisted by the landlords. The clergy appealed to the Court of Exchequer; but although they obtained a decision in their favour, the question was not set at rest: for soon afterwards (on the 18th March 1735), the Irish House of Commons resolved, "that any lawyer assisting in a prosecution for tithes of agistment, should be considered as an enemy to his country." The tendency of this arbitrary and unjust procedure was to deprive the incumbents of the greater part of their income, and, at a time when the cultivated land in Ireland was but a mere fraction of what it now is, to throw the whole burden of their maintenance on the cultivators of tillage lands, thus relieving the extensive landowners at the expense of the small proprietors and tenants. In this position the matter stood at the period of the Union, when Sir John Macartney, aware that the extraordinary resolution of 1735 was not law, attempted to frustrate the Union, by moving that the abolition of the tithe of agistment should be embodied in the act. The measure, however, contrary to expectation, was suffered quietly to pass, and became law by a formal act of the imperial parliament. See *Wakefield's Account of Ireland*, vol. ii. p. 485.

AGISTOR, or Agistator, an officer belonging to forests, who has the care of cattle taken in to be grazed, and levies the moneys due on that account. They are generally called *quest-takers* or *gift-takers*, and are created by letters-patent. Each royal forest has four agistors.

AGITATION, the act of shaking a body, or tossing it backwards and forwards.

Agitation, *in Politics*, is the art of keeping the object to be obtained perpetually under discussion, so as to make a deep impression on the public mind. For this purpose a large number of co-operators is not at first absolutely requisite: the desired sensation may be produced by the well-directed efforts of a few, and it is not even necessary to success that the object of pursuit be important to the great mass of the people, or practically useful. The great agitator Daniel O'Connell was able to stir up the mass of the Irish nation, and keep them for years in a state of intense excitement, in the hopeless struggle for the attainment of his panacea for all their evils—a repeal of the Union. We have an instance of the beneficial effect of this principle, when wisely directed to a legitimate object, in the judicious and constitutional agitation which paved the way to the repeal of the corn-laws.

The effect of political agitation has long been recognised, and prompted the answer of the Marquis of Anglesey when lord-lieutenant of Ireland, to a deputation that waited on him with a petition. "If you really expect success, *agitate, agitate, agitate*." How heartily this advice has been followed, in that country especially, is too well known to all.

The ordinary course pursued by agitators is to hold public meetings, pass resolutions, get up petitions, employ popular lecturers, and procure frequent discussions in the newspapers on the subject; and though at first the public at large may take very little interest in the object proposed, yet, by the loud and constant agitation kept up, it may assume an aspect of the utmost importance. Thus, not only measures of great value have often been obtained, but, on the other hand, by the same means, objects of little or very doubtful advantage have too often acquired public favour. Agitation is a two-edged weapon that requires to be cautiously and prudently used; but when so employed in a good cause, it rarely fails to make an impression on the legislature, in countries blessed with a representative government. Under a despotism agitation cannot exist, but it is an invariable feature of free governments.

AGITATOR, in *Antiquity*, a term sometimes used for a charioteer, especially those who drove in the circus at the curule games.

Agitators (a corruption of *Adjutators*), in *English History*, certain officers appointed by the army in 1647, to take care of its interests during the revolutionary struggle.

AGLAIA, the name of the youngest of the three Graces, espoused to Vulcan.—*Hesiod.*

AGLAPHON, a Greek painter, best known as the father of Polygnotus. He was of Thasos, and flourished about 500 years B.C. He had also a son of his own name.

AGLAR. See Aquileja.

AGLIE, or Aglia, a town of Piedmont, nine miles southwest of Ivrea. It has a population of 4300. Near it is a royal palace, with an extensive park, fine gardens, and a collection of antiquities from Tusculum.

AGLIONBY, John, an English divine, chaplain in ordinary to King James I., was born in Cumberland, and admitted a student at Oxford in 1583. He was a man of universal learning, and took a very considerable part in the translation of the New Testament appointed by King James I. in 1604. He died in 1609.

AGMEN, in *Antiquity*, properly denotes a Roman army in march; in which sense it stands contradistinguished from *acies*, which denoted the army in battle array; though, on some occasions, we find the two words used indifferently for each other. The Roman armies in their marches were divided into *primum agmen*, answering to our vanguard; *medium agmen*, our mainguard; and *postremum agmen*, the rearguard.

AGNANO, Lago d', a small circular lake, near Naples, about two miles in circumference, and evidently the crater of a volcano, now filled with water. On its banks are the *stufe*, or natural vapour-baths of San Germano, and on its opposite shore is the famous *Grotta del Cane*, from the floor of which carbonic acid is continually evolved, in such quantity as to kill dogs that enter it, while a man, on account of his erect posture, escapes wholly the effect of the gas. (See *Spallanzani's Travels.*) This grotto is a small artificial excavation 12 feet long by 4 or 5 wide, and 6 feet high, seemingly made for obtaining puzzolano, or earthy volcanic tufa. The story of birds not frequenting the lake is erroneous, for it abounds in teal ducks and other birds, and in frogs.

AGNATE (from the Roman *Agnatus*), in *Law*, any male relation by the father's side.

AGNEL, an ancient French gold coin, first struck under the reign of St Louis, worth about twelve sols six deniers. The agnel is also called sometimes *mouton d'or*, and *agnel d'or.* The denomination is supposed to have arisen from the figure of a lamb (*agnus*) struck on one side.

AGNES, St, a large mining village in the county of Cornwall, 263 miles from London, and eight from Truro. It is built on a small rocky harbour, only accessible to fishing boats, on the British Channel. Pop. in 1851, 6674.

Agnes, St, one of the Scilly Islands, on the coast of Cornwall. The soil is fertile, and tolerably cultivated; but there is a great deficiency of water. A lighthouse on the island, about 50 feet in height, built on one of the loftiest hills, is an important object to seamen. Its exact position, as ascertained by the great trigonometrical survey, is in Long. 6. 19. 23. W. and Lat. 49. 53. 38. N. from Greenwich. The light is composed of Argand lamps, with reflectors, moving in a circular revolution, and presenting a bright and conspicuous light in every direction once a minute. Westward of St Agnes is the Gillstone rock, on which Sir Cloudesley Shovel was lost in the Association ship of war in 1707.

AGNESI, Maria Gaetana, an Italian lady, who may be justly pronounced one of the greatest wonders and ornaments of her sex, was born at Milan, on the 16th of May 1718. At nine years of age she not only spoke the Latin language with precision, but even composed and delivered an oration in that language, intended to prove that the cultivation of letters is not incompatible with the female character. This singular piece was published at Milan the same year in which it was spoken, with the following title: *Oratio, qua ostenditur artium liberalium studia a fœmineo sexu neutiquam abhorrere, habita a Maria de Agnesiis, rhetoricæ operam dante, anno ætatis suæ nono nondum exacto, die* 18 *Augusti* 1727.

At eleven years of age she spoke Greek with all the fluency of her native tongue. When yet very young, she had also acquired some of the languages of the East; and, in a word, her acquisitions as a linguist were such as to procure for her the appellation of a *Walking Polyglot.* But her aptitude for acquiring languages, however great, was by no means the only, or the most striking feature of her intellectual character. We have seen how early she essayed the discussion of a general question affecting the mental capacities of her sex; and the vigour and acuteness displayed in this aspiring essay were, ere long, exerted with ardour and success in scientific inquiries. Having gone through the elementary branches of mathematics, she proceeded with alacrity to the study of natural philosophy; and she seems also to have carried her researches into the obscurer regions of metaphysical speculation.

About the time when she reached her fifteenth year, her father formed a select assembly of the learned of Milan; and at these meetings, which were held in his house at stated times, for several years, Agnesi maintained a succession of *Theses* on various points of speculation and philosophy. The ability which she displayed on these occasions seems to have been altogether surprising; and the effect was not the less, that her person was agreeable, and her whole deportment gentle and prepossessing. We are indebted to the learned president De Brosses for the following account of one of these conferences at which he assisted, during his travels in Italy, through the introduction of Count Belloni. "I had conceived," says he, "when I went to this *conversazione*, that it was only to talk with this young lady in the usual way, though on learned subjects; but to my surprise Belloni addressed her in a fine Latin harangue, with all the formality of an academic oration. She replied in the same language with promptness and ability; and they proceeded, still in Latin, to discuss the origin of fountains, and the causes of the ebbings and flowings observed in some of them. She spoke like an angel on this subject, and I never heard it treated so much to my satisfaction. We then discoursed with her concerning the manner in which the soul receives impressions from outward objects, and their conveyance to the general *sensorium*, the brain; and afterwards upon the propagation of light, and the prismatic colours. The conversation afterwards became general, every one speaking to her in the language of his own country, and she answering in the same." (*Lettres sur l'Italie*, tom. i. p. 243.) But Agnesi seems to have taken but little delight in the glory which she acquired as a philosophical disputant. Her temper was retired and devout, and she appears to have acted this part more to gratify her father than herself. About her twentieth year she accordingly withdrew from these assemblies, and for a long period devoted the greater part of her time to mathematical studies. The Theses which she had maintained with so much applause were published in a quarto volume, under the following title: *Propositiones Philosophicæ, quas crebris disputationibus domi habitis coram clarissimis viris explicabat extempore, et ab objectis vindicabat, Maria Gaetana de Agnesiis, Mediolanensis.* Med. 1738.

The first fruit of her mathematical studies was a Commentary on the *Conic Sections* of the Marquis de l'Hôpital; but this piece she would never consent to publish, though Mazzuchelli says that it was greatly praised by many who had perused the manuscript. In the course of a few years, however, she gave to the world a mathematical work, which must ever secure her a high rank among the most distinguished cultivators of abstract science. This work, entitled *Instituzioni Analitiche ad uso della Gioventu Italiana*, was published at Milan in 1748, in two volumes quarto. The first volume treats of the analysis of finite quantities; the second, of the analysis of infinitesimals. These two volumes contain a full and satisfactory view of this branch of mathematical science in the state at which it had then arrived; and though improvements have since that time been introduced, the treatise of Agnesi, according to a very competent authority, may still be regarded as perhaps the best introduction that is to be found to the works of Euler and the other mathematicians of the Continent. (*Edinb. Review*, vol. iii. p. 408.) An English translation of this work was long ago executed by the late Professor Colson of Cambridge; but the manuscript lay buried in obscurity for many years, and was only published in 1801, through the care and at the expense of Baron Maseres.

Besides other literary honours which followed the publication of the *Analytical Institutions*, Agnesi was, in 1750, appointed professor of mathematics and natural philosophy in the university of Bologna. The appointment of a young female, of thirty-two years of age, to such a charge, must appear to many as not a little singular; but the truth is, that female professors were by no means uncommon in Italy; and Lalande mentions several as having been eminent in the same university, one of whom was professor of anatomy. (*Voyage en Italie*, tom. ii.) Our scanty information does not enable us to state whether Agnesi ever entered upon the active duties of the mathematical chair. Though her life was long, we can add but little in regard to her after-history. She died, according to the meagre notice contained in the *Biographie Universelle*, in the year 1799. Her mistaken notions of religious duty rendered the greater part of her existence but a blank to the world. She had early expressed a wish to retire into a convent, and seems to have carried this design into effect not long after the period when her great work procured for her the honours to which we have just alluded. We afterwards hear of her only as a devoted sister of the austere order of *Blue Nuns*, repelling the approaches of those of the learned who still desired to converse with her, and thus exhibiting, like Pascal, another melancholy instance of the inconsistencies of our nature, and the darkening power of superstition over the brightest minds. But she lived long enough for the world to vindicate the intellectual capacities of her sex,—to show that the female mind is not only fitted for the lighter exercises of literature, but capable also of fathoming the depths and unravelling the intricacies of abstract science. If there are any, therefore, whose speculations may have led them to more depreciating conclusions, let them, to use the words of the eloquent writer already quoted in this article, "peruse the long series of demonstrations which the author of the *Analytical Institutions* has contrived with so much skill, and explained with such elegance and perspicuity: if they are able to do so, they will probably retract their former opinions; if unable, they will not of course see the reasons for admiring her genius that others do; but they may at least learn to think modestly of their own."—*Edinb. Review*, vol. iii. p. 410. (M. N.)

AGNOETÆ (from αγνοεω, to be *ignorant* of), in *Church History*, a sect of ancient heretics, who maintained that Christ's human nature did not become omniscient by its union with his divinity.—See Reid's edition of *Mosheim*, p. 238, note.

AGNOMEN, in *Roman Antiquity*, a kind of fourth or honorary name, given to a person on account of some extraordinary action, virtue, or accomplishment. Thus the agnomen *Africanus* was bestowed upon Publius Cornelius Scipio on account of his great achievements in Africa. The order in which the names of a Roman citizen followed each other was thus: 1. *Prænomen*, denoting the individual; 2. *Nomen gentilitium*, indicating the *gens* to which he belonged; 3. *Cognomen*, which every citizen had or might have, marked his *familia;* 4. *Agnomen*, given as a mark of distinction, usually honorary, but sometimes the reverse.

AGNONE, a city at the foot of Monte Capraro, in the province of Molise, in the kingdom of Naples, with 7000 inhabitants, chiefly employed in the manufacture of copper wares.

AGNUS DEI, in the Church of Rome, a cake of wax stamped with the figure of a lamb supporting the banner of the cross. These being consecrated by the pope with great solemnity, and distributed among the people, are supposed to have great virtues; as, to preserve those who carry them worthily, and with faith, from all manner of accidents; to expel evil spirits, &c. It was sometimes made of gold.

AGNUS *Dei* is also a popular name for that part of the mass wherein the priest, striking his breast three times, rehearses, with a loud voice, a prayer beginning with the words *Agnus Dei.* It is said to have been first introduced into the missal by Pope Sergius I.

AGOBARD, Archbishop of Lyons from 816 to 840, was one of the most enlightened and distinguished men of his age, the champion of truth, and the successful opposer of every form of superstition. Of his writings, which were rescued from destruction in a shop at Lyons in 1605, the principal are—a *Treatise against Felix D'Urgel; Treatise against the Jews; Against Trial by Combat; On the Privileges and Rights of the Priesthood; Against Sorcery;* and the celebrated treatise *Against the Worship of Images.* 2 vols. 8vo, Paris, 1666.



AGON, a small seaport town of France, in the department of La Manche, with 1561 inhabitants.

AGON, among the *Ancients*, implied any dispute or contest, whether it had regard to bodily exercises or the accomplishments of the mind; and therefore poets, musicians, painters, &c., had their agones, as well as the athletæ. Games of this kind were celebrated at most of the heathen festivals with great solemnity, either annually or at certain periods of years. Among the latter were celebrated at Athens, the *agon gymnicus*, the *agon Nemeus* instituted by the Argives in the 53d Olympiad, and the *agon Olympius* instituted by Hercules 430 years before the first Olympiad.—The Romans also, in imitation of the Greeks, instituted contests of this kind. The emperor Aurelian established one under the name of *agon solis*, the contest of the sun; Diocletian another, which he called *agon capitolinus*, which was celebrated every fourth year, after the manner of the Olympic games. Hence the years, instead of *lustra*, are sometimes numbered by *agones.*

AGON also signified one of the ministers employed in the heathen sacrifices, and whose business it was to strike the victim. The name is supposed to have been derived from hence, that standing ready to give the stroke, he asked *Agon'?* or *Agone?* Shall I strike? Ovid. *Fast.* l. 1.

AGONALIA, in *Roman Antiquity*, festivals celebrated in honour of Janus or the god Agonius, whom the Romans invoked before undertaking any affair of importance.

AGONALIS CIRCUS, now *La Piazza Navona*, a long, wide, and beautiful street in the centre of Rome, adorned with fountains, and with the obelisk of Caracalla. The reason of the name *Agonalis* is either unknown or doubtful. Ovid derives it from the *agones*, or solemn games, there celebrated, supposed to have been the *Ludi Apollinares*, or *Actiaci*, instituted by Augustus; whence the circus was called *Apollinaris;* also *Alexandrinus*, from the emperor Alexander Severus, who either inclosed or repaired it.

AGONISMA, in *Antiquity*, denotes the prize given to the victor in any combat or dispute.

AGONISTARCHA (αγων, and αρχος), in *Antiquity*, seems to have been much the same with *agonotheta;* though some suggest a difference, making it the office of the former to preside at and direct the private exercises of the athletæ, which they went through by way of practice, before they made their appearance on the public theatres.

AGONISTICI, in *Church History*, a name given by Donatus to such of his disciples as he sent to fairs, markets, and other public places, to propagate his doctrine; for which reason they were also called *Circutores, Circelliones, Catropitæ*, and at Rome *Montenses.* They were called *Agonistici*, from the Greek αγων, *combat*, being sent as it were to fight and subdue the people to their opinions.

AGONIUM, in *Roman Antiquity*, was used for the day on which the *rex sacrorum* sacrificed a victim, as well as for the place where the games were celebrated, otherwise called *agon.*—*Fest.* p. 9.

AGONOTHETA, or AGONOTHETES (αγων and τιθημι), in *Grecian Antiquity*, was the president or superintendent of the sacred games; who not only defrayed the expense attending them, but inspected the manners and discipline of the athletæ, and adjudged the prizes to the victors. But in the great public games, such as the Olympic, Pythian, &c., these presidents were the representatives of different states, or were chosen from the people in whose country the games were celebrated. They received the several titles of αἰσυμνῆται, βραβευταί, ἀγωνάρχαι, ἀγωνοδίκαι, ἀγωνοθέται, ἀθλοθέται; but Favorinus makes the distinction, that the term ἀθλοθέται was peculiar to gymnastic exercises, whereas that of ἀγωνοθέται might refer equally to musical contentions. They were also called ῥαβδοῦχοι or ῥαβδονόμοι, from the rod or sceptre emblematic of their authority.

AGONYCLITÆ (α, priv. γονυ and κλινω), in *Church History*, a sect of Christians, in the seventh century, who prayed always standing, thinking it unlawful to kneel.

AGORA (αγειρω, I congregate), in *Grecian Antiquity*, denoted both the public assembly of the people and the place in which they met. In the latter sense the term corresponds to the Roman *Forum.* The open space of the Agora was surrounded by the various buildings connected with the public administration. It was also in general the market place, and formed, as may be supposed, the centre of public resort and business of all kinds.

AGORACRITUS, a famous Greek statuary and sculptor, and the favourite pupil of Phidias, who is said by Pliny to have inscribed even some of his own works with the name of his disciple.

AGORÆUS, in *Heathen Antiquity*, an appellation given to such deities as had statues in the market-places; particularly Mercury, whose statue was to be seen in almost every public place.

AGORANOMI (αγορα and νεμω), in *Grecian Antiquity*, public functionaries, who had the regulation of weights and measures, the prices of provisions, &c.—The *agoranomi*, at Athens, were ten in number, five belonging to the city, and as many to the Piræus, one from each tribe being chosen by lot. To these a certain toll or tribute was paid by foreigners or aliens who brought any thing to sell in the market.

AGORDO, a market town in the Austrian dominions, in Italy, with 2600 inhabitants. It is in the government of Venice, and in the delegation of Belluno, on the river Cordevolo. In its vicinity are mines of copper, lead, sulphur, and vitriol, the preparation of which is the chief occupation of the people.

AGOSTINI, Lionardo, an eminent antiquary of the seventeenth century, author of a great work on Sicilian medals, and another upon ancient gems.

AGOSTINO, and Angelo, Da Siena (1296–1338), two brothers, sculptors and architects, who greatly distinguished themselves in the infancy of Italian art. Their native Siena is adorned by many of their works. See *Lanzi*, i.

Agostino, *Paolo*, of Valerano, an eminent musician, master of the chapel of St Peter's at Rome, and celebrated for his scientific compositions in every branch of his art. He died in the prime of life, A.D. 1629.

AGRA Provinces. In 1833 the British Parliament authorised the division of the territories of Bengal into two distinct presidencies; the one retaining the title of the Presidency of Bengal, and the other to be styled the Presidency of Agra. Subsequently the sanction of the legislature was obtained for the suspension of the contemplated division, and for the appointment, during the interim, of a lieutenant-governor of the districts which were intended to constitute the separate presidency of Agra. The seat of the new government has been fixed in the city of Agra, and from this circumstance the officer charged with the administration is usually styled the Lieutenant-Governor of Agra. The extensive territory subject to his jurisdiction is bounded on the north and north-east by the tract known as the Cis Sutlej territory, and by the native state of Nepaul; on the east and south-east by the kingdom of Oude and by some of the lower provinces of Bengal; on the south by the dominions of the Rajah of Nagpore and those of the Nizam, and on the west by the native states of Central India. It is 720 miles in length from north-west to south-east, and 310 in breadth in the direction of the opposite angle; and extends from Lat. 21. 17. to Lat. 31. 6., and from Long. 73. 2. to Long. 84. 40. It has an area of 101,241 square miles, and a population of upwards of twenty-five millions. The geographical divisions of this vast tract comprise, 1*st*, The thirty-one north-western provinces of India, usually denominated the "Regulation Provinces," most of them larger than English counties, and in all of which the general code of laws passed by the British government in India since 1793 is in full operation; 2*d*, The province of Kumaon, the Deyrah Doon, the Saugur and Nerbudda territories, and other large districts, wherein, though justice is administered in the spirit of the code, considerable discretion rests with the superintending functionaries to dispense with the letter of the law, when the claims of equity may appear to require such a course; 3*d*, Sundry petty native states whose defence from external aggression has devolved upon the British government, but in regard to which that government has pledged itself to abstain from all interference in the internal administration. Statistical and geographical particulars in respect to these states and the non-regulation provinces will be found detailed under their respective names in the alphabetical arrangement. The Regulation Provinces before mentioned occupy the valleys of the Jumna and the Ganges. Here the country is flat and open; little chequered by the interchange of hill and dale; and for the most part bare of trees; but to the south of the river Chumbul, and also towards the western frontier, it rises into hills, and is interspersed with jungle. Owing to the elevation of the ground, the climate for the greater part of the year is temperate, and in the winter months, especially during the night, it becomes actually cold. The general character of these districts affords great facilities for purposes of irrigation. They are intersected throughout their entire length by two great rivers, the Ganges and the Jumna, which derive their sources from the Himalayas, and the drainage of these mountains has been made extensively available by the construction of canals which traverse the land in various directions. Sugar and rice are less largely cultivated than in the lower provinces of Bengal, but cotton is a valuable article of produce, and the export of opium and indigo is annually increasing. The mineral productions are not remarkable: nor do the animals differ in any respect from those found in other parts of Hindostan. A coarse description of cotton cloth is the principal article of manufacture, but no great quantity is exported. The natives are a robust and handsome race of people, and consist of a mixture of Hindoos and Mahometans.

The experiment of a separate administration for these provinces has been eminently successful. Such a result might indeed have been reasonably anticipated. None but servants of the East India Company are eligible for the office of lieutenant-governor; and as the local authorities must obviously be the best judges of the character and qualifications of their respective functionaries, the choice of the individual to discharge its arduous duties was wisely committed to the government of India. Opportunity is thereby afforded for promoting the ablest public servant without reference to the ordinary principle of seniority. That the right of selection has been discreetly exercised may be inferred from the fact, that Agra is popularly denominated "the Model Government" of India; and a passing notice of one or two of the series of comprehensive measures which of late years have been adopted for the improvement of the condition and the elevation of the character of the people, may suffice to show that the title has not been conferred unworthily. We will first advert to the new land revenue settlement. In this part of India, the land is held in the most minute subdivision by the agricultural classes, and the entire breadth of the Regulation Provinces has recently come under government survey. Every separate holding was then measured, and an official record compiled, in which are detailed the boundaries and extent of the farm, the quality of the soil, the name both of landlord and tenant, the government revenue at which the former is assessed, and the amount of rent payable by the latter. The actual condition of the landed property of the country, together with the relations of landlord and tenant, and the rights and obligations of both parties, having been ascertained and defined, ample means are now possessed for the adjustment of all disputes affecting real property; and as the land in India is the great source of litigation, these records have rendered the administration of justice both simple and effective. The government assessment is levied with equity and moderation,—a part only being taken of the surplus constituting the rent. The remainder furnishes an income to the landholder, who has thus the means of effecting improvements, while, moreover, his property acquires a marketable value. Another great work to which it may be proper to draw attention, is the government plan of education. The system of registration which has been sketched was devised for the protection of the rights of the community. The registers are open to public inspection; but owing to the prevailing ignorance of the first elements of learning, these records proved, in the first instance, but a sealed book to the great bulk of the community. The majority of the population, it was discovered, were unacquainted with the simplest rules of arithmetic and land measurement, and unable, for the most part, to read or write. The people knew that they were in possession of valuable rights, and they felt that these rights were liable to be defeated solely because they were unable to define them. A desire for knowledge was suddenly manifested, from the conviction of its necessity to the general weal, and the lieutenant-governor was not slow in availing himself of so favourable an opening for educating the community. A scheme of instruction, admirably adapted to the exigencies of the agricultural classes, came into operation in the year 1848. Its design is to aid the efforts of the people in acquiring so much knowledge as is sufficient for the ordinary purposes of life: it contemplates the fulfilment of this object by the means of indigenous schools scattered over the surface of the country. Where a school is wanted, the villagers are assisted in building one; where the superintendence is defective, the government provides a competent instructor; where books are needed, they are supplied from the stock of vernacular literature prepared and printed by the government. The agency for carrying out the plan consists of a series of government model-schools, with two grades of school-visitors, superintended by a visitor-general. The course of education comprises reading, writing, arithmetic, and land measurement; and when practicable, geography, history, and other subjects, are superadded.

These measures, worthy of a paternal government and an enlightened age, clearly mark the difference of character between British and native rule. Under the Hindu dynasties the social fabric was upheld through the power and influence of privileged classes. The Mahometans, who succeeded, ruled for their own advantage, with little regard to the interests of their conquered subjects, and class legislation prevailed. It is only under British administration that the wants and interests of the masses have been permitted to occupy any share of the attention of the state, and to the government of Agra must be awarded the honour of having been foremost in recognising their paramount importance. (E. T.)

AGRA CITY, the seat of the government of the north-western provinces of Bengal, is situate on the south-west or right bank of the river Jumna, which is here a navigable stream. The extent of the city is about four miles in length, and three in breadth: it sweeps along the banks of the river in a semicircle, and suggests, on a distant view, an idea of grandeur; which, however, is not realised on nearer inspection. A well-constructed strand road leads from the Taj Mehal to the custom-house, a distance of two miles; but the principal thoroughfare is a fine broad street, running almost north and south, and nearly bisecting the city. In this locality, the houses, chiefly built of the red stone found in the neighbouring hills, are from three to four stories high. In other quarters of the town the streets, though cleanly, are narrow and irregular, and the houses, for the most part, of mean character. The fort of Agra is, as to appearance, one of the most imposing in India. It is surrounded by high walls and towers of red stone, which command some noble views of the city, its neighbourhood, and the windings of the Jumna. It has a ditch of great depth, and a double rampart, the inner one being of an enormous height, with bastions at regular distances. The fort was invested in 1803 by the army of Lord Lake, and surrendered after a brief resistance. The defences were subsequently improved, but it is still reported to be a place of no great strength.



Agra is famed for some beautiful edifices, the most remarkable of which is the Taj Mehal, a mausoleum erected by the Emperor Shah Jehan to commemorate the virtues of his favourite consort. The name of this distinguished personage was Arjammed Banoo, which, according to oriental usage, was changed on her elevation to that of Mumtazee Zumanee, signifying *the paragon of the age*. The Taj Mehal, of white marble, with four tall minarets of the same material rising at each of its angles, is placed on an elevated terrace, also of white and yellow marble. The interior, containing a central hall, in which are the tombs of the emperor and his queen, is remarkable for its exquisite finish, the pavement being laid with alternate squares of marble, and the walls, screens, and tombs, crowned with flowers, and inscriptions executed in beautiful mosaic of carnelian, lapis lazuli, and jasper, the whole appearing as fresh and almost as perfect as when first completed. Bishop Heber mentions that after all he had heard of this far-famed mausoleum, its beauty rather exceeded than fell short of his expectations. The Taj is surrounded by a lofty wall of red stone, with cupolas and pillars of marble.

Within the walls of the fort are the palace of Shah Jehan, and the Motee Musjid or Pearl Sanctuary, a celebrated mosque of white marble. Outside the walls is another mosque, termed the Jumna Musjid, and in the adjoining suburbs of Secundra is the mausoleum of the Emperor Akbar. An English church has been erected in Agra, which is described as a handsome building, and calculated to hold 1000 persons. The population of the city was computed in 1846 at 66,000. Lat. 27. 10. Long. 78. 5. (E. T.)

AGRAM, or ZAGRAB, a palatinate in the Austrian province of Croatia. Its extent is 768 square miles, or 491,520 English acres. Pop. in 1829, 392,190; all of the Catholic religion. It is subdivided into two circles, that of Agram and of St John; the latter of which comprehends no town. In the whole palatinate there are one city, two market towns, and 279 villages. The country is undulating, but with a range of hills towards the Warasdin frontier. It is watered by the Save and its tributary streams. The chief productions are corn, tobacco, wine, potashes, and cattle. It contains much wood and pasture land. Agram or Zagrab, the capital of Croatia, on the palatinate of the same name, is situate on a hill near the banks of the Save, in Lat. 45. 49. N. Long. 16. 1. E., 170 miles south of Vienna. It is the seat of the governor of Sclavonia and Croatia, of a bishop, and of the courts of justice. Agram contains 20,000 inhabitants, and is divided into three parts, called the upper and lower town, and the town of the bishop. It has a lyceum, library, museum, gymnasium, an ancient cathedral with forty altars, and a large library. Some silk and porcelain are manufactured, and a brisk trade is carried on in grain, potash, and tobacco.

Agrarian.

AGRARIAN LAWS (*Leges Agrariæ*), when used in the most extended signification of the term, are laws for the distribution and regulation of property in land. The history of these enactments is not only important as explanatory of the constitution of the ancient republics, but is rendered highly interesting by the conflicting opinions which have been entertained respecting their object and operation. It seems to have been a notion generally entertained in the ancient world, that every citizen of a country should be a landholder; and that the territory of a state, so far as it was not left uninclosed or reserved for public purposes, should be divided in equal portions among the citizens. Such a distribution of public land seems to have been acted upon as a recognised principle from the earliest period to which existing historical records extend. Hence we find the Almighty giving express instructions to Moses as to the manner in which the land of Canaan was to be portioned out among the Hebrews (*Num.* xxxiii. 54), and naming the persons to whom the division was to be entrusted (*Num.* xxxiv. 16–18). A division of the land was accordingly made, and the portion assigned to each man became his inalienable property, and descended in perpetuity to his heirs and successors. By the law of Jubilee, all lands were restored free from encumbrances on the recurrence of the "year of release;" so that, though a man's estate might, in the interval, have been repeatedly sold or alienated, yet, on the return of the fiftieth year, it reverted to the heirs of the original possessor (*Levit.* xxv. 10). In the republics of ancient Greece, and also in the Grecian colonies, a similar principle of division of land prevailed (*Thuc.* v. 4., *Herod.* iv. 159). Lycurgus is represented by Plutarch (*Lycur.*), as re-dividing the whole territory of Laconia into 39,000 parcels, of which 9000 were assigned, in equal lots, to as many Spartan families, and 30,000, also in equal lots, to their free subjects; and although this statement is not borne out by any of the early Greek historians, and is even inconsistent with the assertion of Aristotle (*Polit.* ii. 4), yet it is valuable as recognising the principle of the division of the public lands. (See Thirlwall's *Hist. of Greece*, chap. viii., and Grote's *Hist. of Greece*, part ii. chap. vi., with the authorities there quoted.)

It was long a prevalent and undisputed opinion that the territories of the Hebrews, and of the republics of ancient Greece were divided into equal portions, and that the object of such a distribution was to maintain a state of equality among all the members of the community. This, however, does not appear to be consistent with the distinctions of rank which we find admitted in Scripture (*Josh.* ix. 15; xxii. 14; 1 *Sam.* ix. 21, &c., &c.); and from a remark of Thucydides (i. 6), taken in connection with the statement of Aristotle (*Polit.* ii. 9), it may be legitimately inferred that property did not continue to be equally distributed at Lacedæmon. Distinctions of rank are clearly recognised in the legislation of Solon. Aristotle, in the Second Book of his Politics (chap. vi., &c.), explains the constitutions of several of the ancient republics, and endeavours to show how the population is to be accommodated to this equal division of land; but it would be foreign to our object to review his arguments. It may be sufficient to remark, that such an attempt to arrest the progress of enterprise is altogether inconsistent with the spirit of liberty which gave life and energy to the ancient republics; and that though it might have been carried into effect under the despotism of Persia, or the predominant rule of the kings of Macedonia, it was entirely at variance with the freedom of opinion which prevailed in Greece, and the stubborn resistance to control which animated the Romans after the expulsion of the kings. But, granting that such a policy had been practicable, it would have been highly inexpedient. The ignorant Hindoo might remain satisfied with the *class* which nature had transmitted to him through successive generations, because his progenitors had been prevented from emerging from their obscurity; but the citizens of Greece and Italy, being themselves constituent members of the body politic, and not ignorant of the power thereby conferred on them, could not have been kept in check by the same principle of fear. Such an attempt, moreover, to prevent the acquisition of property, would have obstructed the advancement of the arts of civilised life, would have extinguished those feelings of patriotism which led the Greeks so often to hazard their lives in defence of their country, and, by engendering discontent and exciting internal commotions, would have made them an easy prey to their enemies.

The expression Agrarian Laws, however, is more commonly applied to the enactments among the Romans for the management of the public domains (*ager publicus*); and to an account of these the remainder of our space must be devoted. It is a singular fact that, while almost every other subject connected with the Roman constitution had been successfully investigated and explained, the object and intention of the agrarian laws were entirely misunderstood by scholars for many centuries after the revival of letters. They were invariably represented as intended to prohibit Roman citizens from holding property in land above a certain fixed amount; and as authorising the division among the poorer citizens of the estates of private individuals, when these exceeded the prescribed limit; thus legalising a system of plunder which would have been subversive of all social order. No such doctrine had, indeed, been admitted in any well-regulated state, ancient or modern; nor did anything analogous to it appear in the principles or practice of the Roman constitution: yet the expressions used by the ancient authors in reference to these enactments, and the disturbances to which they invariably gave rise, seemed to justify an unfavourable interpretation; and the opinion, when once propounded, was unconditionally received by successive generations of learned men, notwithstanding the many embarrassments and contradictions to which it led.

Romulus is represented as dividing his small territory among the members of his infant community at the rate of two *jugera* (each extending to two-thirds of an English acre) a-piece, as inheritable property. The whole district, however, was not thus assigned; one portion was set apart for the service of the gods, and for the royal domains; and another was reserved as common land for pasture. The stock kept on the common land served to eke out a maintenance which two *jugera* could not otherwise have furnished to a family, and an agistment was paid to the commonwealth for the pasturage. It is probable that the same principle prevailed under the regal government, and that successive adjustments of the territory were made. Such a law existed among those of Servius Tullius. The equality of property thus established seems to have been considered as a fundamental principle of the Roman constitution; and the agrarian laws were regarded as the necessary means of wresting from the large proprietors the possessions which they had illegally acquired. Machiavelli and Montesquieu both participate in this mistake, and are far from condemning the agrarian laws, even when taken in the common meaning. The former alleges that the interest of every republic requires that the state should be rich and the citizens poor, and thus justifies the assumed spoliation; while Montesquieu receives it as an historical fact that Romulus adopted the principle of equality in his original distribution of the territory of Rome, as the future ground of her strength; and that the tribunitian contests were but attempts to restore the original constitution. Adam Smith (*Wealth of Nations*, B. iv. chap. vii. part i.) assents to the same interpretation, without, however, any expression of approval.

The correct interpretation of the agrarian laws must thus be considered as of modern date. Amidst the violence of the French Revolution, a scheme for the equal division of the national property was advocated amidst great popular favour, by some of the frantic leaders, who sought a sanction for their extravagancies in precedents drawn from the ancient republics, and particularly from the agrarian laws of the Romans. The subject was thus invested with a new interest, and engaged the attention of Professor Heyne of Göttingen, who, in 1793 (*Opus. Acad.* iv. 350–373), addressed to the members of his university a paper in which he successfully combated the opinions which, up till that time, had been entertained respecting them; and showed that their object had been entirely misunderstood. Other writers, as Heeren and Hegewisch, embraced and illustrated his views; but it was reserved for the acuteness and learning of Niebuhr fully to develop the theory which had been suggested, and to demonstrate the fact "that the agrarian laws of the Romans were in no case intended to interfere with or affect private property in land, but related exclusively to the public domain." The theory of Niebuhr was too startling to meet with universal approval. It has accordingly been assailed by Rudorff, Dureau de la Malle (*Econ. Polit. des Romaines*), Puchta, and others, who have ingeniously and plausibly supported the opinions formerly maintained; but their arguments fail to produce conviction (*Class. Mus.*, vol. ii.) The language of Livy *passim*, when referring to the agrarian laws, is inexplicable unless the interpretation of Niebuhr be adopted. "If," says Dr Arnold, "amongst Niebuhr's countless services to Roman history, any single one may claim our gratitude beyond the rest, it is his explanation of the true nature and character of the agrarian laws. Twenty-four years have not yet elapsed since he first published it, but it has already overthrown the deeply-rooted false impressions which prevailed universally on the subject; and its truth, like Newton's discoveries in natural science, is not now to be proved, but to be taken as the very corner-stone of all our researches into the internal state of the Roman people."—*Hist. of Rome*, vol. ii.

In almost all countries, the legal property of the land has been originally vested in the sovereign, whether we are to understand under that name a single chief, a particular portion of the nation, or the people at large. In the same manner, the property of all the land in a conquered country was held to be transferred to the sovereign power in the conquering state; and was assumed with more or less rigour as circumstances seemed to require. From the earliest times a portion of the Roman territory was thus regarded as the property of the state, and the profits arising from it were applied to the public service. The public domain (*ager publicus*) was at first small, but was gradually extended by the right of conquest, till it embraced a large portion of the whole peninsula. In this process of extension, the subjugated communities were frequently mulcted of a proportion of their lands, varying according to the alleged offence, or the resistance which they had offered to the arms of the conquerors. Thus the Boii were deprived of one-half of their territory; the Hernici forfeited two-thirds, and the whole of the *ager Campanus*, the richest district in Italy, was taken from the inhabitants of Capua, on the capture of their city after its revolt to Hannibal.

The lands thus acquired were disposed of in various ways. A portion of them was frequently sold by auction, to meet the immediate necessities of the state, and was thus conveyed in perpetuity to the purchasers. The disposal of the remainder depended on the nature and condition of the land, and its position in reference to the bulk of the community. If in good condition, and at no great distance from the city, it was frequently assigned, in small allotments of seven jugera (between 4 and 5 acres) to those of the poorer citizens, whose services in war gave them a claim upon the state; while in hostile districts, and on exposed frontiers, military colonies were planted, each colonist receiving a fixed quantity of land. In both of these cases the land so assigned ceased to form part of the public domain, and became the property of the recipients. In some cases the land, after having been assumed as public property, was allowed to remain in the hands of the former owners, who became the tenants of the state for a fixed period, and paid a certain rent to the Roman exchequer.



The preceding remarks refer only to arable or meadow-land, vineyards, or olive-gardens, which could be turned to immediate advantage. It is obvious, however, that in a country, the greater part of which was acquired by conquest, large districts must have been laid waste, the inhabitants with their houses destroyed, and neither cultivators nor the means of cultivation left. Arrangements of a different description were therefore necessary for lands in this position. Wide ranges of country, fit only for pasture, had to be disposed of, and were available to those alone who were able to stock them with flocks and herds, and to provide slaves to attend to and protect their property. Hence it was usual for the state to invite persons possessed of the necessary means to enter upon the occupation of such lands on advantageous terms; an invitation with which the patricians, as being the wealthy class, could alone comply. The ordinary conditions were, that after the land was again brought into cultivation, the occupants should pay as rent one-tenth of the produce of the corn-lands, and one-fifth of the vines and fruit-trees, with a moderate rate per head for sheep and cattle grazing on the public pastures. The lands were not assigned for any definite period; the occupants were merely tenants at will, liable to extrusion whenever the state found it necessary to employ the land for any other purpose. It was a fundamental principle of Roman law that prescription could not be pleaded against the state; and consequently, though the right of occupancy might not only be transmitted from heir to heir, but might also be sold, no length of time could alter the precarious nature of the tenure by which the lands were held. The state always reserved to itself the power of resuming possession when it thought fit; and though such resumption might in many cases be attended by individual hardship, it was nevertheless justified by the original contract.

Much of the obscurity connected with the Roman agrarian laws has arisen from a misapprehension of the meaning of the words *possidere*, *possessor*, and *possessio*. These terms, when used in a strictly legal sense, denote merely occupancy by a tenant, and never imply an absolute right of property. The act of occupancy was termed *usus*, and the benefit derived by the state *fructus*.

"The *ager publicus*," says Professor Ramsay, "having been acquired and occupied as explained above, numerous abuses arose in process of time, especially among the tenants belonging to the second class. These being, as we have said, in the earlier ages, exclusively patricians, who at the same time, monopolized the administration of public affairs, they were in the habit of defrauding the state, either by neglecting altogether to pay the stipulated proportion of the produce, or by paying less than was due; or, finally, by claiming, what was in reality *ager publicus*, as their own private property; it being easy, of course, in the absence of all strict superintendence, and of scientific surveys, to shift the land-marks which separated public from private property. Meanwhile the deficiencies in the public treasury were made up by heavier taxes; and the plebeians complained that they were impoverished by new imposts, while the lands belonging to the community, which they had acquired by their blood, if fairly managed, would yield a sufficient return to meet all demands upon the exchequer; or, if portioned out in allotments among themselves, afford them the means of supporting the increased burdens. These complaints, unquestionably founded in justice, were soon vehemently expressed, and were revived from time to time more or less loudly, and enforced more or less earnestly, according to the state of public feeling, and the energy of the popular champions. It is true, that the wealthier plebeians soon became tenants of the *ager publicus* as well as the patricians; but, although this circumstance materially strengthened the hands of the occupiers, it did not improve the condition of the poor, or make them less keenly alive to the injustice of the system against which they protested."—*Manual of Rom. Antiq.* p. 228.

Assuming, then, that the agrarian laws had for their sole object the distribution and management of the public lands (*ager publicus*), their effect must have been felt in two ways:—(1.) In enforcing the regular payment of rent from the occupants, preventing them from exceeding the limits assigned to them, and compelling the surrender of portions for division among the poorer citizens;—and, (2.) In insisting upon the immediate application of newly acquired territories to the establishment of colonies, or its assignment to individuals. It is obvious that the laws first referred to, as involving long-established interests, would necessarily lead to violent contests.

The first agrarian law, properly so called, was proposed and passed by Sp. Cassius Viscellinus, when Consul, B.C. 486 (*Liv.* ii. 41, *Dionys.* viii. 76), respecting the provisions of which we have no precise information. Cassius was himself a patrician, and we may, therefore, infer that the law did not encroach upon the just rights of the dominant class to which he belonged. It is not the object of this article to trace in detail the various measures which were proposed, and the agitations with which they were severally attended. Three such are recorded during the fourth century B.C. (*Liv.* iv. 36, 47, 48); but by far the most important measure of this class, and that which served as the model of nearly all subsequent agrarian laws, was that carried by C. Licinius Stolo, when tribune of the people, in B.C. 367 (*Liv.* vi. 42). The provisions of this law were: (1.) that no one should occupy more than 500 jugera (about 333 acres) of the public land; (2.) nor have more than 100 large, and 500 small cattle, grazing on the public pastures; and, (3.) that every occupant of the public lands should employ a certain proportion of free labourers in cultivating it. Niebuhr (vol. iii. p. 11, &c. *Eng. Transl.*) has endeavoured to supply the other details; but these can be received merely as ingenious, and, it may be, successful conjectures. For an able controversy as to this law, see *Class. Museum*, vol. ii.

After the excitement occasioned by the passing of the Licinian law had subsided, two centuries were allowed to pass with only a single interference (*Valer. Max.* v. 4, 5; *Polyb.* ii. 21) with the occupants of the public lands; and during that time large additions had been made to the possessions of the state by the confiscations consequent upon the second Punic war. In the meantime the wealthier families had extended their possessions greatly beyond the limits prescribed by the Licinian law; while the small proprietors had disappeared, and the poor continued to increase. In B.C. 133, Tiberius Gracchus proposed and carried a modification of the Licinian law (*Liv. Epit.*, lviii.; *Appian.*, i. 9), which his premature death prevented from being carried into effect; and a similar result attended the enactment of his brother (*Liv. Epit.*, lx.) Both were set aside or eluded after the death of Caius. During the period which preceded the subversion of the republic, various other laws were passed for the distribution of the public lands; but these it is not necessary to enumerate. It may be mentioned, in conclusion, as a significant fact, that the prominent advocates of the Agrarian laws, Cassius, Licinius, and the Gracchi, all belonged to the class which would have been injured by their operation, had they led to an undue interference with private property. (G. F.)



AGREDA, a very mountainous district of the province of Soria, in Spain, containing 11 towns, 23 villages, and 63 hamlets. Pop. 23,618.

AGREDA, the *Gracchuris* of the Romans, the chief town of the above district, built on the skirts of the Sierra Moncayo, and divided by the River Queiles into two parts, communicating by a fine stone bridge of one arch. It has six churches and four monasteries. Population 3847. Its trade suffered severely from a three days' occupation by a French army of 25,000 men, in the Peninsular war. The chief manufactures are cloth, hats, linen, pottery, and oil.

AGRIA, called by the Germans *Eger*, is a strong town in Upper Hungary, situate on a river of the same name, and has a citadel called *Erlau*. See ERLAU.

AGRICOLA, CNÆUS JULIUS, was born at Forum Julii, now Frejus, in Provence, A.D. 37, and was in Vespasian's time made lieutenant to Vettius Bolanus in Britain. Upon his return he was ranked by that emperor among the patricians, and made governor of Aquitania. This post he held for three years: he then was recalled to Rome, and chosen consul; and was appointed governor of Britain, where he greatly distinguished himself. He reformed many abuses occasioned by the avarice or negligence of former governors, put a stop to extortion, and caused justice to be impartially administered. Vespasian dying about this time, his son Titus, knowing the great merit of Agricola, continued him in the government. In the spring he marched towards the north, where he made new conquests, and ordered forts to be built for the Romans to winter in. He spent the following winter in concerting schemes to bring the Britons to conform to the Roman customs. He thought the best way of diverting them from their warlike propensities was to soften their rough manners by proposing to them new kinds of pleasure, and inspiring them with a desire of imitating the Roman manners. He encouraged the erection of magnificent temples, porticoes, baths, and other fine buildings. The British nobles at length had their sons educated in learning; and they who before had the utmost aversion to the Roman language, now began to study it with great assiduity. They wore likewise the Roman habit; and, as Tacitus observes, they were brought to consider those things as marks of politeness, which were only so many badges of slavery. Agricola, in his third campaign, advanced as far as the Tweed; and in his fourth he subdued the nations betwixt the Tweed and the firths of Forth and Clyde, into which the rivers *Bodotria* and *Glotta* discharged themselves; and here he built fortresses to shut up the nations yet unconquered. In his fifth he marched beyond the firths, where he made some new acquisitions, and fixed garrisons along the western coasts, over against Ireland. In his sixth campaign he passed the river Bodotria; ordering his fleet, the first which the Romans ever had in those parts, to row along the coasts, and take a view of the northern parts. In the following spring, the Britons raised an army of 30,000 men, under the command of Galgacus, to oppose the invaders. In the engagement that ensued the Romans gained the victory, and 10,000 of the Britons are said to have been killed. This happened in the reign of the Emperor Domitian, who, growing jealous of the glory of Agricola, recalled him, under pretence of making him governor of Syria. Agricola was in Britain fully seven years, from A.D. 78 to 85; and he died on the 23d August, A.D. 93, when he had attained the age of 55. The great historian Tacitus, who was married to the daughter of Agricola, has written his life, one of the most beautiful specimens of biography ever composed.

Agricola || Agriculture.

Agricola [properly *Landmann*], *George*, a German physician, famous for his skill in metals. He was born at Glaucha, in Misnia, March 24th, 1494. His discoveries in the mountains of Bohemia gave him so great a desire of examining accurately into every thing relating to metals, that though he had engaged in the practice of physic at Joachimstal by advice of his friends, he still prosecuted his study of fossils with great assiduity, and at length removed to Chemnitz, where he entirely devoted himself to this study. He spent in pursuit of it the pension he had from Maurice Duke of Saxony, and part of his own estate; so that he reaped more reputation than profit from his labours. His great work *De Re Metallica* contains much curious information. He died at Chemnitz on the 21st November 1555.

Agricola, *John*, a Saxon divine, born at Eisleben in 1492. He went as chaplain to Count Mansfield, when that nobleman attended the Elector of Saxony to the diet at Spires in 1529, and that of Augsburg in 1530. He was of a restless, ambitious temper, rivalled and wrote against Melancthon, and gave Count Mansfield occasion to reproach him severely. He obtained a professorship at Wittemberg, where he taught peculiar doctrines, and became founder of the sect of Antinomians; which occasioned warm disputes between him and Luther, who had before been his attached friend. But though he was never able to recover the favour either of the Elector of Saxony or of Luther, he received some consolation from the fame he acquired at Berlin, where he became preacher at court; and was chosen, in 1548, in conjunction with Julius Phlug and Michael Heldingus, to compose the famous *Interim*. He died at Berlin in 1566. His real name was *Schnitter* or *Schneider*.

Agricola, *Rodolphus*, one of the most eminent scholars of the fifteenth century. He was born near Gröningen in Friesland, in 1443, and died at Heidelberg in 1485. He was educated at Louvain; and travelling into Italy, became the pupil of Theodore Gaza in Greek, at Ferrara, for about two years; and at the same time gave instructions on the language and literature of ancient Rome. He was not only a profound scholar, but had much skill in painting and music. In his treatise *De Inventione Dialectica*, he clearly saw and tried to remedy the defects of the then prevalent scholastic philosophy. His real name was *Rolef Huysmann*.

# AGRICULTURE.

## CHAPTER I.

Historical Summary.

It would be interesting to know how the nations of antiquity tilled, and sowed, and reaped; what crops they cultivated, and by what methods they converted them into food and raiment. But it is to be regretted, that the records which have come down to us are all but silent upon these homely topics.

In Mr Hoskyn's admirable treatise,[1] we have an excellent specimen of what may yet be done to recover and construct an authentic history of the Agriculture of the ancients, from the casual allusions and accidental notices of rural affairs which lie thinly scattered through the body of general literature; and, more especially, from those mysterious records of the past, which are now being rescued from their long burial under the ruins of some of the most famous cities of antiquity. Although comparatively little has been found in such records bearing directly upon the subject; we must not despair of the learned industry, and masterly skill, of an advancing and searching criticism, gathering together these gleams of light, and making them happily converge upon the darkness which has hitherto interposed between us and a circumstantial knowledge of the methods and details of ancient husbandry.

Babylonians and Egyptians.

Every reader of the Bible is familiar with its frequent references to Egypt as a land so rich in corn, that it not only produced abundance for its own dense population, but yielded supplies for exportation to neighbouring countries. Profane history corroborates these statements. Diodorus Siculus bears explicit testimony to the skill of the farmers of ancient Egypt. He informs us that they were acquainted with the benefits of a rotation of crops, and were skilful in adapting these to the soil and to the seasons. The ordinary annual supply of corn furnished to Rome has been estimated at 20,000,000 of bushels. From the same author, we also learn, that they fed their cattle with hay during the annual inundation, and at other times tethered them in the meadows on green clover. Their flocks were shorn twice annually, (a practice common in several Asiatic countries), and their ewes yeaned twice a-year. For religious as well as economical reasons, they were great rearers of poultry, and practised artificial hatching, as at the present day. The abundance or scarcity of the harvests in Egypt depended chiefly upon the height of the annual inundation. If too low, much of the land could not be sown, and scarcity or famine ensued. On the other hand, great calamities befell the country when the river rose much above the average level. Cattle were drowned, villages destroyed, and the crops necessarily much diminished; as in such cases, many of the fields were still under water at the proper seed-time. In 1818, a calamity of this kind took place, when the river rapidly attained a height of three-and-a-half feet above the proper level.

It is from the paintings and inscriptions with which the ancient Egyptians decorated their tombs, that we get the fullest insight into the state of agriculture amongst this remarkable people. Many of these paintings, after the lapse of two or three thousand years, retain the distinctness of outline and brilliancy of colour of recent productions. The acquaintance which these give us with their occupations, attainments, and habits, is truly marvellous, and fills the reader of such works as "Wilkinson's Egypt" with perfect amazement. Every fresh detail seems to give confirmation to that ancient saying, "There is nothing new under the sun." Those which refer to rural affairs disclose a state of matters at that early date of the world's history, which may well remind us to speak modestly of our own attainments. An Egyptian villa comprised all the conveniences of a European one of the present day. Besides a mansion with numerous apartments, there were gardens, orchards, fish-ponds, and preserves for game. Attached to it was a farm-yard, with sheds for cattle and stables for carriage horses. A steward directed the tillage operations, superintended the labourers, and kept account of the produce and expenditure. The grain was stored in vaulted chambers furnished with an opening at the top, reached by steps, into which it was emptied from sacks, and with an aperture below for removing it when required. Hand-querns, similar to our own, were used for grinding corn; but they had also a larger kind worked by oxen. In one painting in which the sowing of the grain is represented, a plough drawn by a pair of oxen goes first; next comes the sower scattering the seed from a basket, he is followed by another plough, whilst a roller, drawn by two horses yoked

[1] Short Enquiry into the History of Agriculture, by Chandos Wren Hoskyn, Esq.

Historical Summary.

abreast, completes the operation. The steward stands by superintending the whole. Nothing, however, conveys to us so full an impression of the advanced state of civilisation amongst the ancient Egyptians as the value which they attached to land, and the formalities which they observed in the transfer of it. In the time of the Ptolemies, their written deeds of conveyance began with the mention of the reign in which they were executed, the name of the president of the court, and of the clerk who drew them. The name of the seller, with a description of his personal appearance, his parentage, profession, and residence, was engrossed. The nature of the land, its extent, situation, and boundaries; the name and appearance of the purchaser were also included. A clause of warrandice and an explicit acceptance by the purchaser followed, and finally the deed was attested by numerous witnesses (so many as sixteen occur to a trifling bargain), and by the president of the court.

Patriarchal age.

The Nomades of the patriarchal ages, like the Tartar, and perhaps some of the Moorish tribes of our own, whilst mainly dependent upon their flocks and herds, practised also agriculture proper. The vast tracts over which they roamed were in ordinary circumstances common to all shepherds alike. During summer they frequented the mountainous districts and retired to the valleys to winter. Vast flocks of sheep and of goats constituted the chief wealth of the Nomades, although they also possessed animals of the ox kind. When these last were possessed in abundance, it seems to be an indication that tillage was practised. We learn that Job, whose time is by the best authorities fixed as about contemporaneous with that of Abraham, besides immense possessions in flocks and herds, had 500 yoke of oxen, which he employed in ploughing, and a "very great husbandry." Isaac, too, conjoined tillage with pastoral husbandry, and that with success, for we read that he sowed in the land Gerar, and reaped an hundred fold—a return which, it would appear, in some favoured regions, occasionally rewarded the labour of the husbandman. In the Parable of the Sower, our Lord (grafting his instructions upon the habits, scenery, and productions of Palestine), mentions an increase of thirty, sixty, and an hundred fold. Such increase, although far above the average rate, was sometimes even greatly exceeded, if we take the authority of Herodotus, Strabo, and Pliny.

Israelites.

Along with the Babylonians, Egyptians, and Romans, the Israelites are classed as one of the great agricultural nations of antiquity. The sojourn of the Israelites in Egypt trained them for the more purely agricultural life that awaited them upon their return to Canaan, to take possession of it as their own. Nearly the whole population were virtually husbandmen, and personally engaged in its pursuits. Upon their entrance into Canaan, they found the country occupied by a dense population, possessed of walled cities and innumerable villages, masters of great accumulated wealth, and subsisting on the produce of their highly cultivated soil, which abounded with vineyards and oliveyards. It was so rich in grain, that the invading army, numbering 601,730 able-bodied men, with their wives and children, and a mixed multitude of camp-followers, found "old corn" in the land sufficient to maintain them from the day that they passed Jordan. The Mosaic Institute contained an Agrarian law, based upon an equal division of the soil amongst the adult males, a census of which was taken just before their entrance into Canaan. Provision was thus made for six hundred thousand yeomen, assigning (according to different calculations) from sixteen to twenty-five acres of land to each. This land, held in direct tenure from Jehovah, their sovereign, was strictly inalienable. The accumulation of debt upon it was prevented by the prohibition of interest, the release of debts every seventh year, and the reversion of the land to the proprietor, or his heirs, at each return of the year of jubilee. The owners of these small farms cultivated them with much care, and rendered them highly productive. They were favoured with a soil extremely fertile, and which their skill and diligence kept in good condition. The stones were carefully cleared from the fields, which were also watered from canals and conduits, communicating with the brooks and streams with which the country "was well watered everywhere," and enriched by the application of manures. The seventh year's fallow prevented the exhaustion of the soil, which was further enriched by the burning of the weeds and spontaneous growth of the Sabbatical year. The crops chiefly cultivated were wheat, millet, barley, beans, and lentiles; to which it is supposed, on grounds not improbable, may be added rice and cotton. The ox and the ass were used for labour. The word "oxen," which occurs in our version of the Scriptures, as well as in the Septuagint and Vulgate, denotes the species, rather than the sex. As the Hebrews did not mutilate any of their animals, bulls were in common use. The quantity of land ploughed by a yoke of oxen in one day, was called a yoke or acre. Towards the end of October, with which month the rainy season begins, seedtime commenced, and of course does so still. The seedtime, begun in October, extends, for wheat and some other white crops, through November and December; and barley continues to be sown until about the middle of February. The seed appears to have been sometimes ploughed in, and at other times to have been covered by harrowing. The cold winds which prevail in January and February, frequently injured the crops in the more exposed and higher districts. The rainy season extends from October to April, during which time, refreshing showers fall, chiefly during the night, and generally at intervals of a few days. The harvest was earlier or later as the rains towards the end of the season were more or less copious. It, however, generally commenced in April, and continued through May for the different crops in succession. In the south, and in the plains, the harvest, as might be expected, commenced some weeks earlier than in the northern and mountainous districts. The slopes of the hills were carefully terraced and irrigated wherever practicable; and on these slopes, the vine and olive were cultivated with great success. At the same time, the hill districts and neighbouring deserts afforded pasturage for numerous flocks and herds, and thus admitted of the benefits of a mixed husbandry. With such political and social arrangements, and under the peculiarly felicitous climate of Judea, the country, as a whole, and at the more prosperous periods of the commonwealth, must have exhibited such an example of high cultivation, rich and varied produce, and wide-spread plenty and contentment as the world has never yet elsewhere produced on an equally extensive scale. Not by a figure of speech but literally, every Israelite sat under the shadow of his own vine and fig-tree; whilst the country as a whole, is described (2 Kings xviii. 32) as "a land of corn and wine, a land of bread and vineyards, a land of oil-olive and of honey." An interesting illustration of the advanced state of agriculture in these ancient times is afforded by the fact, that, making allowance for climatic differences, the numerous allusions to it with which the Scriptures abound, seem natural and appropriate to the British farmer of the present day.

Ancient Greeks.

The unrivalled literature of Greece affords us little information regarding the practical details of her husbandry. The people who, by what remains to us of their poetry, philosophy, history, and fine arts, still exert such an influence in guiding our intellectual efforts, in regulating taste, and in moulding our institutions, were originally the invaders and conquerors of the territory which they have rendered so famous. Having reduced the aboriginal tribes to bondage, they imposed upon them the labour of cultivating the soil, and

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hence both the occupation, and those engaged in it, were regarded contemptuously by the dominant race, who addicted themselves to what they regarded as nobler pursuits. With the exception of certain districts, such as Bœotia, the country was naturally unfavourable to agriculture. When we find, however, that valleys were freed from lakes and morasses by drainage, that rocky surfaces were sometimes covered with transported soil, and that they possessed excellent breeds of the domesticated animals, which were reared in vast numbers, we infer that agriculture was better understood, and more carefully practised, than the allusions to it in their literature would seem to warrant.

Ancient Romans.

Amongst the ancient Romans, agriculture was highly esteemed, and pursued with earnest love and devoted attention. "In all their foreign enterprises, even in earliest times," as Schlegel remarks, "they were exceedingly covetous of gain, or rather of land; for it was in land, and in the produce of the soil, that their principal and almost only wealth consisted. They were a thoroughly agricultural people, and it was only at a later period that commerce, trades, and arts, were introduced among them, and even then they occupied but a subordinate place."[1] Their passion for agriculture survived very long; and when at length their boundless conquests introduced an unheard-of luxury, and corruption of morals, the noblest minds amongst them were strongly attracted towards the ancient virtue of the purer and simpler agricultural times. Several facts in their history afford convincing proof, if it were required, of the devotion of this ancient people to agriculture, in their best and happiest times. Whilst their arts and sciences, and general literature, were borrowed from the Greeks, they created an original literature of their own, of which rural affairs formed the substance and inspiration. Schlegel and Mr Hoskyn notice also the striking fact, that whilst among the Greeks the names of their illustrious families are borrowed from the heroes and gods of their mythology, the most famous houses amongst the ancient Romans, such as the Pisones, Fabii, Lentuli, &c., have taken their names from their favourite crops and vegetables. Perhaps it is not too much to assert, that many of those qualities which fitted them for conquering the world, and perfecting their so celebrated jurisprudence, were acquired, or at all events nourished and matured, by the skill, foresight, and persevering industry, so needful for the intelligent and successful cultivation of the soil. The words which Cicero puts into the mouth of Cato give a fine picture of the ancient Roman enthusiasm in agriculture. "I come now to the pleasures of husbandry, in which I vastly delight. They are not interrupted by old age, and they seem to me to be pursuits in which a wise man's life should be spent. The earth does not rebel against authority; it never gives back but with usury what it receives. The gains of husbandry are not what exclusively commend it. I am charmed with the nature and productive virtues of the soil. Can those old men be called unhappy who delight in the cultivation of the soil? In my opinion, there can be no happier life, not only because the tillage of the earth is salutary to all, but from the pleasure it yields. The whole establishment of a good and assiduous husbandman is stored with wealth; it abounds in pigs, in kids, in lambs, in poultry, in milk, in cheese, in honey. Nothing can be more profitable, nothing more beautiful, than a well-cultivated farm."

In ancient Rome, each citizen received, at first, an allotment of about two English acres. After the expulsion of the kings this allotment was increased to about six acres. These small inheritances must of course have been cultivated by hard labour. On the increase of the Roman territory, the allotment was increased to fifty, and afterwards even to five hundred acres. Many glimpses into their methods of cultivation are found in those works of Roman authors which have survived the ravages of time. Cato speaks of irrigation, frequent tillage, and manuring, as means of fertilizing the soil. Mr Hoskyn, from whose valuable contribution to the History of Agriculture we have drawn freely in this historic summary, quotes the following interesting passage from Pliny, commenting on Virgil:[2]—"Our poet is of opinion that alternate fallows should be made, and that the land should rest entirely every second year. And this is, indeed, both true and profitable, provided a man have land enough to give the soil this repose. But how, if his extent be not sufficient? Let him, in that case, help himself thus. Let him sow next year's wheat-crop on the field where he has just gathered his beans, vetches, or lupines, or such other crop as enriches the ground. For, indeed, it is worth notice that some crops are sown for no other purpose but as food for others, a poor practice, in my estimation." In another place, he tells us, "Wheat, the later it is reaped, the better it casts; but the sooner it is reaped, the fairer the sample. The best rule is to cut it down before the grain is got hard, when the ear begins to have a reddish-brown appearance. 'Better two days too soon than as many too late,' is a good old maxim, and might pass for an oracle." The following quotation from the same author is excellent: "Cato would have this point especially to be considered, that the soil of a farm be good and fertile; also, that near it there be plenty of labourers, and that it be not far from a large town: moreover, that it have sufficient means for transporting its produce, either by water or land. Also, that *the house be well built*, and the land about it as well managed. But I observe a great error and self-deception which many men commit, who hold opinion that the negligence and ill-husbandry of the former owner is good for his successor or after-purchaser. Now, I say, there is nothing more dangerous and disadvantageous to the buyer than land so left waste and out of heart; and therefore Cato counsels well to purchase land of one who has managed it well, and not rashly and hand-over-head to despise and make light of the skill and knowledge of another. He says, too, that as well land as men, which are of great charge and expense, how gainful soever they may seem to be, yield little profit in the end, when all reckonings are made. The same Cato being asked, what was the most assured profit rising out of land? made this answer,—'To feed stock well.' Being asked again, 'What was the next?' he answered, 'To feed *with moderation*.' By which answer he would seem to conclude that the most certain and sure revenue was *a low cost of production*. To the same point is to be referred another speech of his, 'That a good husbandman ought to be a seller rather than a buyer;' also, 'that a man should stock his ground early and well, but take long time and leisure before he be a builder;' for it is the best thing in the world, according to the proverb, 'to make use, and derive profit, from other men's follies.' Still, when there is a good and convenient house on the farm, the master will be the closer occupier, and take the more pleasure in it; and truly it is a good saying, that 'the master's eye is better than his heel.'"

"It is curious (says Mr Hoskyn) to read such passages as these, and to find the very same subjects still handled, week after week, in fresh and eager controversy in the agricultural writings and periodicals of the present day, eighteen centuries after those opinions were written."

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[1] The Philosophy of History, by Frederick Von Schlegel. London, 1846; p. 253.
[2] Short Enquiry into the History of Agriculture, pp. 49–51, by Chandos Wren Hoskyn, Esq.

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In the later ages of the empire agriculture was neglected, and those engaged in it regarded with contempt. Many fair regions, once carefully cultivated, and highly productive, were abandoned to nature, and became a scene of desolation; the supplies of overgrown Rome being drawn from Egypt, Sicily, and other provinces, which became notable as the granaries of the empire.

Agriculture during the middle ages.

Saracens and Moors of Spain.

Under the Goths, Vandals, and other barbarian conquerors, agriculture in Europe, during the middle ages, seems to have sunk into the lowest condition of neglect and contempt. We owe its revival, like that of other arts and sciences, to the Saracens of Spain, who devoted themselves to the cultivation of that conquered territory, with hereditary love for the occupation, and with the skilful application of the experience which they had gathered in other lands in which they had established their power. By them, and their successors, the Moors, agriculture was carried in Spain to a height which perhaps has not yet been surpassed in Europe. It is said, that so early as the tenth century, the revenue of Saracenic Spain alone amounted to £6,000,000 sterling,—probably as much as that of all the rest of Europe at that time. The ruins of their noble works for the irrigation of the soil, still attest their skill and industry, and put to shame the ignorance and indolence of their successors. The same remark applies to the Spanish dominions in South America. In the ancient empire of Peru, agriculture seems to have reached a high degree of perfection. The ruins of basins and canals, frequently carried through tunnels, prove their industry and skill in irrigation. One of their aqueducts is said by Mr Prescott[1] to have been traced by its ruins for nearly 500 miles. They cultivated the sides of mountains, by means of terraces, which retained forced soil, and were skilled in the application of manure. That on which they chiefly depended was guano, and their Incas protected the penguins, by which it was deposited, by strict laws, which made it highly penal to kill one of these birds, or to set foot on the islands at breeding time. The Spaniards thus obtained possession of two good patrimonies, and have wasted them both.

The influence of the crusades upon the agriculture of this period is not to be overlooked. The dreadful oppression of the feudal system received at that time a shock most favourable to the liberties of man, and, with increasing liberty, more enlightened ideas began to be entertained, and greater attention to be paid to the cultivation of the soil.

But, during this long interval, the population of Europe was divided into two great classes, of which by far the larger one was composed of bondmen, without property, or the power of acquiring it, and small tenants, very little superior to bondmen; and the other class, consisting chiefly of the great barons and their retainers, was more frequently employed in laying waste the fields of their rivals, than in improving their own. The superstition of the times, which destined a large portion of the country to the support of the church, and which, in some measure, secured it from predatory incursions, was the principal source of what little skill and industry were then displayed in the cultivation of the soil. "If we consider the ancient state of Europe," says Mr Hume,[2] "we shall find, that the far greater part of society were everywhere bereaved of their personal liberty, and lived entirely at the will of their masters. Every one that was not noble was a slave; the peasants were not in a better condition; even the gentry themselves were subjected to a long train of subordination under the greater barons, or chief vassals of the crown, who, though seemingly placed in a high state of splendour, yet, having but a slender protection from law, were exposed to every tempest of the state, and, by the precarious condition on which they lived, paid dearly for the power of oppressing and tyrannizing over their inferiors."—"The villains were entirely occupied in the cultivation of their master's land, and paid their rents either in corn or cattle, and other produce of the farm, or in servile offices, which they performed about the baron's family, and upon farms which he retained in his own possession. In proportion as agriculture improved and money increased, it was found that these services, though extremely burdensome to the villain, were of little advantage to the master; and that the produce of a large estate could be much more conveniently disposed of by the peasants themselves, who raised it, than by the landlord or his bailiff, who were formerly accustomed to receive it. A commutation was therefore made of rents for services, and of money-rents for those in kind; and as men in a subsequent age discovered that farms were better cultivated where the farmer enjoyed security in his possession, the practice of granting leases to the peasant began to prevail, which entirely broke the bonds of servitude, already much relaxed from the former practices. The latest laws which we find in England for enforcing or regulating this species of servitude were enacted in the reign of Henry VII. And though the ancient statutes on this subject remain still unrepealed by Parliament, it appears, that before the end of Elizabeth, the distinction between villain and freeman was totally, though insensibly, abolished; and that no person remained in the state to whom the former laws could be applied."

Leases during the middle ages.

But, long before the fifteenth century, it is certain that there was a class of tenants holding on leases for lives, or for a term of years, and paying a rent in land produce, in services, or in money. Whether they gradually sprung up from the class of bondmen, according to Lord Kames,[3] or existed from the earliest period of the feudal constitution, according to other writers,[4] their number cannot be supposed to have been considerable during the middle ages. The stock which these tenants employed in cultivation commonly belonged to the proprietor, who received a proportion of the produce as rent; a system which still exists in France and in other parts of the Continent, where such tenants are called *metayers*, and some vestiges of which may yet be traced in the *steel-bow* of the law of Scotland. Leases of the thirteenth century still remain;[5] and both the laws and chartularies[6] clearly prove the existence in Scotland of a class of cultivators distinct from the *serfs* or bondmen. Yet the condition of these tenants seems to have been very different from that of the tenants of the present day; and the lease approached nearer in its form to a feu-charter than to the mutual agreement now in use. It was of the nature of a beneficiary grant by the proprietor, under certain conditions, and for a limited period: the consent of the tenant seems never to have been doubted. In the common expression, "granting a lease," we have retained an idea of the original character of the deed, even to the present time.

Crops cultivated.

The corn crops cultivated during this period seem to have been of the same species, though all of them probably much inferior in quality to what they are in the present day. Wheat, the most valuable grain, must have borne a small proportion, at least in Britain, to that of other crops; the remarkable fluctuation of price, its extreme scarcity, indicated by the extravagant rate at which it was sometimes sold, as well as the preparatory cultivation required, may convince us that its consumption was confined to the higher orders, and that its growth was by no means extensive. Rye and

1 "History of the Conquest of Mexico."

2 History of England, chap. xxiii.

3 Kames's *Law Tracts.*

4 Bell's *Treatise on Leases.*

5 Sir John Cullum's *History and Antiquities of Hawsted* (*Suffolk.*)

6 Chalmers's *Caledonia*, book iv. c. 6.

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oats furnished the bread and drink of the great body of the people of Europe. Cultivated herbage and roots were then unknown in the agriculture of Britain. It was not till the end of the reign of Henry VIII. that any salads, carrots, or other edible roots were produced in England. The little of these vegetables that was used, was formerly imported from Holland and Flanders. Queen Catherine, when she wanted a salad, was obliged to despatch a messenger thither on purpose.[1]

The ignorance and insecurity of those ages, which necessarily confined the cultivation of corn to a comparatively small portion of country, left all the rest of it in a state of nature, to be depastured by the inferior animals, then only occasionally subjected to the care and control of man. Cultivators were crowded together in miserable hamlets; the ground contiguous was kept continually under tillage; and beyond this, wastes and woodlands of a much greater extent were appropriated to the maintenance of their flocks and herds, which pastured indiscriminately, with little attention from their owners.

The low price of butcher-meat, though it was then the food of the common people, when compared with the price of corn, has been justly noticed by several writers as a decisive proof of the small progress of civilisation and industry.

Continent of Europe.

According to the reports of a writer who has had access to the best sources of information, in addition to his own observations, the present state of the agriculture of the greater part of the Continent of Europe is not very different from what it was in Britain during the prevalence of the feudal system. "The greater part of France," he says, "a still much greater portion of Germany, and nearly the whole of Prussia, Austria, Poland, and Russia, present a wretched uniformity of system. It is called the three-course husbandry, consisting of, 1*st*, one year's clean fallow; 2*d*, winter corn, chiefly rye, with a proportion of wheat commensurate to the manure that can be applied; 3*d*, summer corn, or barley and oats. There are occasional and small deviations from this system. In some few cases potatoes, in others peas, are grown, in the fallow year; but they are only minute exceptions to the generally established system. It is not surprising that under such a system the produce should not be much more than four times the quantity of seed, at which rate it is calculated, as appears to be rightly, by Baron Alexander Humboldt."

"The fields are almost universally uninclosed, and exposed to the most injurious effects of a changeable and an intemperate climate. The ancient feudal system of tenure is still continued, modified indeed, and softened in some few parts, but not to a degree or an extent that deserves to be taken into account in the view now under consideration of the countries as a whole. The peasants, for the most part, are *adstricti glebæ;* and where, by recent laws, their condition has been changed, the practical effect has yet hardly had time to exhibit any observable improvement in their state. Labour, whether of men or of cattle, is usually exchanged for the occupancy of land; and hence the labour is performed in the most negligent and imperfect manner, that the vigilance of an overseer, who cannot be everywhere present, will allow.

"The lords of the soil, besides their demesnes, have the right of pasturage on the fields of their tenants from harvest to the next seed-time: hence none of those intervening crops which tend to enrich the soil can be cultivated without infringing on their rights.

"Among the cultivators of the land little or no accumulation of capital has been formed; from the lord to the lowest grade of the peasantry, all are alike destitute of disposable funds. The lords are only rich in land, and sufficiently at their ease, if that land be unencumbered with mortgages or annuities. The peasants, whether owners of the live stock and of the implements, or having the use of them with the land from its owners, are content to live on, from year to year, eating their own produce, growing their own wool and flax, and converting them into garments. They are quite satisfied if they can dispose of as much surplus produce as will pay the small share of money-rent which becomes due to their lord." (*Tracts relating to the Corn Trade and Corn Laws*, by William Jacob, Esq., 1828.)

Flemish Agriculture.

The agriculture of nearly the whole of the continent of Europe has made very great progress since the remarks now quoted were penned. In Flanders, the Netherlands, Italy, Switzerland, and Germany, there are certain limited districts which, in general management, rival, and in particular points excel, our own. In nothing is this more apparent than in their scrupulous economy of manure, both as regards its preparation and application. In Flanders, not only the contents of privies, but soap-suds, scullery-water, and slops of every kind containing fertilising matters, are carefully preserved in suitable receptacles, by the town's-folk and villagers, from whom they are purchased by regular manure dealers, who come statedly round with their tub-carts, to collect this sewage, and who store it in tanks, and in due time retail it to the farmers. The latter invariably have tanks of their own, in which the urine of their cattle and similar matters are collected. This liquid manure is frequently enriched by the addition of night-soil and rape-dust, and is always stored for several months before being applied to the land. In South-West Germany, Switzerland, and Holland, the same attention is paid to the preparation of liquid manure, by mingling the dung and urine of the cattle with water, fermenting it in tanks, and then in distributing it over green crops by means of barrel-carts. The following might stand for a description of Myre Mill or Tiptree, but for the want of the steam-engine, force-pump, and underground pipes: "The cows often lie on smooth bricks, which are washed clean twice a-day, for which purpose a pump is an essential appendage to a cow-house. There is generally a deep gutter along the wall behind the cows, into which the water and urine drain, the ground sloping gently towards it. The tank is either immediately under the stable, well vaulted over, or it is so near that all the liquid readily runs into it through a covered drain. The heads of the cows are towards the middle of the stable, and their tails over the gutter along the wall. The width of the building admits of two rows of cows, facing each other, with a space between them sufficiently wide to admit a small cart, to bring the food to them. This is universally the form of a cow-house in Holland. The liquid in the tank is allowed to go through the first stages of fermentation, during which the caustic portion of the urine is rendered mild, and the liquid is better fitted to be taken up by the fibres of the roots. In order that there may be a regular succession of liquid in a proper state for use, there are partitions in the tanks, and by means of small flood-gates in the drain which leads to it, the fresh accumulation may be directed to any one of the pits thus formed, while the ripe liquor may be pumped up into tubs or barrels set on wheels, to be conveyed to the land. There are means of accelerating or retarding the fermentation, according to the time when the liquor is wanted. Stirring and admitting the air assist the process, while the addition of earth, peat, or ashes, and keeping out the air, retard it. The efficacy of the liquid is much increased by adding rape-cake, and other vegetable

[1] Hume's *History of England*, chap. xxiii.

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substances. This is usually done a short time before it is put on the land, as it would otherwise ferment too much."[1]

France.

The Agriculture of France has been influenced in no ordinary degree by the altered tenure and distribution of the soil consequent upon the great Revolution. A large portion of its territory is now minutely subdivided amongst small proprietors, and presents the appearance of one vast cultivated open field. "As far as the eye can reach over vast plains bounded by sloping hills, you see the surface varied by every description of crop; none, perhaps above an acre or two in size,—the larger portion not more than the fourth or eighth of an acre." These small proprietors are, for the most part, without capital, so that the government takes the chief part in instigating and promoting improvements. For this purpose it has instituted various establishments, which are either maintained entirely at its cost, or by grants in aid of local efforts. These consist of agricultural societies, veterinary schools, model farms, sheep-farms, and haras or studs. Of the model farms, Grignon, in the vicinity of Paris, consists of nearly 1200 English acres of land of various qualities. Here numbers of young men are instructed in the theory and practice of agriculture by highly qualified teachers, and have the opportunity of witnessing the daily operations of the farm. The sheep-farms are devoted to rearing the best breeds of sheep; the rams produced upon them being distributed over the country by annual sales. The haras or studs are maintained for improving the breed of horses. Stallions are sent out from them in great numbers, and are stationed at suitable places for the accommodation of the respective neighbourhoods. These institutions have aided considerably in promoting agricultural improvement in France.

Spain.

Spain, with its delicious climate and fertile soil, exhibits the most antiquated agriculture in Europe. For want of means of conveyance, the abundant and choice products of the interior cannot be brought to its out-ports at a cost that would remunerate the exporter. Its great proprietors are indolent, poor, and proud, and everything lags behind for want of energy and capital. Vast tracts of country, including much fertile soil formerly occupied, are now without an inhabitant, and bear the significant designation, "*Despoblado*" (unpeopled).

Germany.

The Society of German Landowners and Foresters was established in 1837 for purposes similar to those of our own National Agricultural Societies, and is supported by the principal landed proprietors of Germany. Mr Handley, who was present at its Fifth Annual Meeting held at Doberan in Mecklenburg, in September 1841, thus speaks of it:—"Although its objects are the same as ours, the arrangements and proceedings of the meeting partake more of the character of the British Association. Thus, while the exhibition of stock and implements forms a secondary consideration, the main business, viz., the discussions of points connected with the science of agriculture, are carried on in sections, under the presidency of some one celebrated for his acquirements in that particular department, with an earnestness which marks the interest with which they pursue the theories of agriculture, and investigate the results of practical experiments. The president of the meeting is named annually by the sovereign or reigning prince of the state in which it is held. The sections appointed were,—on sheep and the management of flocks,—on practical agriculture,—on horned cattle,—on the breeding of horses,—on geology,—on agricultural mechanics,—on pomology—on the management of woods. The sittings occupied eight days. The several sections met at half-past six A.M., daily, and continued in deliberation till eleven. At noon, they all assembled in the grand saloon, under the presidency of Count Sacken, when a résumé of their several proceedings was read, and animated general discussions ensued. That this Society is on a scale to work very great improvements in the agriculture of Germany, there can be no doubt. If I were to form an opinion only from what I heard, I should say it has already materially changed the cultivation of the north."[2]

Northern Europe.

In the northern countries of Europe, improvement in agriculture makes steady, and in some of them, even rapid progress. In all of them institutions analogous to those of France (already referred to), and similarly supported, are in operation, at which great numbers of the rising generation, both proprietors and peasants, are made acquainted, theoretically and practically, with the most approved methods of their own and other countries. By all our continental neighbours Great Britain is looked upon as their agricultural model. Specimens of our best implements, live stock, and crops, are constantly being introduced in these countries. Young men are frequently sent here by their governments, to acquire a knowledge of our agriculture, and numbers of their landowners are constantly to be found amongst us on the same errand. Our best agricultural treatises are also translated into the principal languages of Europe. In this respect we have, however, received payment in kind, particularly in the scientific department, the names of Liebig, Boussingault, Sprengel, and others, being now as familiar to us as those of our native authors. The recent removal by our Legislature of import duties on farm produce has given a powerful stimulus to agricultural improvement on the continent of Europe. The quality as well as numbers, of the live stock sent to us, is already observed to improve.

It would have been interesting to have directed our attention to the agriculture of those more distant parts of the world with which our all-pervading commerce now brings us into constant intercourse. China, with whose skilful and elaborate husbandry Mr Fortune has recently made us acquainted, modern Egypt, the United States of America, and our own vast colonial empire, all possess new interest to us in an agricultural point of view, seeing that they now send corn and wool to our markets, in addition to their peculiar products. Tempting as the subject is, we must, however, refrain, and now direct our attention to the history of our native agriculture.

Agriculture in England to the end of the 15th century.

Of the early agriculture of England, and of the condition of its cultivators, we may form some conception, by adverting to a few of the enactments, from the Conquest, down to the beginning of the reign of Henry VII. in 1485, when the feudal system, which had been gradually falling into decay, was almost dissolved in that country.

One of the earliest and greatest grievances was the levying of Purveyance. This originally comprehended the necessary provisions, carriages, &c. which the nearest farmers were obliged to furnish to the king's armies at the current prices, and to his houses and castles in time of war. It was called the *great purveyance*, and the officers who collected those necessaries were called purveyors. The smaller purveyance included the necessary provisions and carriages for the king's household, when living at home, or travelling through the kingdom, which the tenants on the king's demesne lands were obliged to furnish gratis; and the practice came to be adopted by the barons and great men, in every tour which they thought proper to make in the country These exactions were so grievous, and levied in so licentious a manner, that the farmers, when they heard of the court's approach, often deserted their houses, as if the country had been invaded

1 "On the Agriculture of the Netherlands;" Journal of Royal Agricultural Society of England, vol. ii., p. 57.
2 Account of the Meeting of German Landowners in 1841; Journal of the Royal Agricultural Society of England, vol. iii., pp. 218, 230.

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by an enemy. "Purveyance," says Dirom,[1] "was perhaps for many centuries the chief obstruction to the agriculture and improvement of Great Britain. Many laws were made for the reformation and regulation of purveyance, but without effect; and the practice continued down to so late a period as the reign of James the First."

The home trade in corn was restrained by acts against forestallers in 1360, and at several subsequent periods. For many years after the Conquest, the greater part of the trade of England was carried on in markets and fairs; and a very considerable part of the revenue of the crown arose from the duties payable to the king, upon the goods brought to them for sale. The barons had also tolls at the fairs within their respective jurisdictions. When farmers and merchants were bringing their corn and other necessaries to be sold there, they were sometimes met on the way by persons who purchased their commodities, in order to retail them at a higher price. Thus the king and the lords of the manor lost the several duties payable to them; and the price, it was thought, was at the same time raised to the inhabitants. Such were the original forestallers, who were subjected by several statutes to severe penalties. This crime of forestalling, and the kindred ones of regrating and engrossing, were carefully defined, and the different degrees of punishment specified, in a new statute in 1552, to be afterwards noticed. An early law of 1266, for regulating the assize of bread and ale, furnishes a clear proof of the little intercourse that must have subsisted at that time between town and country. "Brewers in cities," says the statute, "may well afford to sell two gallons of beer or ale for a penny, and out of cities three or four gallons for a penny."

Several laws were made in the fourteenth and fifteenth centuries, permitting the exportation of grain when the price of wheat did not exceed six shillings and eightpence a quarter; and in 1463 importation was prohibited when the price was lower. The last statute, however, was little attended to, and foreign grain was admitted as before; while the state of the country, and the restrictions on internal commerce, scarcely permitted any advantage to be derived from the acts allowing exportation.

Husbandry of Scotland.

In Mr Chalmers's *Caledonia*, a great many valuable notices are collected regarding the husbandry of Scotland during these ages. It is evident from his elaborate researches, that the progress of cultivation in the 13th century had been greater than we should have expected from the turbulence of the times, and the comparatively rude and uncivilized state of society. Purveyance, and other obstructions to improvement, were nearly the same in Scotland as in England; the laws regarding the corn trade appear, in some instances, to have been copied from those of England; and in the northern, as in the southern part of the island, the clergy were by far the most skilful and industrious husbandmen.

Yet it is difficult to reconcile the idea of any considerable improvement, particularly in so far as regards the extensive cultivation of wheat (which Mr Chalmers infers from the authorities he quotes), with an act passed in 1426, which ordained every husbandman tilling with a plough of eight oxen to sow at least a firlot (little more than a Winchester bushel) of wheat, and half a firlot of peas, with a proportion of beans; or with the state of the districts only a few years ago, where wheat is said to have been extensively grown at that early period.

By statute 1449, the tenant was for the first time secured in possession, during the term of his lease, against a purchaser of the land; and in 1469 he was protected from having his property carried off for the landlord's debts, beyond the amount of rent actually due; an enactment which proves his miserable condition before that time.

Writers on agriculture.

Soon after the beginning of the 16th century, agriculture partook of the general improvement which followed the invention of printing, the revival of learning, and the more settled authority of government; and instead of the occasional notices of historians, we can now refer to regular treatises, written by men who engaged eagerly in this neglected and hitherto degraded occupation. We shall therefore give a short account of the principal works, as well as of the laws and general policy of Britain, in regard to agriculture, from the early part of the sixteenth century to the Revolution in 1688, when a new era commenced in the legislation of corn, and soon after in the practice of the cultivator.[2]

Fitzherbert.

The first and by far the best of our early works is the *Book of Husbandry*, printed in 1534, commonly ascribed to Fitzherbert, a judge of the common pleas in the reign of Henry VIII. This was followed, in 1539, by the *Book of Surveying and Improvements*, by the same author. In the former treatise we have a clear and minute description of the rural practices of that period, and from the latter may be learned a good deal of the economy of the feudal system in its decline. The *Book of Husbandry* has scarcely been excelled by any later production, in as far as concerns the subjects of which it treats; for at that time cultivated herbage and edible roots were still unknown in England. The author writes from his own experience of more than forty years; and, with the exception of passages denoting his belief in the superstition of the Roman writers, there is very little of this valuable work that should be omitted, and not a great deal that need be added, in so far as regards the culture of corn, in a manual of husbandry adapted even to the present time. Fitzherbert touches on almost every department of the art, and in about a hundred octavo pages has contrived to condense more practical information than will be found scattered through as many volumes of later times; and yet he is minute even to the extreme on points of real utility. There is no reason to say, with Mr Harte, that he had revived the husbandry of the Romans; he merely describes the practices of the age in which he lived; and from his commentary on the old statute *extenta manerii*, in his *Book of Surveying*, in which he does not allude to any recent improvements, it is probable that the management which he details had been long established. But it may surprise some of the agriculturists of the present day to be told, that, after the lapse of almost three centuries, Fitzherbert's practice, in some material branches, has not been improved upon; and that in several districts abuses still exist, which were as clearly pointed out by him at that early period as by any writer of the present age.

The *Book of Husbandry* begins with the plough and other instruments, which are concisely and yet minutely described; and then about a third part of it is occupied with the several operations as they succeed one another throughout the year. Among other things in this part of the work, the following deserve notice:—"Somme (ploughs) wyll tourn the sheld bredith at every landsende, and plowe all one way;" the same kind of plough that is now found so useful on hilly grounds. Of wheel-ploughs he observes, that "they be good on even grounde that lyeth

[1] *Inquiry into the Corn Laws*, &c. p. 9.

[2] The account of the Writers on Agriculture taken from Mr Cleghorn's Treatise in the former edition of the Encyclopædia Britannica.

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lyghte;" and on such lands they are still most commonly employed. Cart-wheels were sometimes bound with iron, of which he greatly approves. On the much agitated question about the employment of horses or oxen in labour, the most important arguments are distinctly stated. "In somme places," he says, "a horse plough is better," and in others an oxen plough, to which, upon the whole, he gives the preference; and to this, considering the practices of that period, they were probably entitled. Beans and peas seem to have been common crops. He mentions the different kinds of wheat, barley, and oats; and after describing the method of harrowing "all maner of cornnes," we find the roller employed. "They use to role their barley grounde after a showr of rayne, to make the grounde even to mowe." Under the article "To falowe," he observes, "the greater clottes (clods) the better wheate, for the clottes kepe the wheat warme all wynter; and at March they will melte and breake and fal in manye small peces, the whiche is a newe dongynge and refreshynge of the corne." This is agreeable to the present practice, founded on the very same reasons. "In May, the shepe folde is to be set out;" but Fitzherbert does not much approve of folding, and points out its disadvantages in a very judicious manner. "In the later end of May and the begynnynge of June, is tyme to wede the corne;" and then we have an accurate description of the different weeds, and the instruments and mode of weeding. Next comes a second ploughing of the fallow; and afterwards, in the latter end of June, the mowing of the meadows begins. Of this operation, and of the forks and rakes, and the haymaking, there is a very good account. The corn harvest naturally follows: rye and wheat were usually *shorn*, and barley and oats cut with the scythe. This intelligent writer does not approve of the practice, which still prevails in some places, of cutting wheat high, and then mowing the stubbles. "In Somersetshire," he says, "they do shere theyr wheat very lowe; and the wheate strawe that they purpose to make *thacke* of, they do not threshe it, but cut off the ears, and bynd it in sheves, and call it *rede*, and therewith they thacke theyr houses." He recommends the practice of setting up corn in shocks, with two sheaves to cover eight, instead of ten sheaves, as at present; probably owing to the straw being then shorter. The corn was commonly housed; but if there be a want of room, he advises that the ricks be built on a scaffold, and not upon the ground. Corn-stacks are now beginning to be built on pillars and frames. The fallow received a third ploughing in September, and was sown about Michaelmas. "Wheat is moost commonlye sowne under the forowe, that is to say, cast it uppon the falowe, and then plowe it under;" and this branch of his subject is concluded with directions about threshing, winnowing, and other kinds of barn-work.

Fitzherbert next proceeds to live stock. "An housbande," he says, "can not well thryue by his corne without he have other cattell, nor by his cattell without corne. And bycause that shepe, in myne opynyon, is the mooste profytablest cattell that any man can haue, therefore I pourpose to speake fyrst of shepe." His remarks on this subject are so accurate, that one might imagine they came from a storemaster of the present day; and the minutiæ which he details are exactly what the writer of this article has seen practised in the hilly parts of this country. In some places at present, "they neuer seuer their lambes from their dammes;" "and the poore of the peeke (high) countreye, and such other places, where, as they vse to milke theyr ewes, they vse to wayne theyr lambes at 12 weekes olde, and to mylke their ewes fiue or syxe weekes;" but that, he observes, "is greate hurte to the ewes, and wyll cause them that they wyll not take the ramme at the tyme of the yere for pouertye, but goo barreyne." "In June is tyme to shere shepe; and ere they be shorne, they must be verye well washen, the which shall be to the owner greate profyte in the sale of his wool, and also to the clothe-maker." It appears that *hand washing* was then a common practice; and yet in the west and north of Scot nd, at this day, sheep are never washed at all. His remarks on horses, cattle, &c. are not less interesting; and there is a very good account of the diseases of each species, and some just observations on the advantage of mixing different kinds on the same pasture. Swine and bees conclude this branch of the work.

The author then points out the great advantages of inclosures; recommends "quycksettynge, dychynge, and hedgeyng;" and gives particular directions about the *settes*, and the method of training a hedge, as well as concerning the planting and management of trees. We have then a short information "for a yonge gentylman that intendeth to thryue," and "a prolouge for the wiues occupation," in some instances rather too homely for the present time. Among other things, she is to "make her husband and herself somme clothes;" and "she maye haue the lockes of the shepe eyther to make blankettes and courlettes, or bothe." This is not so much amiss; but what follows will bring our learned judge into disrepute even with our most industrious housewives. "It is a wyues occupation," he says, "to wynowe all maner of cornes, to make malte, to washe and wrynge, to make heye, shere corne, and, in time of nede, to helpe her husbande to fyll the mucke wayne or dounge carte, dryue the ploughe, to loode heye, corne, and suche other; and to go or ride to the market to sel butter, chese, mylke, egges, chekyns, capons, hennes, pygges, gese, and all maner of cornes." The rest of the book contains some useful advices about diligence and economy; and concludes, after the manner of the age, with many pious exhortations.

Such is Fitzherbert's *Book of Husbandry*, and such was the state of agriculture in England in the early part of the sixteenth century, and probably for a long time before; for he nowhere speaks of the practices which he describes or recommends as of recent introduction.

The *Book of Surveying* adds considerably to our knowledge of the rural economy of that age. "Four maner of commens" are described; several kinds of mills for corn and other purposes, and also "quernes that goo with hand;" different orders of tenants, down to the "boundmen," who "in some places contynue as yet;" "and many tymes, by colour thereof, there be many freemen taken as boundmen, and their lands and goods is taken from them." Lime and marl are mentioned as common manures; and the former was sometimes spread on the surface to destroy heath. Both draining and irrigation are noticed, though the latter but slightly. And the work concludes with an inquiry "how to make a township that is worth XX. marke a yere, worth XX. li. a year;" from which we shall give a specimen of the author's manner, as well as of the economy of the age.

"It is undoubted, that to every townshyppe that standeth in tyllage in the playne countrey, there be errable landes to plowe and sowe, and leyse to tye or tedder theyr horses and mares upon, and common pasture to kepe and pasture their catell, beestes, and shepe upon; and also they have medowe grounde to get theyr hey upon. Than to let it be known how many acres of errable lande euery man hath in tyllage, and of the same acres in euery felde to chaunge with his neyghbours, and to leye them toguyther, and to make hym one seuerall close in euery felde for his errable lands; and his leyse in euery felde to leye

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them togyther in one felde, and to make one seuerall close for them all. And also another seuerall close for his portion of his common pasture, and also his porcion of his medowe in a seuerall close by itselfe, and al kept in seueral both in wynter and somer; and euery cottage shall haue his portion assigned hym accordynge to his rent, and than shall nat the ryche man ouerpresse the poore man with his cattell; and euery man may eate his oun close at his pleasure. And vndoubted, that hay and strawe that will find one beest in the house wyll finde two beestes in the close, and better they shall lyke. For those beestis in the house have short heare and thynne, and towards March they will pylle and be bare; and therefore they may nat abyde in the fylde before the heerdmen in winter tyme for colde. And those that lye in a close under a hedge haue longe heare and thyck, and they will neuer pylle nor be bare; and by this reason the husbande maye kepe twyse so many catell as he did before.

"This is the cause of this approwment. Nowe euery husbande hath sixe seuerall closes, whereof iii. be for corne, the fourthe for his leyse, the fyfte for his commen pastures, and the sixte for his haye; and in wynter time there is but one occupied with corne, and than hath the husbande other fyue to occupy tyll lente come, and that he hath his falowe felde, his ley felde, and his pasture felde al sommer. And when he hath mowen his medowe, than he hath his medowe grounde, soo that if he hath any weyke catell that wold be amended, or dyvers maner of catell, he may put them in any close he wyll, the which is a great advantage; and if all shulde lye commen, than wolde the edyche of the corne feldes and the aftermath of all the medowes be eaten in X. or XII. dayes. And the rych men that hath moche catell wold have the advantage, and the poore man can have no helpe nor relefe in wynter when he hath moste nede; and if an acre of lande be worthe sixe pens, or it be enclosed, it will be worth VIII. pens whan it is enclosed, by reason of the compostying and dongyng of the catell that shall go and lye upon it both day and nighte; and if any of his thre closes that he hath for his corne be worne or ware bare, than he may breke and plowe up his close that he hadde for his layse, or the close that he hadde for his commen pasture, or bothe, and sowe them with corne, and let the other lye for a time, and so shall he have alway reist grounde, the which will bear moche corne with lytel donge; and also he shall have a great profyte of the wod in the hedges whan it is growen; and not only these profytes and advantages beforesaid, but he shall save moche more than al these, for by reason of these closes he shall save meate, drinke, and wages of a shepeherde, the wages of the heerdman, and the wages of the swine herde, the which may fortune to be as chargeable as all his holle rent; and also his corne shall be better saved from eatinge or destroyeng with catel. For dout ye nat but heerdemen with their catell, shepcherdes with their shepe, and tieng of horses and mares, destroyeth moch corne, the which the hedges wold save. Paraduenture some men would say, that this shuld be against the common weale, bicause the shepeherdes, heerdmen, and swyneherdes, shuld than be put out of wages. To that it may be answered, though these occupations be not used, there be as many newe occupations that were not used before; as getting of quickesettes, diching, hedging, and plashing, the which the same men may use and occupye."

Tusser.

The next author who writes professedly on agriculture is Tusser, whose *Five Hundred Points of Husbandry*, published in 1562, was formerly in such high repute as to be recommended by Lord Molesworth to be taught in schools.[1] The edition of 1604 is the one we make use of here, in which the book of husbandry consists of 118 pages; and then follows the *Points of Housewifrie*, occupying 42 pages more. It is written in verse. Amidst a vast heap of rubbish, there are some useful notices concerning the state of agriculture at the time in different parts of England. Hops, which had been introduced in the early part of the sixteenth century, and on the culture of which a treatise was published in 1574 by Reynolde Scott, are mentioned as a well-known crop. Buckwheat was sown after barley. It seems to have been the practice then, in some places, to "*geld fillies*" as well as colts. Hemp and flax are mentioned as common crops. Inclosures must have been numerous in several counties; and there is a very good comparison between "champion (open fields) country, and several," which Blythe afterwards transcribed into his *Improver Improved*. Carrots, cabbages, turnips, and rape, are mentioned among the herbs and roots for the kitchen. There is nothing to be found in Tusser about serfs or bondmen, as in Fitzherbert's works. This author's division of the crop is rather curious, though probably quite inaccurate, if he means that the whole rent might be paid by a tenth of the corn.

"One part cast forth for rent due out of hand.
"One other part for seed to sow thy land.
"Another part leave parson for his tith.
"Another part for harvest, sickle and sith.
"One part for ploughwrite, cartwrite, knacker, and smith.
"One part to uphold thy teemes that draw therewith.
"Another part for servant and workman's wages laie.
"One part likewise for filbellie daie by daie.
"One part thy wife for needful things doth crave.
"Thyself and thy child the last part would have."

Googe.

The next writer is *Barnaby Googe*, whose *Whole Art of Husbandry* was printed in 1578, and again by Markham in 1614. The first edition is merely a translation of a German work; and very little is said of English husbandry in the second, though Markham made some trifling interpolations, in order, as it is alleged, to adapt the German husbandry to the English climate. It is for the most part made up of gleanings from the ancient writers of Greece and Rome, whose errors are faithfully retained, with here and there some description of the practices of the age, in which there is little of novelty or importance. Googe mentions a number of English writers who lived about the time of Fitzherbert, whose works have not been preserved.

For more than fifty years after this, or till near the middle of the seventeenth century, there are no systematic works on husbandry, though several treatises on particular departments of it. From these it is evident, that all the different operations of the farmer were performed with more care and correctness than formerly; that the fallows were better worked, the fields kept freer of weeds, and much more attention paid to manures of every kind. A few of the writers of this period deserve to be shortly noticed.

Plat.

Sir Hugh Plat, in his *Jewel House of Art and Nature*, printed in 1594 (which Weston in his catalogue erroneously gives to Gabriel Plattes), makes some useful observations on manures, but chiefly collected from other writers. His censure of the practice of leaving farm dung lying scattered about is among the most valuable.

[1] *Some Considerations for the promoting of Agriculture and employing the Poor.* Dublin, 1723.

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Norden.

Sir John Norden's *Surveyor's Dialogue*, printed in 1607, and reprinted with additions in 1618, is a work of considerable merit. The first three books of it relate to the rights of the lord of the manor, and the various tenures by which landed property was then held, with the obligations which they imposed. Among others, we find the singular custom so humorously described in the Spectator, of the incontinent widow riding upon a ram. In the fifth book there are a good many judicious observations on the "different natures of grounds, how they may be employed, how they may be bettered, reformed, and amended." The famous meadows near Salisbury are mentioned; and when cattle have fed their fill, hogs, it is pretended, "are made fat with the remnant; namely, with the knots and sappe of the grasse." "Clouer grasse, or the grasse honey suckle" (white clover), is directed to be sown with other hay seeds. "Carrot rootes" were then raised in several parts of England, and sometimes by farmers. London street and stable dung was carried to a distance by water, though it appears from later writers to have been got for the trouble of removing. And leases of 21 years are recommended for persons of small capital, as better than employing it in purchasing land; an opinion that prevails very generally among our present farmers.

Bees seem to have been great favourites with these early writers; and among others, there is a treatise by Butler, a gentleman of Oxford, called the *Feminine Monarchie*, or the *History of Bees*, printed in 1609, full of all manner of quaintness and pedantry.

Weston.

We shall pass over Markham, Mascall, Gabriel Plattes, and several other authors of this period, the best part of their writings being preserved by Blythe and Hartlib, of whom we shall say a little immediately. In Sir Richard Weston's *Discourse on the Husbandry of Brabant and Flanders*, published by Hartlib in 1645, we may mark the dawn of the vast improvements which have since been effected in Britain. This gentleman was ambassador from England to the elector palatine and king of Bohemia in 1619, and had the merit of being the first who introduced the *great clover*, as it was then called, into English agriculture, about 1645, and probably turnips also. His directions for the cultivation of clover are better than was to be expected. It thrives best, he says, when you sow it on the worst and barrenest ground, such as our worst heath ground is in England. The ground is to be pared and burnt, and unslacked lime must be added to the ashes. It is next to be well ploughed and harrowed; and about ten pounds of clover seed must be sown on an acre in April or the end of March. If you intend to preserve seed, then the second crop must be let stand till it come to a full and dead ripeness; and you shall have at the least five bushels per acre. Being once sown, it will last five years; and then being ploughed, it will yield, three or four years together, rich crops of wheat, and after that a crop of oats, with which clover seed is to be sown again. It is in itself an excellent manure, Sir Richard adds; and so it should be, to enable land to bear this treatment. In less than ten years after its introduction, that is, before 1655, the culture of clover, exactly according to the present method, seems to have been well known in England, and it had also made its way to Ireland.

Blythe.

A great many works on agriculture appeared during the time of the commonwealth, of which Blythe's *Improver Improved*, and Hartlib's *Legacy*, are the most valuable. The first edition of the former was published in 1649, and of the latter in 1650; and both of them were enlarged in subsequent editions. In the first edition of the *Improver Improved*, no mention is made of clover, nor in the second of turnips; but in the third, published in 1662, clover is treated of at some length, and turnips are recommended as an excellent cattle crop, the culture of which should be extended from the kitchen garden to the field. Sir Richard Weston must have cultivated turnips before this; for Blythe says, that Sir Richard affirmed to himself he did feed his swine with them. They were first given boiled, but afterwards the swine came to eat them raw, and would run after the carts, and pull them forth as they gathered them; an expression which conveys an idea of their being cultivated in the fields.

Culture of turnips.

Blythe's book is the first systematic work in which there are some traces of the alternate husbandry so beneficially established since, by interposing clover and turnip between culmiferous crops. He is a great enemy to commons and common fields, and to retaining land in old pasture, unless it be of the best quality. His description of the different kinds of ploughs is interesting; and he justly recommends such as were drawn by two horses (some even by one horse), in preference to the weighty and clumsy machines which required four or more horses or oxen. Almost all the manures now used seem to have been then well known; and he brought lime himself from a distance of 20 miles. He speaks of an instrument which ploughed, sowed, and harrowed at the same time; and the *setting of corn* was then a subject of much discussion. "It was not many years," says Blythe, "since the famous city of London petitioned the parliament of England against two anusancies or offensive commodities, which were likely to come into great use and esteem; and that was Newcastle coal, in regard of their stench, &c., and hops, in regard they would spoyle the taste of drink, and endanger the people."

Hartlib.

Hartlib's *Legacy* is a very heterogeneous performance, containing, among some very judicious directions, a great deal of rash speculation. Several of the deficiencies which the writer complains of in English agriculture must be placed to the account of our climate, and never have been or can be supplied. Some of his recommendations are quite unsuitable to the state of the country, and display more of general knowledge and good intention, than of either the theory or practice of agriculture. Among the subjects deserving notice may be mentioned the practice of steeping and liming seed corn as a preventive of smut; changing every year the *species* of grain, and bringing seed corn from a distance; ploughing down green crops as manure; and feeding horses with broken oats and chaff. This writer seems to differ a good deal from Blythe about the advantage of interchanging tillage and pasture. "It were no losse to this island," he says, "if that we should not plough at all, if so be that we could certainly have corn at a reasonable rate, and likewise vent for all our manufactures of wool:" and one reason for this is, that pasture employeth more hands than tillage, instead of depopulating the country, as was commonly imagined. The *grout*, which he mentions "as coming over to us in Holland ships," about which he desires information, was probably the same with our present shelled barley; and mills for manufacturing it were introduced into Scotland from Holland towards the beginning of the last century.

To the third edition, published in 1655, are subjoined Dr Beatie's Annotations, with the writer of the Legacy's answers, both of them ingenious, and sometimes instructive. But this cannot be said of Gabriel Plattes's *Mercurius Lætificans*, also added to this edition, which is a most extravagant production. There are also several communications from Hartlib's different correspondents, of which the most interesting are those on the early cultivation and great value of clover. Hartlib himself does not appear much in this collection; but he seems to have been a

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very useful person in editing the works of others, and as a collector of miscellaneous information on rural subjects. It is strange that neither Blythe nor Hartlib, nor any of Hartlib's correspondents, seem ever to have heard of Fitzherbert's works.

Ray and Evelyn.

Among the other writers previous to the Revolution, we shall only mention Ray the botanist and Evelyn, both men of great talents and research, whose works are still in high estimation. A new edition of Evelyn's *Silva and Terra* was published in 1777 by Dr Hunter, with large notes and elegant engravings, and reprinted in 1812.

The preceding review commences with a period of feudal anarchy and despotism, and comes down to the time when the exertions of individual interest were protected and encouraged by the firm administration of equal laws; when the prosperity of Great Britain was no longer retarded by internal commotions, nor endangered by hostile invasion.

Laws

The laws of this period, in so far as they relate to agriculture and rural economy, display a similar progress in improvement.

against laying arable land to pasture,

From the beginning of the reign of Henry VII. to the end of Elizabeth's, a number of statutes were made for the encouragement of tillage, though probably to little purpose. The great grievance of those days was the practice of laying arable land to pasture, and suffering the farm-houses to fall to ruin. "Where in some towns," says the statute 4th Henry VII. (1488), "two hundred persons were occupied and lived of their lawful labours, now there are occupied two or three herdsmen, and the residue fall into idleness:" therefore it is ordained, that houses which within three years have been let for farms, with twenty acres of land lying in tillage or husbandry, shall be upheld, under the penalty of half the profits, to be forfeited to the king or the lord of the fee. Almost half a century afterwards, the practice had become still more alarming; and in 1534 a new act was tried, apparently with as little success. "Some have 24,000 sheep, some 20,000 sheep, some 10,000, some 6000, some 4000, and some more and some less;" and yet it is alleged the price of wool had nearly doubled, "sheep being come to a few persons' hands." A penalty was therefore imposed on all who kept above 2000 sheep; and no person was to take in farm more than two tenements of husbandry. By the 39th Elizabeth (1597), arable land made pasture since the 1st Elizabeth shall be again converted into tillage, and what is arable shall not be converted into pasture.

Many laws were enacted during this period against vagabonds, as they were called; and persons who could not find employment seem to have been sometimes confounded with those who really preferred idleness and plunder. The dissolution of the feudal system, and the suppression of the monasteries, deprived a great part of the rural population of the means of support. They could not be employed in cultivating the soil, for there was no middle class of farmers possessed of capital to be vested in improvements; and what little disposable capital was in the hands of great proprietors could not, in those rude times, be so advantageously embarked in the expensive and precarious labours of growing corn, as in pasturage, which required much less skill and superintendence. Besides, there was a constant demand for wool on the Continent; while the corn-market was not only confined by laws against exportation, but fettered by restrictions on the internal trade. The laws regarding the wages of labour and the price of provisions are a further proof of the ignorance of the age in regard to the proper subject of legislation.

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against forestalling,

By the statute 1552 it is declared, that any person that shall buy merchandise, victual, &c. coming to market, or make any bargain for buying the same before they shall be in the market ready to be sold, or shall make any motion for enhancing the price, or dissuade any person from coming to market, or forbear to bring any of the things to market, &c. shall be deemed a *forestaller*. Any person who buys and sells again in the same market, or within four miles thereof, shall be reputed a *regrater*. Any person buying corn growing in the fields, or any other corn, with intent to sell again, shall be reputed an unlawful *ingrosser*. It was also declared, that no person shall sell cattle within five weeks after he had bought them. Licences, indeed, were to be granted in certain cases, and particularly when the price of wheat was at or under 6s. 8d. a quarter, and other kinds of grain in that proportion.

and for regulating the corn trade.

The laws regarding the exportation and importation of corn during this period could have had little effect in encouraging agriculture, though towards the latter part of it they gradually approached that system which was finally established at and soon after the Revolution. From the time of the above-mentioned statute against forestallers, which effectually prevented exportation, as well as the freedom of the home trade, when corn was above the price therein specified, down to 1688, there are at least twelve statutes on this subject; and some of them are so nearly the same, that it is probable they were not very carefully observed. The price at which wheat was allowed to be exported was raised from 6s. 8d. a quarter, the price fixed by the 1st and 2d of Philip and Mary (1553), to 10s. in 1562; to 20s. in 1593; to 26s. 8d. in 1604; to 32s. in 1623; to 40s. in 1660; to 48s. in 1663; and at last, in 1670, exportation was virtually permitted without limitation. Certain duties, however, were payable, which in some cases seem to have amounted to a prohibition; and until 1660 importation was not restrained even in years of plenty and cheapness. In permitting exportation, the object appears to have been revenue rather than the encouragement of production.

The first statute for levying tolls at turnpikes, to make or repair roads in England, passed in 1662.

Agriculture of Scotland in the 16th and 17th centuries.

Of the state of agriculture in Scotland in the 16th and the greater part of the 17th century, very little is known; no professed treatise on the subject appeared till after the Revolution. The south-eastern counties were the earliest improved, and yet in 1660 their condition seems to have been very wretched. Ray, who made a tour along the eastern coast in that year, says, "we observed little or *no fallow grounds* in Scotland; some ley ground we saw, which they manured with sea wreck. The men seemed to be very lazy, and may be frequently observed to plough in their cloaks. It is the fashion of them to wear cloaks when they go abroad, but especially on Sundays. They have neither good bread, cheese, nor drink. They cannot make them, nor will they learn. Their butter is very indifferent, and one would wonder how they could contrive to make it so bad. They use much pottage made of coalwort, which they call *kail*, sometimes broth of decorticated barley. The ordinary country-houses are pitiful cots, built of stone and covered with turfs, having in them but one room, many of them no chimneys, the windows very small holes, and not glazed. The ground in the valleys and plains bears very good corn, but especially bears barley or bigge, and oats, but rarely wheat and rye."[1]

[1] *Select Remains of John Ray.* Lond. 1760.

Historical Summary. It is probable that no great change had taken place in Scotland from the end of the 15th century, except that tenants gradually became possessed of a little stock of their own, instead of having their farm stocked by the landlord. " The minority of James V., the reign of Mary Stuart, the infancy of her son, and the civil wars of her grandson Charles I., were all periods of lasting waste. The very laws which were made during successive reigns, for protecting the tillers of the soil from spoil, are the best proofs of the deplorable state of the husbandman."[1]

Yet in the 17th century were those laws made which paved the way for the present improved system of agriculture in Scotland. By statute 1633, landholders were enabled to have their tithes valued, and to buy them either at nine or six years' purchase, according to the nature of the property. The statute 1685, conferring on landlords a power to entail their estates, was indeed of a very different tendency in regard to its effects on agriculture. But the two acts in 1695, for the division of commons, and separation of intermixed properties, have facilitated in an eminent degree the progress of improvement.

Progress of agriculture from 1688 to 1760. From the Revolution to the accession of George III. the progress of agriculture was by no means so considerable as we should be led to imagine from the great exportation of corn. It is the opinion of well-informed writers,[2] that very little improvement had taken place, either in the cultivation of the soil or in the management of live stock, from the Restoration down to the middle of last century. Even clover and turnips, the great support of the present improved system of agriculture, were confined to a few districts, and at the latter period were scarcely cultivated at all by common farmers in the northern part of the island. Of the writers of this period, therefore, we shall notice only such as describe some improvement in the modes of culture, or some extension of the practices that were formerly little known.

In Houghton's *Collections on Husbandry and Trade*, a periodical work begun in 1681, we have the first notice of turnips being eaten by sheep. " Some in Essex have their fallow after turnips, which feed their sheep in winter, by which means the turnips are scooped, and so made capable to hold dews and rain water, which, by corrupting, imbibes the nitre of the air, and when the shell breaks it runs about and fertilizes. By feeding the sheep, the land is dunged as if it had been folded; and those turnips, though few or none be carried off for human use, are a very excellent improvement, nay, some reckon it so though they only plough the turnips in without feeding."[3] This was written in February 1694; but ten years before, Worlidge, one of his correspondents, observes, " sheep fatten very well on turnips, which prove an excellent nourishment for them in hard winters, when fodder is scarce; for they will not only eat the greens, but feed on the roots in the ground, and scoop them hollow even to the very skin. Ten acres (he adds) sown with clover, turnips, &c. will feed as many sheep as one hundred acres thereof would before have done."[4]

At this time potatoes were beginning to attract notice. " The potato," says Houghton, " is a *bacciferous* herb, with *esculent* roots, bearing winged leaves and a bell flower.

" This, I have been informed, was brought first out of Virginia by Sir Walter Raleigh; and he stopping at Ireland, some was planted there, where it thrived very well, and to good purpose; for in their succeeding wars, when all the corn above the ground was destroyed, this supported them; for the soldiers, unless they had dug up all the ground where they grew, and almost sifted it, could not extirpate them; from whence they were brought to Lancashire, where they are very numerous, and now they begin to spread all the kingdom over. They are a pleasant food boiled or roasted, and eaten with butter and sugar. There is a sort brought from Spain, that are of a longer form, and are more luscious than ours; they are much set by, and sold for sixpence or eightpence the pound."[5]

Mortimer. The next writer is Mortimer, whose *Whole Art of Husbandry* was published in 1706, and has since run through several editions. It is a regular, systematic work, of considerable merit; and it does not appear that much improvement has been made since in the practices he describes, in many parts of Britain. From the third edition of Hartlib's *Legacy*, we learn that clover was cut green, and given to cattle; and it appears that this practice of *soiling*, as it is now called, had become very common about the beginning of last century, wherever clover was cultivated. Ryegrass was now sown along with it. Turnips were hand-hoed, and extensively employed in feeding sheep and cattle, in the same manner as at present.

Tull. The first considerable improvement in the practice of that period was introduced by Jethro Tull, a gentleman of Berkshire, who began to drill wheat and other crops about the year 1701, and whose "*Horse-hoeing Husbandry*," published in 1731, exhibits the first decided step in advance upon the principles and practices of his predecessors. Not contented with a careful attention to details, Tull set himself, with admirable skill and perseverance, to investigate the growth of plants, and thus to arrive at a knowledge of the principles by which the cultivation of field-crops should be regulated. Having arrived at the conclusion that the food of plants consists of minute particles of earth taken up by their rootlets, it followed, that the more thoroughly the soil in which they grew was disintegrated, the more abundant would be the "pasture" (as he called it), to which their fibres would have access. He was thus led to adopt that system of sowing his crops in rows, or drills, so wide apart as to admit of tillage of the intervals, both by ploughing and hoeing, being continued until they had wellnigh arrived at maturity.

As the distance between his rows appeared much greater than was necessary for the range of the roots of the plants, he begins by showing that these roots extend much farther than is commonly believed, and then proceeds to inquire into the nature of their food. After examining several hypotheses, he decides this to be fine particles of earth. The chief, and almost the only use of dung, he thinks, is to divide the earth, to dissolve "this terrestrial matter, which affords nutriment to the mouths of vegetable roots;" and this can be done more completely by tillage. It is therefore necessary not only to pulverise the soil by repeated ploughings before it be seeded, but, as it becomes gradually more and more compressed afterwards, recourse must be had to tillage while the plants are growing; and this is *hoeing*, which also destroys the weeds that would deprive the plants of their nourishment.

The leading features of Tull's husbandry are his practice of laying the land into narrow ridges of five or six feet, and upon the middle of these drilling one, two, or three rows,

[1] Chalmers's *Caledonia*, vol. ii. p. 732.
[2] *Annals of Agriculture*, No. 270. Harte's *Essays*. Comber *on National Subsistence*, p. 161.
[3] Houghton's *Collections on Husbandry and Trade*, vol. i. p. 213. edit. 1728.
[4] *Ibid.* vol. iv. p. 142–144.
[5] *Ibid.* vol. ii. p. 468.

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distant from one another about seven inches when there were three, and ten when only two. The distance of the plants on one ridge from those on the contiguous one he called an *interval;* the distance between the rows on the same ridge, a *space* or *partition:* the former was stirred repeatedly by the horse-hoe, the latter by the hand-hoe.

The extraordinary attention this ingenious person gave to his mode of culture is perhaps without a parellel:—"I formerly was at much pains," he says, "and at some charge in improving my drills for planting the rows at very near distances, and had brought them to such perfection, that one horse would draw a drill with eleven shares, making the rows at three inches and a half distance from one another; and at the same time sow in them three very different sorts of seeds, which did not mix; and these, too, at different depths. As the barley-rows were seven inches asunder, the barley lay four inches deep. A little more than three inches above that, in the same channels, was clover; betwixt every two of these rows was a row of St Foin, covered half an inch deep.

"I had a good crop of barley the first year; the next year two crops of broad clover, where that was sown; and where hop-clover was sown, a mixed crop of that and St Foin; but I am since, by experience, so fully convinced of the folly of these, or any other mixed crops, and more especially of narrow spaces, that I have demolished these instruments, in their full perfection, as a vain curiosity, the drift and use of them being contrary to the true principles and practice of horse-hoeing."[1]

In the culture of wheat, he began with ridges six feet broad, or eleven on a breadth of 66 feet; but on this he afterwards had fourteen ridges. After trying different numbers of rows on a ridge, he at last preferred two, with an intervening space of about ten inches. He allowed only three pecks of seed for an acre. The first hoeing was performed by turning a furrow from the row, as soon as the plant had put forth four or five leaves; so that it was done before or at the beginning of winter. The next hoeing was in spring, by which the earth was returned to the plants. The subsequent operations depended upon the circumstances and condition of the land and the state of the weather. The next year's crop of wheat was sown upon the intervals which had been unoccupied the former year; but this he does not seem to think was a matter of much consequence. "My field," he observes, "whereon is now the thirteenth crop of wheat, has shown that the rows may successfully stand upon any part of the ground. The ridges of this field were, for the twelfth crop, changed from six feet to four feet six inches. In order for this alteration the ridges were ploughed down, and then the next ridges were laid out the same way as the former, but one foot six inches narrower, and the double rows drilled on their tops; whereby, of consequence, there must be some rows standing on every part of the ground, both on the former partitions, and on every part of the intervals. Notwithstanding this, there was no manner of difference in the goodness of the rows; and the whole field was in every part of it equal, and the best I believe that ever grew on it. It is now the thirteenth crop, likely to be good, though the land was not ploughed crossways."[2]

It follows, from this singular management, that Tull thought a succession of crops of different species altogether unnecessary; and he labours hard to prove against Dr Woodward, that the advantages of such a change under his plan of tillage were quite chimerical; though he seems to admit the benefit of a change of the seed itself.

In cultivating turnips he made the ridges of the same breadth as for wheat, but only one row was drilled on each. His management, while the crop was growing, differs very little from the present practice. When drilled on the level, it is impossible, he observes, to hoe-plough them so well as when they are planted upon ridges. But the seed was deposited at different depths, the half about four inches deep, and the other half exactly over that, at the depth of half an inch. "Thus planted, let the weather be never so dry, the deepest seed will come up; but if it raineth immediately after planting, the shallow will come up first. We also make it come up at four times, by mixing our seed half new and half old, the new coming up a day quicker than the old. These four comings up give it so many chances for escaping the fly; it being often seen that the seed sown over night will be destroyed by the fly, when that sown the next morning will escape, and *vice versa:* or you may hoe-plough them when the fly is like to devour them; this will bury the greatest part of these enemies: or else you may drill in another row without new-ploughing the land."

Drilling and horse and hand hoeing seem to have been in use before the publication of Tull's book. "Hoeing," he says, "may be divided into deep, which is our horse-hoeing; and shallow, which is the English hand-hoeing; and also the shallow horse-hoeing used in some places betwixt rows, where the intervals are very narrow, as 16 or 18 inches. This is but an imitation of the hand-hoe, or a succedaneum to it, and can neither supply the use of dung nor fallow, and may be properly called scratch-hoeing." But in his mode of forming ridges his practice seems to have been original; his implements display much ingenuity; and his claim to the title of father of the present horse-hoeing husbandry of Great Britain seems indisputable. A translation of Tull's book was undertaken at one and the same time in France, by three different persons of consideration, without the privity of each other. Two of them afterwards put their papers into the hands of the third, M. du Hamel du Monceau of the Royal Academy of Sciences at Paris, who published a treatise on husbandry, on the principles of Mr Tull, a few years after. But Tull seems to have had very few followers in England for more than 30 years. The present method of drilling and horse-hoeing turnips was not introduced into Northumberland till about the year 1780;[3] and it was then borrowed from Scotland, the farmers of which had the merit of first adopting Tull's management in the culture of this root about 1760, and from whom it has since made its way, but slowly, into the southern parts of the island.

Tull's doctrines and practices being quite in advance of his own times, were, as is usual in such cases, vehemently opposed by his contemporaries. He was, in consequence, involved in frequent controversy, in conducting which he occasionally showed an asperity of temper which excites our regret, but which is not to be wondered at, when we consider the trials of patience which he encountered from the unreasonable opposition of the agricultural community to his improvements; the thwarting of his experiments by his own labourers, who, in their ignorant zeal against innovations, wilfully broke his machines, and disregarded his orders; and from acute and protracted bodily disease. The soundness of his views and practice, as regards turnip culture, came by and by to be acknowledged, and have ever since been generally adopted. But it is only now that his full merit begins to be understood. The Rev. Mr Smith, in his "Word in Season," has recalled attention to his peculiar system of wheat culture, in a way that has startled the whole community; while Professor Way, in his eloquent lectures recently delivered before the Royal Agricultural Society, has shown

[1] *Horse-hoeing Husbandry*, p. 62. Lond. 1762.

[2] *Ibid.* p. 424.

[3] *Northumberland Survey*, p. 100.

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that his science is true in the main, and even more strikingly ahead of his times than his practice.

Among the English writers of this period may be mentioned Bradley, Lawrence, Hales, Miller, Ellis, Smith, Hill, Hitt, Lisle, and Home. Most of their works went through several editions in a few years; at once a proof of the estimation in which they were held, and of the direction of the public mind towards investigating the principles and practice of agriculture.

Writers on Scottish husbandry. Donaldson.

Of the progress of the art in Scotland, till towards the end of the 17th century, we are almost entirely ignorant. The first work, written by Donaldson, was printed in 1697, under the title of *Husbandry Anatomized; or, an Inquiry into the Present Manner of Teiling and Manuring the Ground in Scotland.* It appears from this treatise, that the state of the art was not more advanced at that time in North Britain than it had been in England in the time of Fitzherbert. Farms were divided into infield and outfield; corn crops followed one another without the intervention of fallow, cultivated herbage, or turnips, though something is said about fallowing the outfield; inclosures were very rare; the tenantry had not begun to emerge from a state of great poverty and depression; and the wages of labour, compared with the price of corn, were much lower than at present; though that price, at least in ordinary years, must appear extremely moderate in our times. Leases for a term of years, however, were not uncommon; but the want of capital rendered it impossible for the tenantry to attempt any spirited improvements.

Donaldson first points out the common management of that period, which he shows to have been very unproductive; and afterwards recommends what he thinks would be a more profitable course. "Of the dale ground," he says, "that is, such lands as are partly hills and partly valleys, of which sorts may be comprehended the greatest part of arable ground in this kingdom, I shall suppose a farmer to have a lease or tack of three score acres, at three hundred merks of rent per annum (L.16. 13s. 4d. sterling). Perhaps some who are not acquainted with rural affairs may think this cheap; but those who are the possessors thereof think otherwise, and find difficulty enough to get the same paid, according to their present way of manuring thereof. But that I may proceed to the comparison, I shall show how commonly this farm-room is managed. It is commonly divided into two parts, viz. one-third croft, and two-thirds outfield, as it is termed. The croft is usually divided into three parts; to wit, one-third barley, which is always dunged that year barley is sown thereon; another third oats; and the last third peas. The outside field is divided into two parts, to wit, the one half oats, and the other half grass, two years successively. The product which may be supposed to be on each acre of croft, four bolls (three Winchester quarters), and that of the outfield, three ($2\frac{1}{4}$ quarters); the quota is seven score bolls, which we shall also reckon at five pounds (8s. 4d.) per boll, cheap year and dear year one with another. This, in all, is worth L.700 (L.58. 6s. 8d. sterling).

"Then let us see what profit he can make of his cattle. According to the division of his lands, there is 20 acres of grass, which cannot be expected to be very good, because it gets not leave to lie above two years, and therefore cannot be well swarded. However, usually, besides four horses, which are kept for ploughing the said land, ten or twelve nolt are also kept upon a farm-room of the above-mentioned bounds; but, in respect of the badness of the grass, as said is, little profit is had of them. Perhaps two or three stone of butter is the most that can be made of the milk of his kine the whole summer, and not above two heffers brought up each year. As to what profit may be made by bringing up young horses, I shall say nothing, supposing he keeps his stock good by those of his own upbringing. The whole product, then, of his cattle cannot be reckoned above fifty merks (L.2. 15s. 6d.). For, in respect his beasts are in a manner half-starved, they are generally small; so that scarce may a heffer be sold at above twelve pounds (L.1 sterling). The whole product of this farm-room, therefore, exceeds not the value of L.733 (L.61. 1s. 8d. sterling), or thereabout." The labourers employed on this farm were two men and one woman, besides a herd in summer, and other servants in harvest.

Donaldson then proceeds to point out a different mode of management, which he calculates to be more profitable; but no notice is taken of either clover or turnips as crops to be raised in his new course, though they are incidentally noticed in other parts of the work.

"I also recommend potatoes as a very profitable root for husbandmen and others that have numerous families. And because there is a peculiar way of planting this root, not commonly known in this country, I shall here show what way it is ordinarily planted or set. The ground must be dry; and so much the better it is if it have a good soard of grass. The beds or riggs are made about eight foot broad, good store of dung being laid upon your ground; horse or sheep dung is the proper manure for them. Throw each potatoe or sett (for they were sometimes cut into setts) into a knot of dung, and afterwards dig earth out of the furrows, and cover them all over, about some three or four inches deep; the furrows left between your riggs must be about two foot broad, and little less will they be in depth before your potatoes be covered. You need not plant this root in your garden; they are commonly set in the fields, and wildest of ground, for enriching of it." As to their consumption, they were sometimes "boiled and broken, and stirred with butter and new milk; also roasted, and eaten with butter; yea, some make bread of them, by mixing them with oat or barley meal; others parboil them, and bake them with apples, after the manner of tarts."

There is a good deal in this little treatise about sheep, and other branches of husbandry; and, if the writer was well informed, as in most instances he appears to have been, his account of prices, of wages, and generally of the practices of that period, is very interesting.

Lord Belhaven.

The next work on the husbandry of Scotland is, *The Countryman's Rudiments, or an advice to the Farmers in East Lothian, how to labour and improve their grounds;* said to have been written by Lord Belhaven about the time of the Union, and reprinted in 1723. In this we have a deplorable picture of the state of agriculture in what is now the most highly improved county in Scotland. His lordship begins with a very high encomium on his own performance. "I dare be bold to say, there was never such a good easy method of husbandry as this, so succinct, extensive, and methodical in all its parts, published before." And he bespeaks the favour of those to whom he addresses himself, by adding, "neither shall I affright you with hedging, ditching, marling, chalking, paring and burning, draining, watering, and such like, which are all very good improvements indeed, and very agreeable with the soil and situation of East Lothian; but I know ye cannot bear as yet a crowd of improvements, this being only intended to initiate you in the true method and principles of husbandry." The farm-rooms in East Lothian, as in other districts, were divided into infield and outfield. "The infield (where wheat is sown) is generally divided by the tenant into four divisions, or breaks, as they call them, viz. one

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of wheat, one of barley, one of pease, and one of oats; so that the wheat is sowed after the pease, the barley after the wheat, and the oats after the barley. The outfield land is ordinarily made use of promiscuously for feeding of their cows, horse, sheep, and oxen; 'tis also dunged by their sheep, who lay in earthen folds; and sometimes, when they have much of it, they fauch or fallow a part of it yearly." Under this management the produce seems to have been three times the seed; and yet, says his lordship, "if in East Lothian they did not leave a higher stubble than in other places of the kingdom, their grounds would be in a much worse condition than at present they are, though bad enough."—"A good crop of corn makes a good stubble, and a good stubble is the equalest mucking that is." Among the advantages of inclosures, he observes, "you will gain much more labour from your servants, a great part of whose time was taken up in gathering thistles and other garbage for their horses to feed upon in their stables; and thereby the great trampling and pulling up, and other destruction of the corns, while they are yet tender, will be prevented." Potatoes and turnips are recommended to be sown in the yard (kitchen-garden). Clover does not seem to have been in use. Rents were paid in corn; and, for the largest farm, which he thinks should employ no more than two ploughs, the rent was about six chalders of victual "when the ground is very good, and four in that which is not so good. But I am most fully convinced they should take long leases or tacks, that they may not be straitened with time in the improvement of their rooms; and this is profitable both for master and tenant."

Society of Improvers.

Such was the state of the husbandry of Scotland in the early part of last century. The first attempts at improvement cannot be traced farther back than 1723, when a number of landholders formed themselves into a society, under the title of the *Society of Improvers in the Knowledge of Agriculture in Scotland*. The earl of Stair, one of their most active members, is said to have been the first who cultivated turnips in that country. The *Select Transactions* of this society were collected and published in 1743 by Mr Maxwell, who took a large part in its proceedings. It is evident from this book that the society had exerted itself in a very laudable manner, and apparently with considerable success, in introducing cultivated herbage and turnips, as well as in improving the former methods of culture. But there is reason to believe that the influence of the example of its numerous members did not extend to the common tenantry, who are always unwilling to adopt the practices of those who are placed in a higher rank, and supposed to cultivate land for pleasure rather than profit. Though this society, the earliest probably in the United Kingdom, soon counted upwards of 300 members, it existed little more than 20 years. Maxwell delivered lectures on agriculture for one or two sessions at Edinburgh, which, from the specimen he has left, ought to have been encouraged.

Maxwell.

In the introductory paper in Maxwell's collection, we are told, that "the practice of draining, inclosing, summer fallowing, sowing flax, hemp, rape, turnip and grass seeds, planting cabbages after, and potatoes with, the plough, in fields of great extent, is introduced; and that, according to the general opinion, more corn grows now yearly where it was never known to grow before, these twenty years last past, than perhaps a sixth of all that the kingdom was in use to produce at any time before."

Invention of a threshing-machine.

In this work we find the first notice of a threshing-machine; it was invented by Mr Michael Menzies, advocate, who obtained a patent for it. Upon a representation made to the society that it was to be seen working in several places, they appointed two of their number to inspect it; and in their report they say, that one man would be sufficient to manage a machine which would do the work of six. One of the machines was "moved by a great water-wheel and triddles," and another "by a little wheel of three feet diameter, moved by a small quantity of water." This machine the society recommended to all gentlemen and farmers.

The next work is by the same Mr Maxwell, printed in 1757, and entitled the *Practical Husbandman; being a collection of miscellaneous papers on Husbandry*, &c. In this book the greater part of the *Select Transactions* is re published, with a number of new papers, among which, an *Essay on the Husbandry of Scotland*, with a proposal for the improvement of it, is the most valuable. In this he lays it down as a rule, that it is bad husbandry to take two crops of grain successively, which marks a considerable progress in the knowledge of modern husbandry; though he adds, that in Scotland the best husbandmen after a fallow take a crop of wheat; after the wheat, peas; then barley, and then oats; and after that they fallow again. The want of inclosures was still a matter of complaint. The ground continued to be cropped so long as it produced two seeds; the best farmers were contented with four seeds, which was more than the general produce.

The first act of parliament for collecting tolls on the highway in Scotland was passed in 1750, for repairing the road from Dunglass bridge to Haddington. In ten years after, several acts followed for the counties of Edinburgh and Lanark, and for making the roads between Edinburgh and Glasgow. The benefit which agriculture has derived from good roads, it would not be easy to estimate. The want of them was one great cause of the slow progress of the art in former times.

The Revolution in 1688 was the epoch of that system of corn laws to which very great influence has been ascribed, both on the practice of agriculture and the general prosperity of the country. But for an account of these and later statutes on the subject, we must refer to the article Corn Laws.

The exportation of wool was prohibited in 1647, in 1660, and in 1688; and the prohibition strictly enforced by subsequent statutes. The effect of this on its price, and the state of the wool trade, from the earliest period to the middle of last century, are distinctly exhibited by the learned and laborious author of *Memoirs on Wool*, printed in 1747.

Progress from 1760 to 1792.

The gradual advance in the price of farm produce soon after the year 1760, occasioned by the increase of population, and of wealth derived from manufactures and commerce, gave a powerful stimulus to rural industry, augmented agricultural capital, and called forth a more skilful and enterprising race of farmers. The arable lands of the country, which, under the operation of the feudal system, has been split up into minute portions, cultivated by the tenants and their families without hind labour, began now to be consolidated into larger holdings, and let to those tenants who possessed most energy and substance. This enlargement of farms, and the letting of them under leases for a considerable term of years, continued (in Scotland) to be a marked feature in the agricultural progress of the country until the end of the century, and is to be regarded both as a cause and a consequence of that progress. The passing of more than 3000 inclosure bills during the reign of Geo. III., before which the whole number was but 244, shews how rapidly the cultivation of new land now proceeded. The disastrous American war for a time interfered with the national prosperity; but with the return of peace in 1783, the cultivation of the country made more rapid pro-

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gress. The quarter of a century immediately following 1760, is memorable in our agricultural annals for the introduction of various important improvements.

Bakewell.

It was during this period that the genius of Bakewell produced such an extraordinary change in the character of our more important breeds of live stock; but especially by the perfecting of a new race of sheep—the well-known Leicesters—which have ever since proved such a boon to the country, and have added so much to its wealth. Bakewell's fame as a breeder was for a time enhanced by the improvement which he effected on the long-horned cattle, then the prevailing breed of the midland counties of England. These, however, were ere long rivalled, and have now been entirely superseded by the short-horn or Durham breed, which the brothers Colling obtained from the useful race of cattle that had long existed in the valley of the Tees, by applying to them the principle of breeding which Bakewell had already established.

Alternate Husbandry

A more rational system of cropping now began very generally to supersede the thriftless and barbarous practice of sowing successive crops of corn until the land was utterly exhausted, and then leaving it foul with weeds, to recover its power by an indefinite period of rest. Instead of this, green crops, such as turnips, clover, and ryegrass, began to be alternated with grain crops, and hence the name *alternate husbandry*, by which this improved system is generally known. The land was now also generally rendered clean and mellow by a summer fallow, before being sown with clover or grasses. Hitherto, the husbandry of England had been very superior in every respect to that of Scotland.

Stimulus given to agriculture in Scotland

Improvements now, however, made rapid progress in the latter. So early as 1764, Mr Dawson, at Frogden, in Roxburghshire, is said to have had 100 acres of drilled turnips on that farm in one year. A few years after this, the Messrs Culley—one of them a pupil of Bakewell—left their paternal property on the banks of the Tees, and settled on the Northumbrian side of the Tweed, bringing with them the valuable breeds of live stock and improved husbandry of their native district. The improvements introduced by these energetic and skilful farmers, spread rapidly and exerted a most beneficial influence upon the border counties. An act passed in 1770, which relaxed the rigour of strict entails, and afforded power to landlords to grant leases and otherwise improve their estates, had a beneficial effect on Scottish agriculture. From 1784 to 1795, improvements advanced with steady steps. This period was distinguished for the general adoption and industrious working out of ascertained improvements. Small's swing plough, and Meikle's thrashing-machine, although invented some years before this, were now perfected and brought into general use, to the great furtherance of agriculture. Two important additions were about this time made to the field crops, viz., the Swedish turnip and potato oat. The latter was accidentally discovered in 1788, and both soon came into general cultivation.

Merino Sheep.

In the same year, Merino sheep were introduced by his Majesty, George III., who was a zealous farmer. For a time, this breed attracted much attention, and sanguine expectations were entertained that it would prove of national importance. Its unfitness for the production of mutton, and increasing supplies of fine clothing wool from other countries, soon led to its total rejection.

In Scotland, the opening up of the country by the construction of practicable roads, and the enclosing and subdividing of farms by hedge and ditch was now in active progress. The former admitted of the general use of wheel-carriages, of the ready conveyance of produce to markets, and in particular, to the extended use of lime; the application of which was immediately followed by a great increase of produce. The latter, besides its more obvious advantages, speedily freed large tracts of country from stagnant water, and their inhabitants from ague; and prepared the way for the under-ground draining which soon after began to be practised.

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Remarkable progress from 1795 to 1815.

The agriculture of the country was thus steadily improving, when suddenly the whole of Europe became involved in the wars of the French Revolution. In 1795, under the joint operation of a deficient harvest, and the cutting off of foreign supplies of grain by the policy of Napoleon, the price of wheat, which, for the twenty preceding years, had been under 50s. a quarter, suddenly rose to 81s. 6d., and in the following year, reached to 96s.

Bank Restriction Act.

In 1797, the fear of foreign invasion led to a panic and run upon the banks, in which emergency the Bank Restriction Act, suspending cash payment, was passed and ushered in a system of unlimited credit transactions. Under the unnatural stimulus of these extraordinary events, every branch of industry extended with unexampled rapidity. But in nothing was this so apparent as in agriculture; the high prices of produce holding out a great inducement to improve lands then arable, to reclaim others that had previously lain waste, and to bring much pasture-land under the plough. Nor did this increased tillage interfere with the increase of live stock; as the green crops of the alternate husbandry more than compensated for the diminished pasturage. This extraordinary state of matters lasted from 1795 to 1814; the prices of produce even increasing towards the close of that period. The average price of wheat for the whole period was 89s. 7d. per quarter; but for the last five years it was 107s., and in 1812 it reached to 126s. 6d. The agriculture of Great Britain, as a whole, advanced with rapid strides during this period; but nowhere was the change so great as in Scotland. Indeed, its progress there, during these twenty years, is probably without parallel in the history of any other country. This is accounted for by a concurrence of circumstances. Previous to this period, the husbandry of Scotland was still in a backward state as compared with the best districts of England, where many practices, only of recent introduction in the north, had been in general use for generations. This disparity made the subsequent contrast the more striking. The land in Scotland was now, with trifling exceptions, let on leases for terms varying from twenty to thirty years, and in farms of sufficient size to employ at the least two or three ploughs. The unlimited issues of Government paper, and the security afforded by these leases, induced the Scotch banks to afford every facility to landlords and tenants to embark capital in the improvement of the land. The substantial education supplied by the parish schools, of which nearly the whole population could then avail themselves, had diffused through all ranks such a measure of intelligence as enabled them promptly to discern, and skilfully and energetically to take advantage of this spring-tide of prosperity; and to profit by the agricultural information now plentifully furnished by means of the Bath and West of England Society, established in 1777; the Highland Society, instituted in 1784; and the National Board of Agriculture in 1793; of which, however, more anon. As one proof of the astonishing progress of Scottish husbandry during this period, we may mention that the rental of land which in 1795 amounted to L.2,000,000, had in 1815 risen to L.5,278,685, or considerably more than doubled in twenty years.

But of the causes which have influenced the agriculture of the period under review, none have been so powerful as the extraordinary increase of our population, which, in round numbers, has twice doubled during the past seventy years. Not only are there four times as many people requiring to be fed and clad now as there was then, but from the increased wealth and altered habits of the people, the individual rate of consumption is greater now than formerly

Historical Summary.

This is particularly apparent in the case of butcher-meat, the consumption of which has increased out of all proportion with that of bread-corn. To meet this demand, there behoved to be more green crops and more live stock; and from that has resulted more wool, more manure, and more corn. While this ever-growing demand for farm-produce has stimulated agricultural improvement, it has also operated in another way. The productiveness of the soil has been greatly increased, and will no doubt be still more so in future; but the area of the country cannot be increased. Land—the raw material from which food is produced—being thus limited in amount, and in increasing demand, has necessarily risen in price. So much is this the case, that whereas the average price of wheat for the five years preceding 1852, has been L.2, 8s. $7\frac{3}{4}$d. per quarter, or L.2, 13s. 10d. less than during the five years preceding 1815, the rent of land is actually higher now than it was then. The raw material of the food-grower having thus risen in price, his only resource has been to fall upon plans for lowering the cost of producing his crops and for increasing their amount. To such an extent has he succeeded, that the produce-market has been kept full, and prices have decreased. The business of farming has in the main been a less prosperous one than most other branches of national industry, and yet agriculture, as an art and as a science, has made steady progress. We believe it is only in this way that the contemporaneous existence of two things apparently so incompatible as a steady rise in the rent of land, and a steady decrease in the price of its produce, can be satisfactorily accounted for.

From 1815 to present time.

The abundant crop of 1813, and restored communication with the continent of Europe in the same year, gave the first check to these unnaturally exorbitant prices and rents. The restoration of peace to Europe, and the re-enactment of the Corn-Laws in 1815, mark the commencement of another era in the history of our national agriculture. It was ushered in with a time of severe depression and suffering to the agricultural community. The immense fall in the price of farm-produce which then took place was aggravated, first, by the unpropitious weather and deficient harvest of the years 1816, 1817; and still more by the passing in 1819 of the Bill restoring cash payments; which coming into operation in 1821, caused serious embarrassment to all persons who had entered into engagements at a depreciated currency, which had now to be met with the lower prices of an enhanced one. The much-debated Corn-Laws, after undergoing various modifications, and proving the fruitful source of business uncertainty, social discontent, and angry partisanship, were finally abolished in 1846, although the Act was not consummated until three years later. Several other Acts of the Legislature, passed during this period, have exerted an important influence on agriculture. Of these, the first in date and importance is the Tithe Commutation Act of 1836. All writers on agriculture had long concurred in pointing out the injurious effects on agriculture, of the tithe system as it then stood. The results of the change have amply verified the anticipations of those who were instrumental in procuring it. Since the removal of this formidable hindrance to improvement, it has been stimulated by those acts under which the Government has been empowered to advance money on certain conditions, for the draining of estates. An important feature in these advances is, that the $6\frac{1}{2}$ per cent. of interest charged upon them, provides a sinking fund by which the debt is extinguished in 22 years. Additional facilities have also been granted, by the Act passed in 1848 for disentailing estates, and for burdening such as are entailed with a share of the cost of certain specified improvements.

Sir Robert Peel's Bill restoring cash payments.

Corn-Laws

Act commuting tithes into a rent charge.

Drainage Acts.

Another class of outward events, which has had an important influence upon agriculture, requires our notice. We refer to those mysterious diseases affecting both the animal and vegetable kingdoms, the causes and remedies for which, we have alike failed to discover. The murrain, or "vesicular epizootic" appeared first in 1841; having been introduced, as is supposed, by foreign cattle. It spread rapidly over the country, affecting all our domesticated animals, except horses, and causing everywhere great alarm and loss, although seldom attended by fatal results. It has prevailed ever since, in a greater or less degree. It was soon followed by the more terrible lung-disease, or pleuro-pneumonia, which continues to cause such mortality among our herds. But these have been as nothing in comparison with the dreaded potato-disease, which first appearing in 1845, has since pervaded the whole of Europe, and in Ireland especially has been the sad precursor of famine and pestilence. This seemingly insignificant blight, has already wellnigh withdrawn from cultivation one of our most esteemed field crops; it influences the business of farming in a way that baffles the shrewdest calculators, and is producing social changes of which no man can predict the issue.

Historical Summary.

Cattle Murrain.

Potato-disease.

We can here do little more than enumerate some of the more prominent improvements in practical agriculture which have taken place during the period under review. Before the close of the past century, and during the first quarter of the present one, a good deal had been done in the way of draining the land; either by open ditches, or by Elkington's system of deep-covered drains. This system has now been superseded by one altogether superior to it both in principle and practice. In 1835, James Smith of Deanston (honour to his memory!) promulgated his now well-known system of thorough draining and deep ploughing. It has been carried out already to such an extent, as to have altered the very appearance and character of whole districts of our country, and has prepared the way for all other improvements. The words "Portable Manures," indicate at once another prominent feature in the agriculture of the times. Early in the present century, ground bones began to be used in the eastern counties of England as a manure for turnips; whence the practice spread, at first slowly, and then very rapidly, over the whole country. It was about 1825 when it began to be generally used in Scotland. In 1841 the still more potent guano was introduced in Great Britain; and about the same time, bones, under the new form of superphosphate of lime. By means of these invaluable fertilizers, a stimulus has been given to agriculture which can scarcely be overrated.

Smith of Deanston's system of Draining.

Bone Dust.

Guano and Superphosphate of Lime.

The labour of agriculture has been greatly lightened and its costs curtailed, by means of improved implements and machines. The steam-engine has taken the place of the jaded horses, as a thrashing power. This was first done in East Lothian, by Mr Reid at Drem, who in 1820 erected such an engine at a cost of L.600. It would be tedious to particularise other instances in this department, as it will be treated of fully in its proper place. It is especially in this department that the influence of the ever-memorable Exhibition of the Industry of all Nations in 1851, has told upon agriculture. Reaping by machinery, may virtually be regarded as one of the fruits of that great gathering.

Thrashing by Steam.

The railways, by which the country is now intersected in all directions, have proved of great service to farmers, by conveying their bulky produce to distant markets cheaply and quickly; and by making lime and other manures available to the occupiers of many inland and remote districts. In nothing has this benefit been more apparent, than in the case of fatted live stock, which is now invariably transported by this means, with manifold economy to all concerned.

Railways.

During the whole of this period, there has been going on great improvements in all our breeds of domesticated ani-

Historical Summary.

Improved live stock and field crops.

mals. This has been manifested, not so much in the production of individual specimens of high merit—in which respect the Leicesters of Bakewell, or the short-horns of Colling, have perhaps not yet been excelled—as in the diffusion of these and other good breeds over the country, and in the improved quality of our live stock as a whole. The fattening of animals is now conducted on more scientific principles. Increased attention has also been successfully bestowed on the improvement of our field crops. Improved varieties, obtained by cross-impregnation, either naturally or artificially brought about, have been carefully propagated, and generally adopted. Increased attention is now bestowed on the cultivation of the natural grasses. The most important additions to our list of field crops during this period, have been Italian ryegrass, winter beans, white Belgian carrot, and sugar beet.

Agricultural Societies.

Let us look now at the means by which, during this period, agricultural knowledge has at once been increased and diffused. Notice has already been taken of the institution of the Highland Society and National Board of Agriculture. These patriotic societies were the means of collecting a vast amount of statistical and general information connected with agriculture, and by their publications and premiums made known the practices of the best-farmed districts of the country and encouraged their adoption elsewhere. These national associations were soon aided in their important labours by numerous local societies which sprung up in all parts of the kingdom. After a highly useful career, under the zealous presidency of the amiable Sir John Sinclair, the Board of Agriculture was dissolved, but has left in its Statistical Account, county surveys, and other documents, much interesting and valuable information regarding the agriculture of that period. In 1800, the original Farmer's Magazine entered upon its useful career under the editorship of Robert Brown of Markle, the author of the well-known treatise on "Rural Affairs." The Highland Society having early extended its operations to the whole of Scotland, by and by made a corresponding addition to its title, and as the *Highland and Agricultural Society of Scotland* continues to occupy its important sphere with a steadily increasing membership, popularity, and usefulness. As its revenue and experience increased, it gradually extended its operations. In 1828, shortly after the discontinuance of the Farmer's Magazine, its "Prize Essays and Transactions" began to be issued statedly in connection with the "Quarterly Journal of Agriculture," a periodical which still occupies a prominent place in our professional literature. This Society early began to hold a great annual show of live stock, implements, &c., the popularity of which continues unabated. In 1842, Mr John Finnie at Swanstone, near Edinburgh, having suggested to some of his neighbours the desirableness of obtaining the aid of chemistry to guide farmers in many departments of their business, the hint was promptly acted upon, and these Mid-Lothian tenant-farmers had the merit of originating an Agricultural Chemistry Association (the first of its kind), by which funds were raised, and an eminent chemist engaged, for the express purpose of conducting such investigations as the title of the Society imports. After a successful trial of a few years this association was dissolved, after transferring its functions to the Highland and Agricultural Society, which has ever since devoted much of its attention to this subject. The accompanying article on Agricultural Chemistry from the pen of its present accomplished chemist, Dr Anderson, shows the nature and importance of the labours in which he, and his predecessor, Professor Johnston, have been engaged. This society has of late years established itself on a broader basis, and imparted new energy to its operations by lowering its admission-fee in behalf of tenant-farmers, who have in consequence joined it in great numbers, and now take an important part in the conduct of its business. The practice adopted by it, about the same time, of holding periodical meetings for the discussion of important practical questions, by means of essays from selected individuals, is doing good service to the cause of agricultural progress.

Farmer's Magazine.

Quarterly Journal of Agriculture.

Agricultural Chemistry Association.

Royal Agricultural Society of England.

The obvious success of this National Scottish Society has led to the formation of similar ones in England and in Ireland. The former instituted in 1838, and shortly afterwards incorporated by Royal Charter, at once entered upon a career of usefulness, the extent of which cannot well be overrated. Its membership—comprising the most influential persons in the kingdom—and its revenues are now so large as to enable it to conduct its proceedings on a scale befitting its position and objects. These are of a varied character, but its efforts are concentrated upon its journal and annual show. The former, published twice a-year, is chiefly composed of the essays and reports to which the liberal prizes of the society have been awarded, and undoubtedly stands at the head of our present agricultural periodicals. At its annual shows, a prominent place is assigned to implements and machines. Such as admit of it, are subjected to comparative trials, which are conducted with such skill and pains that the awards command the entire confidence of exhibitors and their customers. The extent and rapidity of the improvement in agricultural machinery which the society has been the means of effecting, is altogether extraordinary.

Farmers' Clubs.

There are few market-towns of any importance that have not their organised club or occasional gathering of the farmers in their neighbourhood, for the discussion of professional topics. We have now also a goodly list of agricultural periodicals, both weekly and monthly, most of them ably conducted, which are extensively read, and are the means of collecting and diffusing much valuable knowledge, which, but for them, would often, as in former times, perish with its authors, or be confined to corners. The facilities now afforded by railways for cheap and expeditious travelling, induce most farmers to take an occasional peep at what is going on beyond their own neighbourhood. This, more than anything, deals deathblows to prejudices, and extends good husbandry.

In reviewing the history of our national agriculture for the past fifty years, it is pleasing to note the growing intelligence displayed by our agriculturists in the prosecution of their calling. It is curious, also, to observe the analogy betwixt the order of that progress, and that which is usually observed in individual minds. For a length of time we see agricultural societies and writers occupying themselves chiefly about the practical details and statistics of husbandry, and attaching much importance to empirical rules. Gradually, however, we observe, along with a zealous collecting of facts, a growing disposition to investigate the *causes* of things, and to know the *reason* why one practice is preferable to another. When, therefore, the Royal Agricultural Society adopted as its motto "Practice with Science," it expressed not more the objects to be aimed at in its own proceedings, than the characteristic feature of our present stage of agricultural progress.

## CHAPTER II.

### PRACTICE OF BRITISH AGRICULTURE.

Practical Agriculture. Plan of Treatise.

We shall now endeavour to present a picture of British Agriculture in its present state. In doing this, we shall take much the same course which we should pursue, if we were asked to conduct a visitor over our own farm, and to give him a detailed account of its cultivation and management. In the case supposed, we should, first of all, explain to him

Practical Agriculture.

that the farm comprises a great diversity of *soils;* that its fields are very variously circumstanced as regards altitude, exposure, and distance from the homestead; and that in its tillage, cropping, and general management, regard must be had to these diversities, whether natural or artificial. Having thus premised, we should then conduct him through the homestead, pointing out the position and uses of the various FARM BUILDINGS, and of the MACHINERY and IMPLEMENTS contained in them. From thence we should proceed to the fields, examine their FENCES and the TILLAGE OPERATIONS. With some observations about the SUCCESSION OF CROPS, and the MANURES applied to them, there would follow an examination of the CULTIVATED CROPS, PASTURES, and MEADOWS; of the LIVE STOCK of the farm; and of the measures adopted in reclaiming certain WASTE LANDS belonging to it. This survey being completed, there would naturally follow some discussion about the TENURE of land, the CAPITAL required for its profitable cultivation, the condition of FARM LABOURERS, the necessity for devoting more attention to the EDUCATION of the agricultural community, and the duty of the legislature to remove certain OBSTRUCTIONS to agricultural improvement. In the sequel we shall give, from authentic sources, some examples to illustrate the British husbandry of the present day.

Soils.

The soil constituting the subject-matter on which the husbandman operates, its character necessarily regulates to a large extent the nature of his proceedings. The soil or surface covering of the earth in which plants are produced is exceedingly varied in its qualities. Being derived from the disintegration and decomposition of the rocks which constitute the solid crust of the globe, with a mixture of vegetable and animal remains, soils take their character from that of the rocks from which they have chiefly been derived. There is hence a generally prevailing resemblance betwixt the soils of a district and the rocks over which they lie, so that a knowledge of the composition of the one affords a key to the character of the other. But this connection is modified by so many circumstances that it is altogether impossible by the mere study of geology to acquire an easy and certain rule for determining the agricultural character of the soil of any particular district or field, as it has been the fashion with some writers of late years to assert. "When indeed, we regard a considerable tract of land, we can for the most part trace a connection between the subjacent deposits and the subsoil, and consequently, the soil. Thus, in a country of sandstone and arenaceous beds we shall find the soil sandy; in one of limestone, more or less calcareous; in one of schistose rocks, more or less clayey. But even in tracts of the same geological formation, there exist great differences in the upper stratum, arising from the prevalence of one or other member of the series, or from the greater or less inclination of the strata, by which the debris of the different beds are more or less mixed together on the surface. The action of water, too, in denuding the surface at one part, and carrying the debris in greater or smaller quantity to another, exercises everywhere an important influence on the character of soils. Thus the fertility of a soil on the higher ground from which the earthy particles are washed, is found to be very different from that of the valley to which these particles are carried. It is seen accordingly, that within the limits of the same geological formation, soils are greatly varied, and that the mere knowledge of the formation will not enable us to predicate the character of the soil of any given tract, either with respect to its texture, its composition, or its productiveness."[1] Even a very limited acquaintance with the geology of Great Britain serves, however, to account for the exceedingly diversified character of its soils. The popular definitions of soils, and to which it is safest for practical farmers to adhere, have respect to their most obvious qualities. Thus they are designated from their composition, as *clays, loams, sands, gravels, chalks, or peats;* or from their texture, in which respect those in which clay predominates are called *heavy, stiff,* or *impervious;* and the others *light, friable,* or *porous.* From the tendency of the former to retain moisture they are often spoken of as *wet* and *cold*, and the latter, for the opposite reason, as *dry* and *warm.* According to their measure of fertility they are also spoken of as *rich* or *poor.* The particular crops for the production of which they are respectively considered to be best adapted, have also led to clays being spoken of as *wheat* or *bean soils*, and the friable ones as *barley* and *turnip soils.* This latter mode of discriminating soils is however becoming every day less appropriate; as those of the lighter class, when sufficiently enriched by suitable manuring, are found the most suitable of all for the growth of wheat; while the efforts of agriculturists are now successfully directed to the production of root crops on those so strong as heretofore to have been reckoned unfit for the purpose. But still, such extreme diversities as we everywhere meet with in our soils, must necessarily lead to a corresponding diversity in their agricultural treatment, and hence the necessity for keeping this fact prominently in view in every reference to British agriculture as a whole.

Popular definition of soils.

Influence of Climate.

But if diversity of soil necessarily modifies the practice of the husbandman, that of climate does so far more powerfully. The soils of the different parts of the globe do not very materially differ from each other, and yet their vegetable products vary in the extreme. This is chiefly owing to difference of temperature, which decreases more or less regularly as we recede from the equator, or ascend from the sea-level. Places in the same latitude and at the same elevation, are found however to vary exceedingly in temperature, according to their aspect, the prevailing winds to which they are exposed, their proximity to seas or mountains, and the condition of their surface. The different parts of Great Britain are accordingly found to possess very differing climates. In passing from south to north its mean temperature may be taken to decrease one degree Fahrenheit for every 80 miles, and the same for every 300 feet of elevation. The temperature of the west side of our island also differs materially from that of the east, being more equal throughout the year. This is owing to the prevalence of mild westerly winds charged with moisture, which, while they equalise the temperature, cause the average fall of rain on the west side of Britain to be in many cases the double, and in some nearly the triple, of that on the opposite side. In the central parts of England cultivation is carried on at 1000 feet of elevation, but 800 may be taken as the ordinary limit. In Scotland the various crops are usually from two to three weeks later in coming to maturity than in England. In both divisions of the island the western counties, owing to their mild and humid climate, are chiefly devoted to pasturage, and the eastern, or dry ones, to tillage. As compared with the continent of Europe our summers are neither so hot, our winters so cold, nor our weather so steady. We want therefore many of its rich products, but on the other hand, our milder winter and moister climate are eminently favourable to the production of pasturage and other cattle crops, and admit of agricultural operations being carried on more regularly throughout the year. Indeed, looking to the immense varieties of the products of our soil, there is probably no other country so favourably circumstanced for a varied and successful agriculture.

[1] Low's Practical Agriculture, p. 42.

Practical Agriculture.

Agriculture influenced by distribution of population.

Besides those variations in the agricultural practice of this country which arise from diversities of soil and climate, there are others which are due to the distribution of the population. The proximity of cities and towns, or of populous villages, inhabited by a manufacturing or mining population, implies a demand for dairy produce and vegetables, as well as for provender and litter, and at the same time, affords an ample supply of manure to aid in their reproduction. Such commodities, from their bulk or perishable nature, do not admit of long carriage. The supplies of these must therefore be drawn from comparatively limited areas, and the character of the husbandry there pursued is determined apart from those general influences previously referred to. From these and other causes there is a diversity in the practice of British agriculture which increases the difficulty of describing it accurately. Indeed, it is so well known that there are peculiarities of character attaching to almost every individual field and farm, and still more to every different district or county, which demand corresponding modifications of treatment in order to their successful cultivation, that a prudent man if required to take the management of a farm in some district greatly inferior in its general system of farming to that which he may have left, will yet be very cautious in innovating upon specific practices of the natives. To such peculiarities it is obviously impracticable to refer in such a treatise as the present. They are referred to now because they suggest an explanation of some of those discrepancies in the practice and opinions of farmers, equally successful in their respective localities, which we constantly meet with; and because, in proceeding to delineate the practice of Berwickshire, where our personal experience has been gained by twenty years of actual farming, we would deprecate the idea of claiming for its modes a superiority over those of other districts. Its geographical position, and the mixed husbandry pursued in it would justify, in some measure, its being referred to as a fair sample of the national agriculture. But it is on the specific ground that it is best to speak from actual experience as far as that will serve, that we vindicate this selection.

Farm-Buildings.

In pursuance of the plan already indicated, let us now refer for a little to *Farm-Buildings*. We have spoken of the soil as the raw material upon which the farmer operates: his homestead may, in like manner, be regarded as his manufactory. That it may serve this purpose in any good measure, it is indispensable that the accommodation afforded by it be adequate to the extent of the farm, and adapted to the kind of husbandry pursued upon it. It should be placed upon a dry, sunny, sheltered site, have a good supply of water, and be as near as possible to the centre of the farm. The buildings should be so arranged as to economise labour to the utmost. It should be constructed of substantial materials, so as to be easily kept in repair, and to diminish, to the utmost, risk from fire. The most cursory examination of existing homesteads will suffice to show that in their construction these obvious conditions have been sadly neglected. For one farm really well equipped in this respect, hundreds are to be met with in all parts of the kingdom, and more especially in England, most wretchedly deficient. Wherever this is the case it is impossible that the farmer, however skilful or industrious, can make the most of his materials, or compete on equal terms with his better furnished neighbours. As the agricultural community becomes more generally alive to the importance of economising labour by a judicious arrangement of buildings, and of reducing the cost of the production of beef (and adding to the amount and fertilizing power of the home-made manure) by the manner in which the live stock is housed, we may hope that improvement in this department will make rapid progress. Tenants will refuse to embark their capital, and waste their skill and labour on farms unprovided with suitable apparatus for cultivating them to the best advantage. Landlords, and their agents, will by and by find that until this is done, they must put up with an inferior tenantry, an antiquated husbandry, and with lower and worse-paid rents.

Evils of defective Homesteads.

Economy of consulting a competent architect.

In erecting new homesteads, or in making considerable additions to or alterations upon existing ones, it is of much importance to call in the aid of an architect of ascertained experience in this department of his art, and then to have the work performed by contracts founded upon the plans and specifications which he has furnished. A reasonable sum thus expended will be amply returned in the cost, trouble, and disappointment which it usually saves to both landlord and tenant. It is to be hoped that in future a greater number of thoroughly qualified architects will devote themselves to this department of their profession, and that they will meet with adequate encouragement. It is not, therefore, with the view of superseding their services, but simply to illustrate our references to existing practices, that we subjoin a plan of farm-buildings.

While protesting against the utter rudeness and inadequacy of the great majority of homesteads, we must also deprecate the hurtful expenditure sometimes lavished in erecting buildings of an extent and style altogether disproportionate to the size of the farm, and out of keeping with its homely purposes. When royalty or nobility, with equal benefit to themselves and their country, make agriculture their recreation, it is altogether befitting that in such cases the farm-yard should be of such a style as to adorn the park in which it is situate. And even those intended for plain everyday farming need not be unsightly; for ugliness is sometimes more costly than elegance. Let utility, economy, and comfort first be secured, and, along with these, as much as possible of that pleasing effect which arises from just proportions, harmonious arrangement, and manifest adaptation to the use they are designed for.

Much has recently been written on this subject, in the journals of our national agricultural societies, and other agricultural periodicals; and plans in great variety have been offered to public notice. Indeed, there is at present so much diversity of opinion about the best plan of farm-buildings, that most practical farmers, if offered a new homestead, would have considerable difficulty in deciding upon that which should be adopted in their own case. That now given has been designed by an experienced Roxburghshire farmer, Mr Hardie, Harrietfield, near Kelso. It is calculated for a farm of 600 acres of good arable land, cultivated on the system presently pursued in Berwick or Roxburgh shires. It expresses very fairly the present state of opinion in these counties on the question of housing fattening cattle, as provision is made in it for using at once yards, stalls, and boxes.

Principles to be attended to in the arrangement of Farm Buildings.

The barn, with its thrashing machinery, and other appurtenances, naturally forms the nucleus of the homestead, and regulates the distribution of the other buildings. The command of water-power will often determine the exact site of the barn, and indeed of the whole buildings. The cheapness and safety of this motive-power render it well worth while to make considerable sacrifices to secure it, when a really sufficient and regular supply of it can be had. But the difficulty of securing this when the adjoining lands are thoroughly drained, with the great efficiency, and facility of application of steam-power, are good reasons why precarious supplies of water-power should now be rated very differently than when a horse-wheel or windmill were the only alternatives. A very usual and suitable arrangement is to have the whole buildings, forming a lengthened parallelogram, facing south or south-east. The barn being placed in the centre of the north range, with the engine-house behind it, and the straw-house at right angles in front, with doors on both sides for the ready con-

Practical Agriculture.

veyance of litter and fodder to the yards, &c. It is always advantageous to have the barn of sufficient height to afford ample accommodation to the thrashing and winnowing machinery. When the disposition of the ground admits, it is a great convenience to have the stackyard on a level with the upper barn, so that the unthrashed corn may be wheeled into it on barrows, or on a low-wheeled truck drawn by a horse. Failing this, the sheaves are usually pitched in at a wide opening from a framed cart. The space on which the cart stands while this is going on is usually paved, that loose ears and scattered grain may be gathered up without being soiled; and it is a further improvement to have it covered by some simple roof, to protect the sheaves from sudden rain.

Rickyard Railways.

In several recent instances stackyards have been laid with rails, and the stacks built on low platforms set on wheels, so that each stack, as required, can be pushed close up to the barn, and the sheaves pitched from it directly to the side of the feeding-board. A friend who recently visited the farm of Mr Favell at Stockeld near Harrowgate, where this plan has been adopted, has kindly furnished the following notice of it. The rails for the stackyard are laid 7 feet 3 inches apart. On these are ranged a series of trucks, each on two pairs of wheels, the axles of which are 11 feet apart, and having a platform 20 feet long and 7½ feet wide formed of planks placed close together to prevent the ascent of vermin. On this the stack is built to the height of 16½ feet above the truck. The stacks are ranged on one set of rails only, which lead directly to the door of the thrashing machine. Mr Favell admitted the inconvenience of having his wheat, barley, beans, and oats, all on one line, and stated his intention of having a series of rails radiating from the door of the barn.

On a farm near Hull the stackyard is fitted with rails and turn-tables in a more complete manner. Where this expedient has been adopted, the rails, trucks, &c., have usually been second-hand railway materials.

It is a good arrangement to have the straw-barn fitted up with a loft, on the level of the opening at which the straw is discharged from the thrashing-mill, so as to admit of fodder being stored above and litter below. A sparred trap-door in front of the shaker retains the straw above, or lets it fall to the ground as required. This upper floor of the straw-barn

Place for Chaffcutter

is the most convenient place for fixing a chaff-cutter to be driven by the thrashing-power. The granary should communicate with the upper barn, that the dressed grain may be raised to it by machinery.

Grinding Mill, &c.

A loft over the engine-room, communicating with the upper barn and granary, forms a suitable place for fixing a grinding-mill, bruising-rollers, and cake-breakers, as it affords opportunity for having these machines easily attached to the steam-power. It suits well to have the house in which cattle food is cooked attached to and under the same roof as the engine-house. One coal store and chimney thus serves for both. The small boiler can even be built in so close to the large one as to derive some benefit from its waste heat; and meal, &c., can be conveyed by spouts from the grinding loft above. An open shed outside the barn, for the accommo-

Circular Saw.

dation of a circular saw, is also a desideratum. By the aid of the latter machine and a handy labourer, the timber required for ordinary repairs on the farm may be cut out at trifling expense.

The cattle-housing of whatever description, where there are the largest and most frequent demands for straw, is placed nearest to the straw-house, and in communication with the turnip-stores, and the house (if any) in which food is cooked or otherwise prepared. Where cattle are bred, the cow-house and calf-house are kept together. A roomy working court is always a great convenience, and it suits well to have the stable opening to it, and the cart-shed and tool-house occupying another side. Costly machines, such as corn-drills, require to be kept in a locked place, to preserve them from the collisions, and the loss or derangement of their minute parts, to which they are exposed in an open cart-shed.

Water.

An abundant supply of good water is a most important matter. The best source is from springs, at such an elevation as to admit of its being brought in a pipe, with a continuous flow. Failing this, a well and pump is the usual alternative, although it is sometimes necessary to collect the rain-water from the roofs, and preserve it in a capacious and carefully-made tank. In every case it is desirable to have a regulating cistern, with ball-cock, from which it is distributed by pipe to every part of the homestead where it is required. It is, in every case, of importance to have the eaves of the whole buildings spouted, and the rain-water carried off to where it can do no mischief. Where fattening cattle are kept in open yards with sheds, by spouting the eaves, and slightly hollowing the yards towards their centres, the whole urine is absorbed by their litter, and retained in the manure. If stall feeding is practised, a pit is required, into which the solid dung is wheeled, and the liquid conveyed by drains.

Tanks for Liquid Manure.

Liquid manure tanks are at present in universal repute, but we shall endeavour to show, when treating of manures, that they are not such an indispensable appendage to a farm-yard as is generally asserted. In Scotland, it is customary to carry the dung from the byres into a yard in which young cattle are kept, where it is daily spread about and subjected to further treading, along with such quantities of fresh litter as are deemed necessary. That from the stables is carried into the adjoining feeding-yard, and it is usually remarked, that the cattle occupying it make more rapid progress than their neighbours.

Labourers' Cottages.

An important part of the buildings of a farm are the cottages for its labourers. It is in all cases expedient to have the people required for the ordinary working of a farm resident upon it; and it is always much better to have families, each in their own cottage, than a number of young people boarded in the farm-kitchen, or with the farm-overseer. These cottages are usually a little removed from the other farm-buildings, and it is, on various accounts, better to have them so. There is, however, an advantage in having the cottages of the farm-steward and cattleman either within the court-yard, or close to its entrance, that these responsible functionaries may at all times be near to their charge, and especially that they may be at hand when any of the live stock require night attendance. As there are manifold advantages in having but one main entrance to the homestead, and that closed by a gate which can be locked up at night, it will be obviously necessary to have the keeper of the key close at hand to open the gate by night if required. Much more attention than formerly is now paid to the construction of cottages. The apartments are better floored, higher in the roof, and so arranged as to secure comfort and decency. Besides a small garden, each cottage is usually provided with a pig-sty and ash-pit, and in some cases with a coal-place and privy besides.

Farm-House.

The position and style of the farmer's dwelling also claims a remark here. The approved mode used to be, to place it either directly in front or rear of the farm-yard, on the ground that the farmer would thus have his premises and cattle under his eye even when in his parlour or bedroom. As has been well remarked, "The advantages of this parlour-farming are not very apparent, the attendant evils glaringly so. If the condition of ready communication be obtained, the farm-house should be placed where the amenities of a country residence can be best enjoyed."[1] On all hands

[1] For further information on Farm Buildings, see Appendix (B.) to this article, *infra;* see also *Morton's Cyclopædia of Agriculture*, article "Farm Buildings."

Fences.

we now hear it urged, that it is only by men possessed of capital and intelligence that the business of farming can be rendered remunerative. Those who desire to have such men for tenants, will be more likely to succeed by providing a commodious and comfortable Farmery, pleasantly placed among trees and shrubs, than by setting it down in the precincts of the dung-heap.

### FENCES.

The fences by which farms are generally enclosed and subdivided, form another part of what may be termed their fixtures, and may therefore be suitably noticed here. When lands are let to a tenant, the buildings and fences are usually put into sufficient repair, and he is taken bound to keep and leave them so, at the issue of his occupancy. Although there are some persons who advocate the total removal of subdivision fences, it is admitted on all hands, that the farm as a whole, and the sides of public thoroughfares which may intersect it, should be guarded by sufficient fences of some kind. The general belief has hitherto been, that there is a farther advantage in having the land subdivided by permanent fences into enclosures of moderate size. The use of such partition fences is not only to confine the live stock to particular fields, or restrain them from trespassing on the other crops; but to afford shelter from cutting winds. It is now frequently urged, that the heavier cattle should never be turned to pasture at all, but kept on roots and green forage the whole year round; and that sheep can be managed satisfactorily by means of moveable hurdles. It is highly probable that the practice of soiling will become more general, as it undoubtedly deserves to do. Still this does not necessarily call for the total removal of subdivision fences, which we cannot but regard as an imprudent proceeding. It is probable that those who have adopted it have done so very much owing to the prevalence of the opposite extreme. There are large portions of the finest land in England so encumbered with hedges and hedgerow trees, as to be utterly incapable of profitable cultivation. In many cases the fields are so small and the trees so large, that their roots actually meet from the opposite sides and pervade the entire surface soil of the area enclosed by them. When manure is applied to such fields, it is monopolised by these freebooters from the hedges, and the crops of grain or hay, such as they are, are so screened from the sun and wind, that there is great risk of their being spoiled in the harvesting. If drains are made in such fields they are speedily filled up by the rootlets, and thus rendered useless.[1] In such circumstances, it is no wonder that zealous agricultural improvers should look upon hedgerows much as American settlers do upon their forests; and, like them, be sometimes indiscriminate in their clearings. We believe that there is an advantage in having land, whether for pasture or tillage, subdivided into parallel-sided fields of from 10 to 40 acres each, according to the size of the farm, by means of permanent fences of a kind adapted to the locality. When the soil and climate are favourable to the growth of the common *white thorn*, hedges formed of it combine efficiency, economy, and ornament, in a greater degree than any other fence. But to have a really efficient thorn hedge, much attention must be paid to its planting, rearing, and after management. In proceeding to *run* a new line of thorn hedge, care must be taken that the soil is clean and in good heart; and that the subsoil is porous and dry. When these conditions do not obtain, they must be secured by fallowing, manuring, draining, and trenching. The young quicks should be stout and well rooted; not taken indiscriminately as they stand in the nurseryman's beds, but of uniform stoutness. Such selected plants are always to be had for a small additional price, which will be found to be well repaid in the superior progress of such plants, when contrasted with that of others taken as they chance to come to hand. The embryo fence must be kept free of weeds, and secured from the encroachments of cattle by a line of rails on both sides. Some persons advise that the young hedge should from the first be trimmed into line by using the pruning hook after each year's growth. It is certainly better not to touch it with the knife, or, at least, only to restrain an occasional shoot that unduly overtops its neighbours, until the centre stems are at least a couple of inches in diameter. If the plants are then headed over fence-high, and the lateral shoots pruned to a straight line, a close fence with a substantial backbone in it is secured; whereas by pruning annually from the first, a fence is obtained that pleases the eye, but which, consisting only of a mass of spray, presents no effectual barrier to cattle. When a thorn hedge has reached the stage just referred to, the protecting rails may be removed, and the hedge kept in a neat and efficient state by annual pruning. On good, deep soil, thorns will stand this constant removal of the annual growth of spray for many years without injury. In less favourable circumstances, it is found necessary from time to time to withhold the pruning knife for a few years together. When the hedge has been reinvigorated by such periods of unrestrained growth, it can again be cut back to the centre stems, and subjected anew to a course of annual pruning. To insure a close fence, the bottom of the hedge must at all times be kept clear of tall weeds. The constant use of the weeding-iron is however objectionable; for, besides being expensive, it injures the bark of the thorns, and thereby impairs their health. It is quite sufficient to cut the weeds close to the surface, twice a year, by means of a reaping hook or short scythe.

Benefit of fences.

Evils of very small enclosures.

Thorn hedges.

In arable lands, by this plan of keeping hedges about four feet high, and cutting down the weeds as required, an efficient and ornamental fence is maintained at comparatively small cost, and with little injury to the adjoining crops from shading, or the harbouring of weeds and vermin.

Although the white thorn forms a better hedge than any shrub yet tried for the purpose in this country, there are many upland situations where the beech or hornbeam grow more freely, and are to be preferred either alone or in mixture with it. These plants, and also crab or sloe, are sometimes useful in filling a gap occasioned by the removal of a hedgerow tree, or the death of a portion of thorn hedge.

Stone walls.

In exposed situations where thorns do not thrive, *dry-stone walls* are the most usual substitute. When carefully constructed, of stones suitable for the purpose, they last a long time, and form an excellent fence. Their durability is much enhanced by having the cope-stones set in lime-mortar. A layer along the centre of the wall, and an external pointing, of lime-mortar will also repay the additional first cost thus incurred. A wall of this kind, four feet high, exclusive of the cope, while quite sufficient to restrain cattle and the heavier kinds of sheep, is no barrier to the mountain breeds, which can easily clear a six-foot wall. A simple and very effective fence has however come much into use of late

[1] It has been computed that not less than 1¼ million acres are occupied by hedge-rows in England and Wales, and that, if the land overshaded and plundered by roots be included, the amount is 3 millions. In Devonshire one-fourth of the enclosures in many parishes are under *two* acres; more than one-third under *three* acres, and nearly two-thirds under *four* acres. Two millions, at least, of these acres might be redeemed, and what a margin is here available for increased production. The land thus wasted would probably yield a sum equal to county and poor rates, and perhaps malt-tax too. *See Farmers' Magazine for March* 1852, p. 253.

Fences.

Wire fences.

years. It is composed of iron wire, (No. 8 being the size most commonly used,) which is attached by small staples to common stakes such as are used for wooden railings, driven firmly into the ground about five feet apart. The wire is drawn out of the coil, and the ends of the various lengths or *threads* are neatly joined by first heating them and then twisting the one into the other, until the quantity required for the stretch of fence is run out. It is then attached to every third or fourth stake by a staple, which must not be driven home. The other lines of wire are then treated in the same manner, each being attached to the stakes at such width apart as has been determined upon, and marked upon the stakes. A ready way of doing this is by stretching along the stakes a common gardener's line which has been previously rubbed with chalk, or a charred stick, and striking it against the stakes at the required heights in the way that sawyers mark a plank. When the requisite number of wires has thus been loosely attached, they are pulled as tight as possible by the hands of the workmen, after which a screw or lever is applied to each in turn until it is made perfectly tight. As the efficiency of this kind of fence is wholly dependent on perfect tightness being obtained, a stout straining-post must be fixed securely in the ground at the end of each line of fence. This serves the double purpose of furnishing a fulcrum for the stretching instrument, and a secure attachment for the ends of the wires. When the straining is accomplished, each wire is stapled to each stake. The gates are usually hung upon these straining posts. Although wooden straining-posts are commonly used, some persons prefer iron ones, fixed into large blocks of stone. Five wires thus stretched, at an average width of six inches, form an effectual fence for the wildest sheep. They could indeed easily clear it so far as height is concerned, but they are afraid to leap at an object which they cannot see until they are close upon it. They may be seen at first walking along the line anxiously looking for an opening, and if one more bold than the others makes a run at it, he is sure to catch such a fall as effectually deters him from repeating the attempt. A cwt. of No. 8 wire costs at present 16s., and when drawn out, yields a line about 620 yards in length. Staples cost 1s. 8d. per gross; stakes ready for driving, from one penny to twopence each. With these cheap and portable materials, which any labourer of ordinary intelligence can easily put together, a fence admirably adapted for enclosing or subdividing mountain pastures, is now quite attainable by every sheep-farmer, and will well repay its cost. It is equally available for protecting young thorn hedges, and generally for all purposes for which wooden railing is used. As a fence for cattle or horses, it is advisable to add a single rail of wood nailed *flat* along the tops of the stakes, which must be sawn off evenly for this purpose. As compared with wooden railing, wire is much cheaper and more durable, and more easily kept in repair. It is cheaper also than stone walls, available in many situations where they are not, and a more certain barrier to agile sheep; but it is less durable and affords no shelter.

The latter defect can in some situations be remedied by raising a low mound of turf, running the wire-fence along the top of this mound, and sowing on it the seeds of the common whin.

Fences should be maintained at mutual expense of Landlord and Tenant

We have already noticed, that the fences of a farm are usually erected by the landlord, and kept in repair by the tenant. The latter is at least usually taken bound in his lease to keep and leave them in good order; but as this obligation is often very indifferently performed, and much damage and vexation occasioned in consequence, it is always expedient that a person should be appointed by the landlord to attend to the fences, and the half of his wages charged against the tenant. By such a course, dilapidation and disputes are effectually guarded against, and the eyesore of defective, ill-kept fences is wholly removed.

Machines and Implements.

### MACHINES AND IMPLEMENTS OF HUSBANDRY.

That the cultivation of the soil may be carried on to the best advantage, it is necessary that the farmer be provided with a sufficient stock of machines and implements of the best construction. Very great improvement has of late years taken place in this department of mechanics. The great agricultural societies of the kingdom have devoted much of their attention to it; and under their auspices, and stimulated by their premiums and exhibitions, manufacturers of skill and capital have embarked largely in the business. In many instances the quality of the article has been improved and its cost reduced. There has hitherto been a tendency to produce implements needlessly cumbrous and elaborate, and to introduce variations in form which are not improvements. The inventors of several valuable implements, the exclusive manufacture of which they have secured to themselves by patent, appear to have retarded their sale, and marred their own profits by the exorbitant prices which they have put upon them. Some, however, have become alive to the advantages of looking rather to large sales with a moderate profit on each article, and of lowering prices to secure this. A most salutary practice has now become common of inventors of implements of ascertained usefulness granting license to other parties to use their patent-right on reasonable terms, and thus removing the temptation to evade it by introducing some alteration which is trumpeted as an improvement, although really the reverse.

The lower price and extended use of iron in the construction of agricultural implements is materially adding to their durability, and generally, to their efficiency, and is thus a source of considerable saving. While great improvement has taken place in this department, it too commonly happens, that the village mechanics, by whom a large portion of this class of implements is made and repaired, are exceedingly unskilled, and lamentably ignorant of the principles of their art. They usually furnish good materials and substantial workmanship, but by their unconscious violation of mechanical laws, enormous waste of motive power is continually incurred, and poor results are attained. This can probably be remedied only by the construction of the more costly and complex machines being carried on in extensive factories, where, under the combined operation of scientific superintendence, ample capital, and skilled labour, aided by steam-power, the work can be so performed as to combine the maximum of excellence with the minimum of cost.

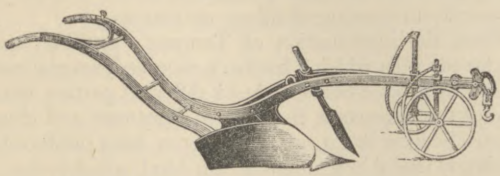
We begin our brief notice of the implements of the farm, with those used for the tillage of the soil. Of these the first place is unquestionably due to the plough. A history of this implement, tracing its gradual progress from the ancient Sarcle to its most improved form at the present day, is necessarily a history of Agriculture. So much is this the case, that a tolerably correct estimate of the progress of the art in any country, whether in ancient or modern times, may be formed by ascertaining the structure of the plough. Much attention has been paid to its construction in Britain for the last 100 years, and never more than at the present day. After all that has been done, it is still, however, an unsettled point, which is the best plough for different soils and kinds of work; and, accordingly, many varying forms of it are in use in those parts of the kingdom which have the reputation of being most skilfully cultivated. Ever since the introduction of Small's improved swing-plough, the universal belief in Scotland, and to a considerable extent in England, has been, that this is the best form of the implement. Wheel-ploughs have accordingly been spoken of by

Ploughs.

Wheel-plough.

Machines and Implements.

Scottish Agriculturists in the most depreciatory terms, and yet it turns out that this has been nothing better than an unfounded prejudice. For when subjected to careful comparative trial, as has been frequently done of late, the balance of excellence is undoubtedly in favour of the plough with wheels. Its advantages are, that it is easier of draught

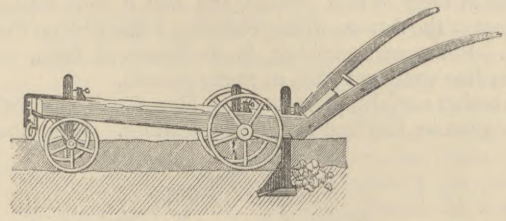


RANSOME'S PATENT TWO-WHEELED PLOUGH.

—that the quality of its work is better and greatly more uniform than can be produced by a swing plough—that in land rendered hard by drought, or other causes, it will enter and turn over even furrows where its rival either cannot work at all, or at best with great irregularity and severe exertion to the ploughman; and lastly, that its efficiency is independent of skill in the ploughman. This last quality has indeed been usually urged as an objection to wheel-ploughs, as their tendency is said to be to produce an inferior class of workmen. Those who know the difficulty of getting a field ploughed uniformly, and especially of getting the depth of furrow specified by the master adhered to over a field, and by all the ploughmen, can best appreciate the value of an implement, that when once properly adjusted, will cut every furrow of an equal width and depth, and lay them all over at exactly the same angle. The diversity in the quality of the work at those ploughing competitions, to which only the picked men of a neighbourhood are sent, and where each may be supposed to do his very best, shews conclusively how much greater it must be on individual farms, even under the most vigilant superintendence. In every other art the effects of improved machinery is to supersede manual dexterity; and it does seem absurd to count that an objection in agriculture which is an advantage in everything else. There is more force in the objection that wheel-ploughs are inferior to swing ones in ploughing cloddy ground, or in crossing steep ridges, and that they cannot be used for forming drills for turnip or other crops. This objection vanishes when it is known that in the most improved wheel-ploughs, the wheels can be laid aside at pleasure, and that they can then be used in all respects as swing-ploughs. A mould-board, somewhat higher and wider behind than that best adapted for ordinary work, is required for forming turnip-drills. This, however, is easily managed by having two distinct mould-boards for each plough. An important feature in the English ploughs is, that they are fitted with cast-iron shares, which being case-hardened on their under surface, wear unequally, and so preserve a sharp edge. The necessity for daily recourse to the smithy is thus removed, and along with it, that irregularity in the quality of the work and draught of the plough, which so often arises from witting or unwitting alterations being made in the *set* of the share in the course of its unceasing journeys thither. It remains to be seen whether these more brittle shares will withstand the collisions to which they are liable in our stony Scottish soils. A good implement of this kind should therefore be sufficient for all usual kinds of ploughing. When it is desired to turn a very deep furrow, a plough differing from the common one only in being somewhat larger and stronger in all its parts is used, with four horses to draw it.

Subsoil-plough.

Ploughs which break and stir the subsoil, without bringing it to the surface, by following in the wake of the common plough, are now much used. The first of the kind—the invention of the late Mr Smith of Deanston—is a ponderous implement, requiring at least four good horses to draw it. It is well adapted for displacing and aiding in the removal of earth-fast stones. The inventor has happily described its operation by terming it a "horse pick." Read's subsoil-plough is a much lighter implement, which can usually be drawn by two horses. Since the introduction of thorough

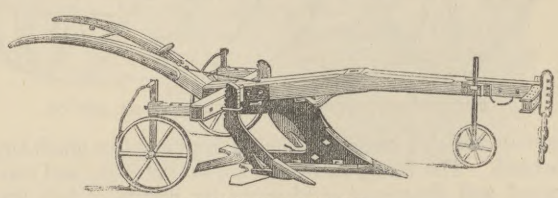


READ'S SUBSOIL PULVERIZER, AS MADE BY BARRIT AND CO.

draining, it is found beneficial to loosen the soil to much greater depth than was formerly practicable, and this class of implements is well fitted for the work.

Paring-plough.

Broadshare or paring ploughs are much used in various parts of England in the autumn cleaning of stubbles. A broad-cutting edge is made to penetrate the soil to the depth of one or two inches, so as to cut up the root-weeds which at that season lie for the most part near the surface.



BENTALL'S BROADSHARE.

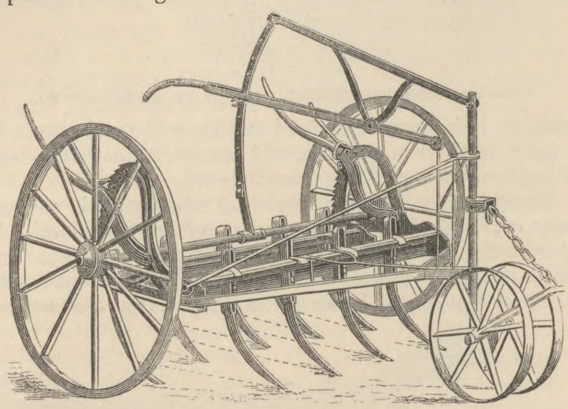
These, as well as the stubble, being thus detached from the firm soil, are removed by harrowing and raking; after which, the land is worked by the common plough. An implement of this kind is frequently used in carrying out the operation of paring and burning.

Various implements of the plough type, so modified as to adapt them for particular processes, have from time to time been offered to public notice, but have failed to meet with general favour. We limit our notice to those of ascertained utility, and refer the reader who desires fuller information, to "Ransome's Implements of Agriculture," and similar works, where he will find descriptions of the most interesting of them.

## GRUBBERS, &c.

Next in importance to the plough, is the class of implements variously called grubbers, cultivators, or scarifiers. To prepare the soil for the crops of the husbandman, it is necessary to pulverize it to a sufficient depth, and to rid it of weeds. The appropriate function of the plough is to penetrate, break up, and reverse the firm surface of the field. This, however, is only the first step in the process, and does but prepare for the more thorough disintegration which has usually been accomplished by harrowing, rolling, and repeated ploughings. Now, however excellent in its own place, the plough is a cumbrous and tedious pulverizer, besides needlessly exposing a fresh surface at each operation, and cutting the weeds into minute portions, which renders their removal more difficult. These defects were long felt, and suggested the desirableness of having some implement of intermediate character betwixt the plough and harrow, which should stir the soil deeply and expeditiously without reversing it, and bring the weeds unbroken to the surface. The whole tribe of grubbers, &c., has arisen to meet this demand, and we shall now consider the comparative merits of the more prominent of the group. The first notice is due to Finlayson's harrow, which, as improved by Scoular, was, until recently, the best implement of its kind. Its faults—and they attach equally to Kirkwood's and Wilkie's—are, that it is severe work for two horses; is liable to choke in turfy or foul ground, and that it consolidates the bottom of the furrow, while producing a fine tilth on the surface. Finlayson's grubber, in its improved form, weighs about five cwt., and costs as many pounds.

Another useful implement of this class which enjoys a large reputation in England is Biddle's scarifier. It is mounted

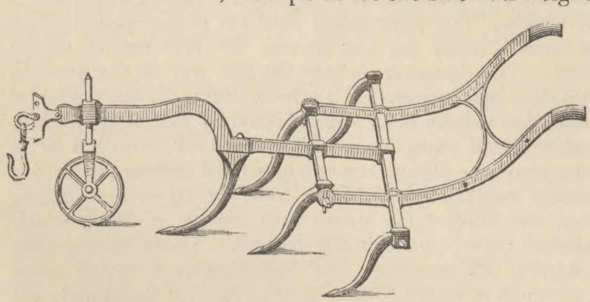


BIDDLE'S SCARIFIER, AS MADE BY RANSOME AND CO.

on four wheels; two small ones in front and two much larger behind. The frame and tines are of cast-iron, and can be raised and depressed at pleasure by means of two levers which regulate the depth to which the tines shall penetrate. The tines are prepared to receive case-hardened cast-iron points of different widths, or steel hoes of nine inches width, so that the implement can be used for breaking up and paring the surface, or for grubbing out weeds and pulverising the soil, as may be required. An important feature in this scarifier is, that it keeps its hold of a hard surface much better than a plough. It weighs half a ton, is drawn by four or six horses, and costs about L.18.

The Ducie or Uley cultivator has many features in common with Biddle's, and although brought forward as an improvement upon it, has not established its title to be so regarded. The great weight, high price, and amount of horse-power required to work them, are serious objections to both of these implements.

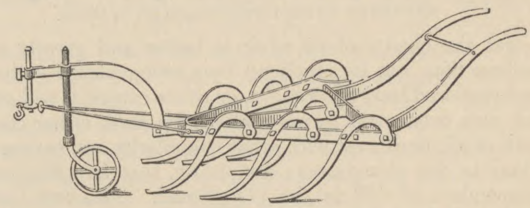
Of more recent notoriety than either, and contrasting with them favourably in these respects, is an implement invented by Mr John Tennant, at Shields, near Ayr, and now popularly known as Tennant's grubber. Its construction, as the annexed cut will shew, is simple in the extreme. Its weight



TENNANT'S GRUBBER.

is about 2 cwt., its price L.4, 10s., and its draught easily overcome by two horses. The depth at which it works is regulated by raising or lowering the shank which supports its single wheel in front. Its tines can be easily moved on their supporting bars, and it may be worked with five or seven as desired. By substituting a shorter hind-bar, and setting the tines more closely together, it makes a most efficient drill grubber. We shall have occasion to refer to this implement frequently in treating of tillage operations.

Since the introduction of Tennant's grubber, and from the favour with which it has been received, several variations on its form have been made by different parties, but all retaining the important features of lightness and cheapness. Messrs Scoular & Co., of Haddington, have produced an exceedingly useful implement of this kind, which is also in very



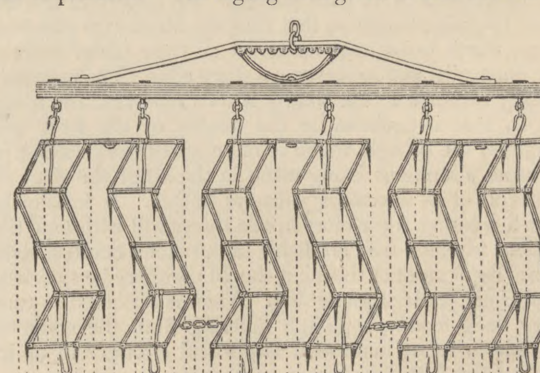
SCOULAR'S GRUBBER.

general use. There seems no reason why these light grubbers should not have their tines so constructed as to have the working parts moveable (as in Biddle's scarifier), so that sharp points for grubbing, or broad hoes for paring, could be used at pleasure.

## HARROWS.

When a field has been broken up by the plough, it is usually next operated upon by the harrow, whether the object be to prepare it for and to cover in seeds, or to bring clods and roots to the surface. It is virtually a rake dragged by horses. In its most ordinary form, the frame-work is of wood with iron tines, of which each harrow contains twenty. Formerly each horse dragged a single harrow, although two or more were worked abreast. Under this arrangement the harrows had too much independent motion, and were liable to get foul of each other. This has been remedied, first partially, by coupling them loosely by riders, and then more effectually by a hinge-like joining, which allows a separate vertical motion, but only a combined horizontal one. A rhomboidal form is also given to this *pair* of harrows—usually called *brakes*—so that when properly yoked, no two tines can work in the same track. This description of harrow is now frequently made entirely of iron.

Howard's patent harrows are a further improvement on this implement. The zigzag form given to each section ena-



HOWARD'S PATENT HARROW.

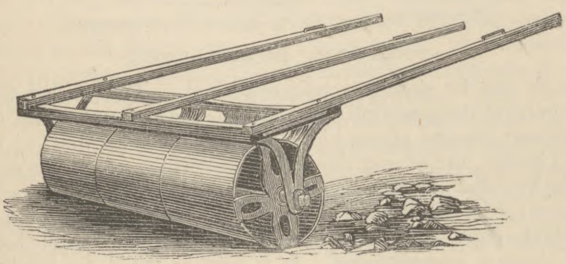
bles the whole so to fit in, that the working parts are equally distributed over the space operated upon. The number of tines is 75, instead of 40, as in the form last noticed, and yet from

Machines and Implements.

the form of frame and manner of coupling, the tines are well apart, and have each a separate line of action. Practical farmers speak very highly of the effective working of this implement. By an exceedingly simple contrivance the centre part when turned on its back forms a sledge on which its fellows can be piled, and drawn along from one field to another. A light description of harrows with smaller and more numerous tines, is sometimes used for covering in grass-seeds. If a harrow is to be used at all for this purpose, Howard's is a very suitable kind, but a much better implement is the chain-web with discs, the invention of Smith of Deanston. The old-fashioned ponderous break harrow is now entirely discarded, and the more efficient cultivator used in its stead. A form of the latter, from its close resemblance to harrows, is noticed now rather than before. It is a very strong iron harrow, with the tines made longer and very considerably curved forwards. An iron rod with a loop handle is fixed to the hind bar, by means of which the driver can easily hitch it up and get rid of weeds, &c. Two such harrows are coupled together and drawn by four horses. Its pulverizing power is very considerable. But when clods have been brought to the surface they are most effectually reduced by various kinds of

ROLLERS.

Those formerly used were solid cylinders of timber or stone attached to a frame and shafts, for which hollow ones of cast-iron are now generally substituted. The simplest form of these has a smooth surface, and is cast in sections to admit of more easy turning. They are made of diverse weights,

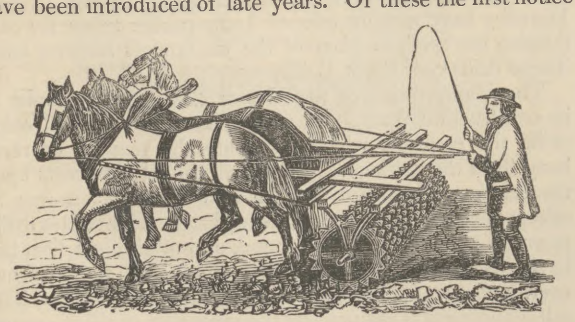


SMOOTH CAST-IRON FIELD ROLLER.

so as to be adapted for the draught of one or two horses as required. Those of the former description, weighing in all 6 cwt., and costing as many pounds sterling, are exceedingly useful for all purposes where expedition rather than heavy pressure is wanted. From their greater durability, smoother surface, and less liability to clog, the readiness with which they can be cast of any weight that is required, and their moderate price, it is probable that cast-iron cylinders will speedily supersede all others.

Crosskill's clod-crusher.

Several important variations on the common smooth roller have been introduced of late years. Of these the first notice

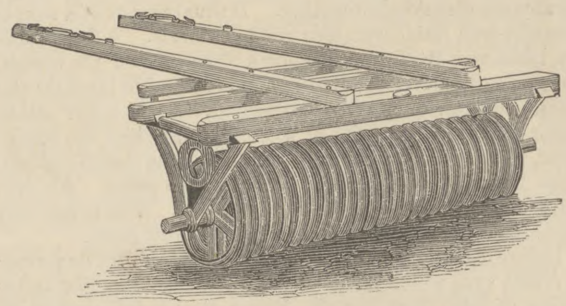


CROSSKILL'S CLOD-CRUSHER.

is due to Crosskill's clod-crusher. It consists of cast-iron discs $2\frac{1}{2}$ feet in diameter, with serrated edge and a series of side-way projecting teeth. Twenty-three of these discs are strung loosely upon a round axle, so as to revolve independently of each other. The free motion thus given to each disc, and which has latterly been increased by casting each alternate one wider in the eye, adds at once to the pulverizing and self-cleaning power of the roller. Three horses yoked abreast are required to work it. The axle is prolonged at each end sufficiently to receive travelling wheels, on which it is transported from place to place. Although primarily designed and actually much used for breaking clods, it is even more in request for consolidating loose soils, checking the ravages of wire-worm, and covering in clover and grass seeds. For the latter purpose, its action is perfected by attaching a few bushes to it, which fill up the indentations and leave a surface so beautifully even, as to rival the accuracy and neatness of a well-raked border. We have long thought that it would be an improvement in this valuable implement to reduce its weight so far as to suit it to the draught of two horses.

Cambridge's roller.

Cambridge's roller possesses several features in common with Crosskill's, and is used for similar purposes. It consists of discs with fluted instead of serrated edges.



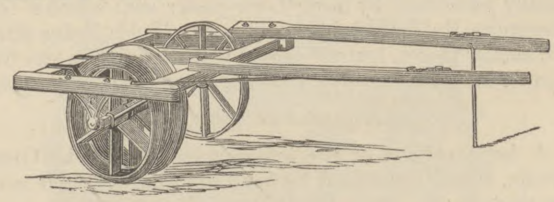
CAMBRIDGE'S PRESS-WHEEL ROLLER.

Gibson's clod-crusher.

Gibson's clod-crusher has a double row of smooth discs on separate axles, the projecting edges of which work into each other. Both implements have this advantage over Crosskill's, that they do not so readily clog on a damp surface.

Land-presser.

Under this head may be noticed press drills, which, by means of a series of narrow cylinders with conical edges, form corresponding grooves in loose soil. Seeds sown broadcast over a surface thus treated come up in rows. The land-presser is a modification of the press-roller. It is made with

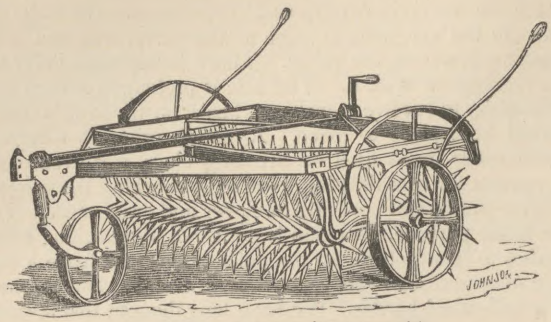


LAND-PRESSER.

two or three conical edged cylinders to fit into the seams of the same number of plough furrows, the other end of the axle on which they are fixed being supported by a plain carriage-wheel. It is drawn by one horse, and follows in the wake of two or three ploughs, according to the number of its cylinders. When wheat is sown after clover lea, this implement is found exceedingly useful in closing the seams, and forming a uniform seed-bed.

Norwegian harrow.

The Norwegian, or as it should rather be called, the Swedish, harrow is strictly a clod-crushing implement. From its radiating spikes penetrating the surface over which it is drawn, it has been called a harrow; but its revolving motion entitles it rather to be classed with rollers. In its usual form it consists of three rows of cast-iron rowels arranged upon parallel axles fixed in an iron frame, which is supported on three wheels,—one in front and two behind. The outline and arrangements are in fact the same as in Finlayson's grubber,




NORWEGIAN HARROW (CROSSKILL'S).

only substituting parallel rows of rowels for tines. There is also the same leverage for raising and depressing the frame. But this implement has recently been constructed on a much simpler and cheaper plan, in which the wheels and lever apparatus are discarded altogether. It thus consists of a simple wrought-iron frame with four rows of rowels. A few boards are laid across the frame, forming a platform over the rowels, on which the driver stands when it is wished to increase the weight and efficiency of the implement. On the upper side at either end, is fixed a piece of wheel-tire, on which the implement, when turned on its back, can slide along, sledge-fashion, when it is wished to move it from place to place. As thus constructed, it can be made for about L.5. This is the best implement yet introduced for breaking *moist* clods.

Breast-plough and trenching-fork.

Before leaving the implements of tillage, it may be proper to notice two, which have been a good deal brought under notice of late years, viz. the breast-plough and trenching-fork. The former is extensively used in carrying out the process of paring and burning. It is the implement so well known in Scotland as the flaughter-spade. In using it the workman guards his thighs with a piece of board, fastened on apron-wise, and with this presses against the cross-head of the implement, and urges forward its cutting edge. When a thin turf has thus been severed from the surface, he throws it topsy-turvy by a jerk of his arms. The fork is used in giving a deep autumn digging to land, in preparation for root crops. Both operations can ordinarily be more economically performed by using horse-power with suitable implements. But for clearing out corners of fields, hedge sides, and similar places, manual labour with these tools can frequently be made to supplement the plough to good purpose.

IMPLEMENTS FOR SOWING.

Broadcast sowing.

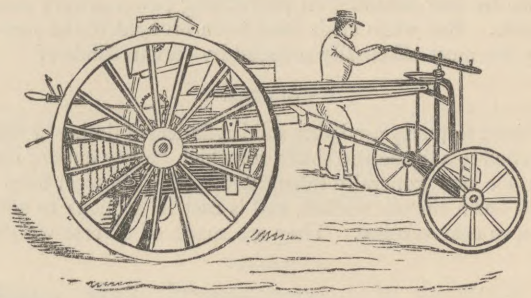
A large portion of the grain annually sown in Great Britain, is still distributed by hand from the primitive sowing sheet.

> "The sower stalks
> With measured step, and liberal throws the grain
> Into the faithful bosom of the ground."

In Scotland, a decided preference is still given to broadcast sowing, for which purpose a machine is used which covers from 15 to 18 feet, according to the width of ridges adopted. It consists of a long seed-box carried on a frame mounted on two wheels. From these, motion is communicated to a spindle which revolves in the seed-box, and expels the seed by means of cogs or brushes, through openings which can be graduated to suit the required rate of seeding. It is drawn by a single horse, is attended by one man, and can get over 30 acres a-day. It is peculiarly adapted for the regular distribution of clover and grass seeds. In one exhibited at the Highland Society's Show at Perth in 1852, by an ingenious apparatus on the principle of the odometer, the machine itself is made to register the space which it travels over, and thus to indicate the rate per acre at which it is distributing the seed. Excellent results have been, and still are, obtained from broadcast sowing. But as tillage becomes more perfect, there does arise a demand for greater accuracy in the depth at which seeds are deposited in the soil, for greater precision in the rate and regularity of their distribution, and for greater facilities for removing weeds from amongst the growing crop. These considerations led, at a comparatively early period, to the system of sowing crops in rows or drills, and hence the demand for machines to do this expeditiously and accurately. We accordingly find in our best cultivated districts, the sowing and after-culture of the crops now conducted with a precision which reminds the spectator of the processes of some well-arranged factory. This is accomplished by means of a variety of drilling machines, the most prominent of which we shall now notice.

Suffolk drill.

The Suffolk drill is the kind in most general use. It is a complicated and costly machine by which manure and



SUFFOLK DRILL. (GARRETT AND CO.)

seeds can be simultaneously deposited. That called the "general purpose drill," can sow 10 rows of corn, with or without manure, at any width between the rows, from 4½ to 10 inches, and at any rate per acre betwixt two pecks and six bushels. It can be arranged also to sow clover and grass seeds—the heavier seeds of clover being thrown out by minute cups—and the lighter grass seeds brushed out from a separate compartment. It is further fitted for sowing beans and turnips—the latter either two drills at a time on the ridge, or three on the flat. This drill, as most recently improved by Messrs Hornsby of Granthan, and Garrett of Leiston, has an apparatus for preserving the machine in a level position when working on sloping ground. As a main object in drilling crops at all. is to admit of the use of the hoe, it become an important point to accomplish the drilling with undeviating straightness, and exact parallelism in each successive course of the drill. This is now obtained by means of a fore carriage, which an assistant walking alongside so controls by a lever as easily to keep the wheel in the same rut down which it had previously passed. Messrs Hornsby have also introduced India-rubber tubes for conducting the seed, in place of the tin funnels hitherto used. These drills cost about L.42.

Woburn drill.

The Woburn drill of the Messrs Hensman, is simpler in its construction than those already noticed. "In all other drills, the coulters, which distribute the manure or seed, hang from the carriage. In this drill the carriage rests upon the coulters, which are like the iron of skates; it may be said, indeed, to run on four pairs of skates. Hence this drill's power of penetrating hard ground, and of giving a firm bed to the wheat-seed in soft ground. Each drill coulter, however, preserves its independence as when suspended. This self-adjustment is required by the inequality of tilled ground, and is thus obtained: each pair of coulters is fixed to the end of a balance beam, these again to others, and they to a central one. Thus each coulter, in well-poised rank, gives its independent share of support. It varies from the generality of drills, as it is drawn from the centre by whipple-trees instead of shafts; and the drill-man behind can steer or direct the drill with the greatest nicety. The corn-box of the drill is entirely self-acting, and delivers the seed equally well going either up or down hill. It is also capable of horse-hoeing, by attaching hoes to the levers instead of the coulter-shares. It is drawn by a pair of horses, and the price from L.18 to L.20."[1]

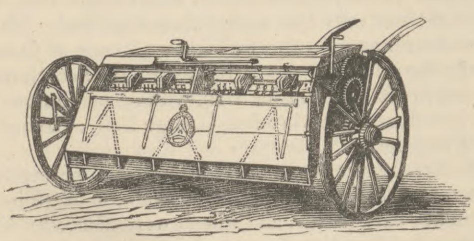
Turnip drill.

Turnip Drill. In Scotland, and in the north and west of England, turnips are usually sown on the ridge by a machine which sows two rows at a time. In the south-eastern parts of England, which are hotter and drier, it is found better to sow them on the flat, for which purpose machines are constructed which sow four rows together, depositing manure at the same time. Both kinds are adapted for sowing either turnips or mangold-wurzel seeds as required. With the view of economising seed and manure, what are called drop-drills have recently been introduced, which deposit both—not in continuous streams—but in jets, at such intervals apart in the rows as the farmer wishes the plants to stand. What promises to be a more useful machine is a water-drill invented by a Wiltshire farmer—Mr Chandler, of Market Lavington. "His water-drill pours down each manure-coulter the requisite amount of fluid, mixed with powdered manure, and thus brings up the plant from a mere bed of dust. Having used it largely during three years, I may testify to its excellence. Only last July, when my bailiff had ceased turnip-sowing on account of the drought, by directing the use of the water-drill, I obtained from this latter sowing an earlier and a better show of young plants than from the former one with the dust-drill. Nor is there any increase of expense, if water be within a moderate distance, for we do not use powder-manures alone. They must be mixed with ashes, that they may be diffused in the soil. Now the expense and labour of supplying these ashes are equal to the cost of fetching mere water; and, apart from any want of rain, it is found that this method of moist diffusion, dissolving, instead of mingling only, the superphosphate, quickens its action even upon damp ground, and makes a little of it go further."[2]

Chandler's water-drill.

The practice of top-dressing wheat, vetches, clover, or meadows, with guano and various light manures, has now so much increased, and the inconvenience of scattering them over the surface by hand is so great, that various machines have recently been invented for distributing them. That by Holmes of Norwich has obtained the prize offered for such a machine by the Royal Agricultural Society of England.

Holmes' manure distributor



MANURE DISTRIBUTOR. (J. HOLMES AND SONS, NORWICH.)

It can also be used for sowing such manures over turnip drills, covering three at once. Such machines will probably be more used in future for distributing lime, which can thus be done much more regularly than by cart and shovel, especially when it is wished to apply small quantities for the destruction of slugs or for other purposes. It seems quite practicable to have this or a similar machine so constructed as that it could be readily hooked on to the tail of a cart containing the lime or other substance which it is desired to distribute by it. The top-dressing material could by such an arrangement be drawn into the hopper of the distributor, as it and its tender move along, and the cart, when emptied, be replaced by a full one with little loss of time.

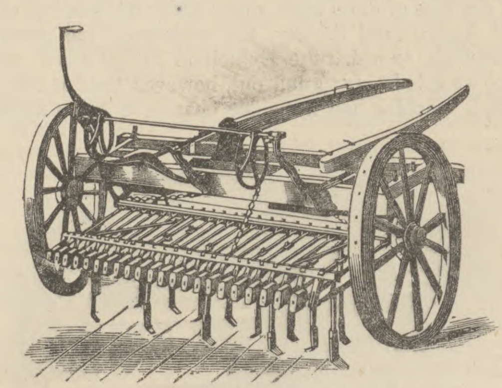
A cheap and effective machine, capable of being in a similar manner attached to a dung-cart, and which could tear asunder fold-yard manure, and distribute it evenly in the bottoms of turnip drills, would be a great boon to farmers, and seems a fitting object to be aimed at by those possessed of the inventive faculty.

### HORSE-HOES.

It has already been remarked, that the great inducement to sow grain and green crops in rows is, that hoeing may be resorted to, for the double purpose of ridding them of weeds and stimulating their growth by frequent stirring of the soil. It is now upwards of a century since Jethro Tull demonstrated in his books and on his fields, the facility with which horse-power could be thus employed. His system was early adopted in regard to turnips, and led, as we have seen, to a complete revolution in the practice of agriculture. The peculiar manner in which he applied his system to grain crops, and the principles on which he grounded his practice, have hitherto been for the most part repudiated by agriculturists, who have thought it indispensable to drill their grain at intervals so narrow as to admit, as was supposed, of the use of the hand-hoe only. But the accuracy with which corn-drills perform their work, has been skilfully taken advantage of, and we now have horse-hoes, covering the same breadth as the drill, which can be worked with perfect safety in intervals of but seven inches wide. By such a machine, and the labour of a pair of horses, two men, and a boy, ten acres of corn can be hoed in as many hours. Not only is the work done at a fifth of the expense of hand-hoeing, and far more effectually; but it is practicable in localities and at seasons in which hand-labour cannot be obtained.

Garrett's horse-hoe.

Garrett's horse-hoe is admitted to be the best implement of its kind. It can be used for hoeing either beans, turnips,



GARRETT'S HORSE-HOE.

or corn, as the hoes can be adapted to suit any width betwixt rows, and the axle-tree being moveable at both ends, the wheels, too, can be shifted so as to be kept betwixt the rows of plants. The shafts can be attached to any part of the frame to avoid injury to the crop by the treading of the horses. Each hoe works on a lever independent of the others, and can be loaded with different weights on the same prin-

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[1] See Mr Pusey's Report on Implements.—*Journal of the Royal Agricultural Society of England*, vol. xii. p. 604.

[2] Ib., p. 607.

ciple as the coulters of the corn-drill to accommodate it to uneven surfaces and varying degrees of hardness in the soil.

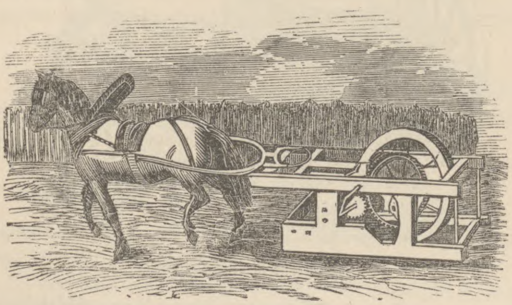
A great variety of implements under the general names of horse-hoes, scufflers, scrapers, or drill-grubbers, fitted for the draught of one horse, and to operate on one drill at a time, is in use in those parts of the country where root crops are chiefly sown on ridgelets from 24 to 30 inches apart. With considerable diversity of form and efficiency, they in general have these features in common, viz., provision for being set so as to work at varying widths and depths, and for being armed either with hoes or tines, according as it is wished to pare the surface or stir the soil more deeply. A miniature Norwegian harrow is sometimes attached to drill-grubbers, by which weeds are detached from the soil, and the surface levelled and pulverized more thoroughly. Tennant's grubber with its tines set close together, and two horses yoked to it abreast by a tree long enough to allow them to walk in the drills on either side of that operated upon, is the most effective implement for cultivating betwixt the rows of beans, potatoes, turnips, or mangold, that we have yet seen used for this purpose. The next class that claims attention is

HARVESTING IMPLEMENTS.

These, until recently, comprised only the reaping-hook and scythe. An implement, by means of which horse-power could be made available for this important operation has long been eagerly desired by farmers. Repeatedly during the past 50 years have their hopes been excited by the announcement of successful inventions of this kind; but, after much fair promise, have hitherto always met with disappointment. These hopes have recently been revived, and raised to a higher pitch than ever, by the appearance, in the Great Exhibition of the Industry of all Nations, of two reaping-machines, known as M'Cormick's and Hussey's, from the United States of America, where, for several years past, they have been used extensively and successfully. These implements were subjected to repeated trials in different parts of England, on crop 1851, but never in circumstances which admitted of their capabilities being tested in a thoroughly satisfactory manner.

American reaping-machine.

At the first of these trials, made under the auspices of the Royal Agricultural Society, the preference was given to M'Cormick's, to which the Exhibition Medal was in consequence awarded. It turned out, however, that at this trial Hussey's machine had not a fair chance, it being attended



HUSSEY'S REAPING MACHINE, BY GARRET AND CO.

by a person who had never before seen it at work, for, when a further trial took place before the Cleveland Agricultural Society, with Mr Hussey himself superintending his own machine, an all but unanimous decision was given in his favour. Hussey's machine was in consequence adopted by the leading implement makers, such as Messrs Garrett, Crosskill, &c.

Early in 1852, a very important communication from the pen of Mr James Slight, curator of the museum of the Highland and Agricultural Society, appeared in the Transactions of the Society, by which the attention of the public was recalled to a reaping machine of home-production, viz., that invented by the Rev. Patrick Bell, now minister of the

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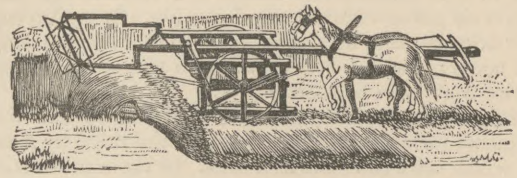

BELL'S REAPING MACHINE, BY CROSSKILL.

Bell's reaping-machine.

parish of Carmylie in Forfarshire, and for which a premium of L.50 had been awarded to him by the Highland Society so long as 26 years ago. This machine attracted much attention at that time. Considerable numbers were made and partially used, but from various causes the invention was lost sight of, until by the arrival of these American machines, and the notoriety given to them by the Great Exhibition, with concurring causes about to be noticed, an intense interest was again excited regarding reaping by machinery. From Mr Slight's report, the public learned that the identical Bell's machine to which the prize was awarded, had for the last 14 years been statedly employed on the farm of Inch-Michael in the Carse of Gowrie, occupied by Mr George Bell, a brother of the inventor, who, during all that period, and on the average of years, succeeded in reaping four-fifths of his crop by means of it. Mr Slight further stated, that at least *four* specimens of it had been carried to America, and that from the identity in principle betwixt them and those now brought thence, with other corroborating circumstances, there is little doubt that the so-called American inventions are after all but imitations of this Scottish machine. When it became known that Bell's machine was to be exhibited, and if possible, subjected to public trial, at the meeting of the Highland and Agricultural Society at Perth, in August 1852, the event was looked forward to by Scottish farmers, with eager interest. On that occasion, it was accordingly again brought forward, with several important improvements made upon it, by Mr George Bell, already referred to, and was fully tested in competition with Hussey's, as made by Crosskill. To the disappointment of many, Mr M'Cormick did not think fit to enter the lists either at this or at subsequent opportunities. The following is the report of the judges who acted upon that occasion:—

"Out of five reaping machines exhibited, four were on the principle of Hussey's, and one on that of the Rev. Patrick Bell. Of these only two were entered for trial. The Hussey machine was from the well-known house of Crosskill of Beverly, the other was the early constructed Scotch machine, invented in 1828 by Patrick Bell, with certain improvements lately introduced by his brother, George Bell, of Inch-Michael farm, Perthshire.

"As has already been stated, arrangements were made by the secretary to conduct the trial on the farm of Muirton, and three fields, oats, barley, and wheat, were placed by Mr Morton, the tenant, at the disposal of the society, for the experiment.

"The following judges were appointed to superintent the trial:—Laurence Oliphant of Condie; Henry Stephens, author of The Book of the Farm; James Stirling, civil engineer, Edinburgh; John Finnie, farmer, Swanston; John Dickson, farmer, Saughton Mains; John Gibson, farmer, Woolmet; James Steedman, farmer, Boghall; William Watson, millwright, Errol; John Young, engineer, Newton-upon-Ayr.

"A space was first cut by the sickle along the ends of the fields, so as to enable the machines to commence. Hussey's,

Machines and Implements.

from being *drawn* by the horses, requires a further clearance along the sides sufficiently broad to allow the horses to walk. Bell's, on the other hand, being *propelled* by the horses, and having the power of delivering the grain to the right or left, opens a passage for itself at any point, whether at the side or in the centre of a field; hence in each trial it took precedence in starting. Each machine was worked by two horses.

"The first essay was in a field of oats. The crop was standing, and nearly ripe, consequently in a favourable condition for machine-cutting, although it stood rather thin on the ground. Bell's machine at first created an impression, from the slow movement of its shears (making only about 110 strokes per minute), that it might pass over and crush the grain. A second or two, however, sufficed to dispel this; and as the implement progressed, it left a stubble about four inches high, cut with the most perfect regularity, and so clean, that scarcely a straw or a grain was observable on it. A stoppage occurred, to allow some adjustment to the height of stubble, and during the five or six turns made by the machine, two or three stoppages took place in crossing deep furrows and unequal ground; but, on the whole, the work was well and continuously performed. The cutting was perfect throughout, and the corn laid with great regularity in an unbroken swathe, the straw lying at an angle of 30 degrees with the line of progress. The breadth of the cut, when shut on both sides, is 6 feet, but cutting with an open side, the breadth seems not to exceed 5½ feet. In the present case the average of four turns was only 5 feet.

"Hussey's machine next came into operation on the oats. The rapid vibration of its cutters, which gave about 570 strokes per minute, produced a feeling of confidence at the start that it would leave nothing uncut; and the first turn, though not performed without stoppage, was satisfactory with respect to cutting. The grain, however, was not so well laid as by Bell's, and the stubble was higher and not so clean. The succeeding cuts were less satisfactory, frequent stoppages occurred, and when there was any undergrowth of grass, the machine was greatly baffled. While the operation of cutting was fairly performed, it was evident that the radical defect of the machine lay in the want of sufficient and regular means for removing the grain when cut. This division of the process depended exclusively on the rakeman, and when he missed the proper moment for removal, the cutters were immediately choked. In point of economy a most important defect was observable, —the breadth cut by Hussey's did not, on an average, exceed 3¼ feet.

"The barley crop was much heavier than the oats, and partially laid, thus presenting greater difficulties to the machines. The superiority of Bell's was here decided in every respect, while the more frequent stoppages of Hussey's from choking, seemed to be caused partly by the greater weight of the crop, but mainly by the inability of the rakeman to perform his duties under the combined difficulty of a partially matted and a heavy crop.

"In the wheat field the crop was of great weight and strength, estimated at a produce of six quarters the imperial acre; and here the decided superiority of uniformly continued mechanical action over intermitting muscular force was strikingly illustrated. Bell's machine, at the outset, cutting a breadth of 5½ feet along the edge of a ditch, had a stoppage, from inequality of surface, after which it proceeded almost without intermission, cutting its regular breadth, and laying the wheat with great regularity, three or four straws only being seen out of the proper angle on the top of the swathe. Under this ordeal, Hussey's had still some merit. It cut a fair stubble, though higher than desirable. It began with its usual breadth, but even that (small compared with Bell's) was beyond the powers of the rakeman to remove; the machine, consequently, became choked at intervals of a few yards, and it ultimately appeared necessary to reduce the breadth of cut to about two feet. In the wheat, therefore, the comparative failure of this machine was, under any economical view, obvious and decided. The action of the fan in Bell's machine, in gathering and depositing the crop upon the web, induced an apprehension that the grain might to some extent be beaten out. This the judges carefully investigated and found to be groundless.

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"Taking into consideration all the circumstances of these trials, the judges unanimously felt warranted in awarding the premium to Mr Bell, for the following reasons:—

"1*st*, For the decided superiority of his machine in economising time and expense, owing to the greater breadth cut by it with the same horse-power, the difference being as 10 to 6½.

"2*d*, For the character and quality of the work performed by it, as being cleaner cut, producing less waste or shake, and laying the swathe with a regularity better suited for binding in sheaves, than when laid off in unequal bundles.

"3*d*, For being less liable to choke, and to the consequent stoppages.

"4*th*, For being mechanically adapted to deposit the grain in rows, performing the operation in a superior manner, and saving, in the opinion of the judges, the labour of two men, as compared with Hussey's.

"5*th*, For the advantages arising from its having the means of laying off the grain to the right side or the left, this feature, combined with that of being propelled instead of being drawn, enabling it to enter on either side, or into the centre of a field, without any previous clearing, and to continue the cutting without interruption, while the cut portion of the crop was lying on the ground.

"6*th*, For greater efficiency when operating on a crop partially lodged."[1]

Subsequent to this, Bell's machine, besides being seen at work by many visitors on his own farm at Inchmichael, was publicly exhibited at four different places,—viz., Phantassie in East Lothian; in the neighbourhood of Dunfermline in Fife; in Ireland, at the special invitation of the Royal Society, who handsomely paid the expense of transporting it thither; and last of all, at Keillor in Forfarshire, on which occasion a challenge was given by public advertisement to all other reaping machines to compete with Bell's for a sweepstakes of L.50 a side. The subject is so important that we shall here quote from the report of the last of these trials:—

"KEILLOR, *September* 4, 1852.

Trial of reaping-machine at Keillor.

"We, the undersigned, having been requested to act as Judges at the trial of reaping machines, which took place this day at the above farm, pursuant to a challenge given by Hugh Watson, Esq., and Mr George Bell, for a sweepstakes of Fifty Sovereigns each, to test the merits of the different machines which are now attracting public attention in this country, and, if possible, to decide upon the best before next season,

REPORT

"That only three reapers appeared upon the field, viz.:—

"1*st*, An American machine, known by the name of Hussey's, constructed and improved under the superintendence of Mr Crosskill, of Beverley, and worked by his agent, Mr Love.

[1] Transactions of the Highland and Agricultural Society of Scotland, Oct. 1852, p. 419.

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"2*d*, A similar machine, with some important improvements, exhibited by Lord Kinnaird; and,

"3*d*, The old original reaping machine, invented by the Rev. Mr Bell of Carmylie, Forfarshire, and which, it appears, has been worked by his brother, Mr George Bell, on his farm of Inchmichael, in the county of Perth, for upwards of twenty years.

"Another machine, constructed by an ingenious mechanic at Invergowrie, near Dundee, was also expected, but met some accident on trial the previous evening, which was the cause of much disappointment.

"It was understood that Mr M'Cormick, from America, was also on the ground, but the machine which bears his name did not appear.

"Mr Love, on the part of Mr Crosskill, stated before the trial commenced, that, after the decision of such a high and competent authority as the Highland Society, at Perth, and after witnessing a trial of the machine itself at Phantassie, Mr Crosskill considered it would be useless to contend against Mr Bell's any longer, which he considered a far superior and more effective machine than any he had yet seen; but that he (Mr Love) would give every assistance in his power to work Hussey's that day for the satisfaction of the large and influential body who were then present.

"As it was desirable that the merits of the machines should be tested in every possible way, it was deemed advisable that the locality should not be too favourable to their easy working, but should possess all the average difficulties of an ordinary corn crop, so as to ascertain the working powers of each. Accordingly the ground selected for the trial was a large field of barley, on the slope to the south of Keillor House; and three lots of one imperial acre each having been measured off, Bell's machine was started first, and performed its work steadily and well in 45 minutes. We examined the stubble carefully, both up and down hill, and it was cut much to our satisfaction, though some difference of opinion existed as to which way the machine worked best. It appeared that the breadth cut each time was something over six feet, and the corn was delivered at the side of the machine in one uniform long line, and most convenient for the binders. Mr Bell concluded by driving a transverse cut obliquely across the field, and right through the centre of the grain, which appeared to show off the merits of the machine to much advantage.

"The other two machines were then set to work on similar lots of ground, and Hussey's, under the superintendence of Mr Love, cut about two-thirds of the prescribed quantity within the 45 minutes, while, from some reason not explained, the other did not complete its task. As these two machines were nearly similar, with the exception of that exhibited by Lord Kinnaird, which had an endless cloth revolving directly in the track of the machine, and intended to facilitate the delivery of the corn in a straight line behind it, the work performed by them was nearly alike. We found on examination that the breadth cut was about three feet and a half each time; and though the stubble was well cut up hill, and when the machine worked against the inclination of the barley, yet it was quite the contrary down hill, where the stalks were often dragged and left uncut. Indeed, so strongly did the director of Hussey's machine feel this difficulty, that, after the first round, he avoided cutting down hill at all, and confined himself to working up hill exclusively, by which nearly one half the time was lost. The stops of these two machines were also much more frequent than with Bell's, arising from stones and other impediments, as well as from the cutters driving into the ground, which not only caused great delay, but also ran much risk in damaging the machines irreparably. From the shortness and peculiar construction of the cutters, it appeared to us that they were much too liable to choke or clog, particularly when they came in contact with anything green, or lying at an angle from them, which rendered it often necessary to stop the machines, in order to have the teeth cleared, and the impediments otherwise removed.

"When the trial at the barley was completed, the parties adjourned to the wheat field, and Bell's machine first charged directly into the centre, and cut a large lane for itself, upwards of six feet in breadth, laying the wheat, which was an exceedingly heavy crop, in a perfectly straight line, and peculiarly well placed for the binders. The reaping of this heavy crop appeared to be comparatively easy work after the barley, and the easy, masterly way in which it was cut down, without any apparent difficulty or noise, gave general satisfaction. Three-quarters of an acre was cut within the half-hour, or at the rate of an acre within the three-quarters, while the stubble appeared beautifully clean and well cut, and no delay whatsoever took place in the performance by Bell's. A lane having been thus cleared, the two other machines set to work, and completed half an acre each in shorter time, and with greater ease than with the barley, and the stubble exhibited none of those inequalities which marked the down-hill work at the other crop.

"With regard to the relative merits of the different machines, it is evident that two of them are imitations, but not improvements, of Mr Bell's original one; and, with the exception of their being somewhat lighter and more portable, when not actually at work, and more easily turned, they do not retain what we consider the leading and important features of his; while, though doing only two-thirds of the work, they appear to be as distressing to the men and horses that work them." . . . . . . . .

(Signed) George A. Grey, Millfield Hill, Northumberland; Charles Chambers, Aberdeenshire; John Garland, Kincardineshire; Andrew Archer, Forfarshire; William Blackadder, C.E., Glammis; Archibald Turnbull, Perthshire, *Judges.* John Ogilvy, Bart., Baldovan; Edward Bullen, Dublin, *Stewards.* Alexander Geekie, Baldowrie, *Timekeeper.*[1]

Since these trials, Mr Bell has informed the public that he has committed the manufacture of his machine, now secured to him by patent, to Mr Crosskill of Beverley, and that he has added to it a contrivance, by means of which he anticipates that it will deposit the cut corn in quantities ready for sheaving, instead of a continuous swathe as hitherto.

Before leaving this subject a remark is due in connection with the strange neglect of this machine for 25 years, and the enthusiasm with which it has now been hailed on its reappearance. The first is so far accounted for by the fact recently noticed by Mr George Bell, that such specimens of his brother's machine as formerly got into the hands of farmers were so imperfectly constructed that they did not work satisfactorily and thus brought discredit on his invention. The true explanation seems to be, that at that date the country was not ready for such a machine. Not only was manual labour then abundant and cheap, from the number of Irish labourers, who annually, as harvest drew near, flocked into the arable districts of Great Britain; but thorough draining had made little progress, and the land was everywhere laid into high ridges, presenting a surface peculiarly unfavourable for the successful working of a reaping machine. Now, however, the conditions are reversed. Under the joint operation of a famine at home pressing out, and the gold discoveries in Australia alluring, emigration from Ireland and elsewhere

[1] North British Agriculturist, 8th September 1852.

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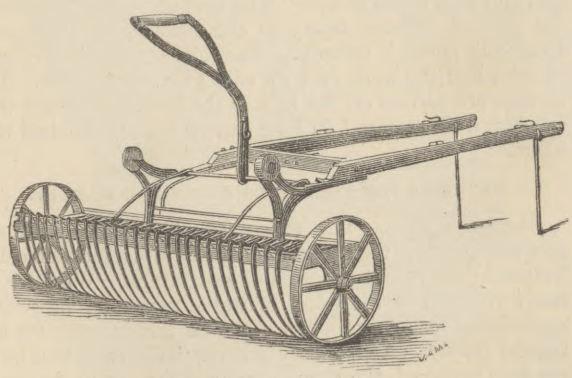
has so thinned the population as already to tell seriously on the supply of labour. The lower price of farm produce consequent on free-trade, urgently demands a reduction in the rate of producing it; and from the extent to which thorough draining has now been carried, high ridges and deep furrows are not merely useless, but positively hurtful. In these altered conditions lies the true explanation of the former apathy and present enthusiasm manifested by our farmers towards this invention. In America, where reaping by machinery has already become a well-established agricultural practice, much progress appears to have been made during 1851-52 in improving this class of machines. At a meeting of the New York State Agricultural Society, in July 1852, no less than eight to ten different mowing and reaping machines were subjected to public trial, all of which accomplished their work in a more or less satisfactory manner. The report of this trial in the *American Cultivator* concludes thus—"On the whole, the trial was a complete triumph of machinery over hand-work, for both mowing and grain-cutting; and, when machines shall be perfected, simplified, and rendered much cheaper than at present, mowers and reapers must become as indispensable on all farms of moderate size, as horse-rakes, ploughs, and thrashing machines."[1]

Now that our leading agricultural mechanists have set themselves in good earnest to the task, and with such eager demand from their customers to stimulate them, we may with some confidence anticipate that really efficient reaping machines will, ere long, be available to British farmers. The trials which have recently been made, suffice to shew that we have already several machines by which the mere reaping is upon the whole performed in a satisfactory manner. What we now want is to have the cut grain deposited out of the track of the machine, and in parcels ready for sheafing. So long as the gatherers and binders must work *in column*, each hurrying past the other, to clear the course for the next round of the reaper, there must necessarily be much loss of time and unnecessary waste. With a machine thus improved, starting so long beforehand as to admit of the same number of people working *in line*, each with a ready parcelled swathe to himself, proper superintendence, economical arrangement, and accurate work will be attainable.

### HORSE RAKES.

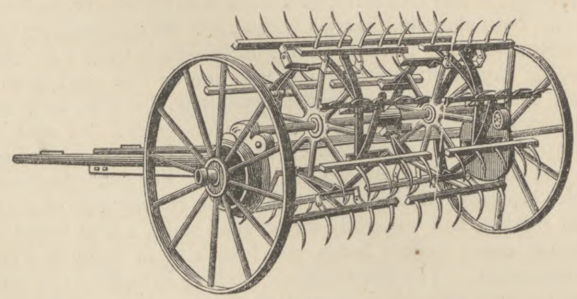
Horse-rakes are in frequent use for gathering together the stalks of corn which are scattered during the process of



HORSE-RAKE (SMITH'S).

reaping; for facilitating the process of haymaking, and also for collecting weeds from fallows. By an ingenious contrivance in the most improved form of this implement, the teeth are disengaged from the material which they have gathered without interrupting the progress of the horse.

Haymakers are valuable implements, and well deserving of more general use. They do their work thoroughly, and



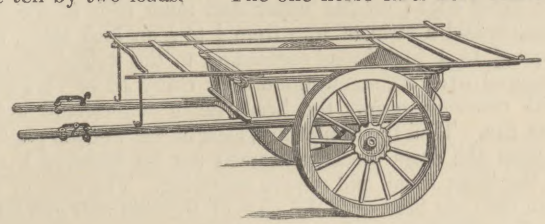
HAYMAKER.

enable the farmer to get through a great amount of it in snatches of favourable weather. Where manual labour is scarce, or when, as in Scotland, haymaking and turnip-thinning usually come on hand together, the haymaker and horse-rake render the horse power of the farm available for an important process which cannot be done well unless it is done rapidly and in season.

We seem to be verging on the time when, by means of reaping, haymaking, and raking machines worked by horse power, farmers will be enabled to cut and carry their grass and corn with little more than the ordinary forces of their farms.

### WHEEL CARRIAGES.

The cartage of crops, manure, &c. upon an arable farm, is such an important part of the whole labour performed upon it, (equal, as shown by a recent estimate, to one-half,)[2] that it is a matter of the utmost consequence to have the work performed by carriages of the most suitable kind. It was for a long time keenly debated by agriculturists, whether waggons or carts are most economical. This question is now undoubtedly settled. Mr Pusey says, "It is proved beyond question, that the Scotch and Northumbrian farmers, by using one-horse carts, save one-half of the horses which south-country farmers still string on to their three-horse waggons and three-horse dung-carts, or dung-pots, as they are called. The said three-horse waggons and dung-pots would also cost nearly three times as much original outlay. Few, I suppose, if any, farmers *buy* these expensive luxuries now; though it is wonderful they should keep them; for last year at Grantham, in a public trial, *five* horses with five carts were matched against five waggons with *ten* horses, and the five horses beat the ten by two loads."[3] The one-horse carts here referred



HARVEST-CART.

to are usually so constructed as to be easily adapted to the different purposes for which wheel-carriages are needed upon

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[1] See Farmers' Magazine, November 1852, p. 392.
[2] See Morton's Cyclopædia of Agriculture. Article "Carriages."
[3] Journal of the Royal Agricultural Society of England. Mr Pusey's Report, p. 617 (vol. xii.).

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a farm. For each pair of wheels and axle there is provided a close-bodied cart, and another with sparred sides and broad shelvings, called a long-cart, or harvest-cart, either of which can easily be attached to the wheels, according to the nature of the commodities to be carried. Such a cart, weighing from 7 to 8 cwt., with iron axle and oak shafts, costs at present, in Berwickshire, from L.10 to L.11, when complete, with both close and harvest bodies, &c. Sometimes a simple moveable frame is attached to the close-body to fit it for carrying hay or straw; but although one or two such frames are useful for casual purposes throughout the year, they are inferior for harvest work to the regular sparred cart with its own shafts. In some districts the whole of the close-bodied carts used on the farm are made to tip. For many purposes this is a great convenience; but for the conveyance of grain to market, and generally for all road work, a firm frame is much easier for the horse, and less liable to decay and derangement. The Berwickshire practice is to have one pair of tip-carts on each farm, and all the rest firm or dormant-bodied, as it is sometimes called.

Many farms are now provided with a water or tank cart, for conveying and distributing liquid manure.

A plan for lessening the expenditure of horse-labour in the carriage of roots, &c. and accomplishing it with less injury to the land, by means of a portable railway, has been introduced by R. Neilson, Esq., of Halewood, near Liverpool, and tried by others in various parts of the country. When we first heard of this portable farm railway, we confess to having regarded it as a mere toy for amateurs, to whom expense was no object. Further inquiry and reflection have led us to a different conclusion, and we now regard it as likely ere long to come into general use. In the Agricultural Gazette, of 22d March 1851, Mr Neilson, after stating that his farm consists of heavy clay land, on which the difficulty of carting off root crops, or carting on manures, &c. was so great as to lead him to invent a rude sort of railway of wood, which so well answered the purpose, that for the last nine or ten years he had used it always for taking off his root crop, and frequently in putting on manure, thus describes his contrivance:—" The sides are of the common deal, 18 feet long, or shorter if thought more desirable, nearly 3 inches deep and $2\frac{1}{2}$ thick. A balk of timber 18 feet long and 12 inches by 13 square, will cut up into 20 of them. They are connected by means of wooden sleepers of tougher material (slabs or thinnings of oak, ash, beech, &c.), 2 feet 5 long, 3 inches broad by 2 inches thick, and morticed through the side pieces about 4 feet; the tenon is left in the upper side of the cross piece, and the mortice is cut in the side piece, so as to allow the bottom of it and the cross piece to be on a level, so that the flange of the wheel will travel above. The tenons are fastened by a half-inch wooden pin driven through the side piece $\frac{3}{4}$ of an inch from the outer edge; on the upper and inner edge of the side piece is laid a strip of iron from $\frac{1}{4}$ to $\frac{1}{2}$ an inch thick, and from $\frac{3}{4}$ to 1 inch broad (according to the weight of work required over it), screwed down at every 15 or 18 inches with two-inch screws, the heads being countersunk in the iron rim. Thus the iron strip is clear of the wooden pin that fastens the cross pieces, and need not be removed if any of the latter break and require renewing. The ends of the iron strip are bent over the ends of the side rails and let in flush, and are secured by a band of hoop-iron covering the mortice hole outside, passing round the end, and for six inches along the inside of the side rail, and through this plate is fastened the joint for attaching to the next rail. After many contrivances, I have found the following the best and most convenient mode of connecting two consecutive rails together: a pin three inches long, of half-inch square iron, turned with a half-inch eye at one end, and driven nearly home in each end of each side piece. Care must be taken that these pins are fixed half an inch on the inside of the centre on one end, and half an inch on the outside of the centre on the other end of the same rail, so that when two rails are brought together, the two pins of the one rail are both inside or both outside the two pins of the other rail, which prevents them separating sideways, and the eyes being level, are fastened by a half-inch pin or plug put through them, and which forming a joint, enables the railway to be laid more easily over undulating ground. These pins or plugs are secured to the side pieces by a small piece of light jack chain. Though this description is but an imperfect one, I trust that with the accompanying sketch it may be sufficiently understood to be tried; and where the surface is suitable and not too hilly, I'll answer for it, that on heavy land it will not readily be discontinued. Of the waggons and turn-tables I presume no description is needed; the latter is very simple, adapted to the length of the former, and costs about L.10. The former will hold about ten or twelve cwt. of turnips, and discharges sideways over the wheel, which is about 18 inches high. Cost about L.2, 15s., or L.3. My arrangement for getting off my turnips is to deliver the rails, waggons, and turn-tables in proper working order to the labourers who contract to deliver the turnips at the field-gate at so much per acre, and to restore the rails, &c. in good order, or pay for breakage and damage." [1]

Mr Caird, who visited Mr Neilson's farm in October 1850, thus notices the invention:—" A light tramway with waggons is made use of for taking the turnip crop off the ground in moist weather. The tramway is readily shifted, and the crop is thrown into the waggons, which are then each pushed along by a man, so that the entire crop may be removed from the ground, which thus receives no injury from the feet of horses. The tramway can be constructed for 1s. 4d. per yard, and might be very advantageously introduced on all heavy farms where it is found difficult to take off the turnip crop in moist weather. A gang of men are at present employed on a considerable field of Mr Neilson's in taking off the turnip crop, which they draw from the ground, fill into the waggons, and convey outside of the gate at the rate of 6s. an acre, shifting the tramway at their own cost. At this work they earn 2s. 3d. a-day." [2] On the Home farm of Earl Grey at Hawick, he found the same contrivance in use, and thus refers to it,—" The root crops are taken from the ground, without injury to the surface, by the use of Crosskill's portable railway. The rails are found very easy to shift, and the work goes on with great expedition. The Swedes are carried on the rails to the headland, where they are stored till required, in long narrow heaps, thatched with straw." [3]

### MACHINES FOR PREPARING CROPS FOR MARKET.

*Steam Engines.*—The extent to which steam power is now employed for the purposes of the farm is another marked feature in the recent progress of agriculture. We have already referred to the value of water power for propelling agricultural machinery when it can be had in sufficient and regular supply. As it is only in exceptional cases that farms are thus favoured, the steam-engine is the power that must generally be reckoned upon; and accordingly its use is now so common that a tall chimney has become, over extended districts, the prominent feature of nearly every homestead. It has been satisfactorily shewn that grain can be thrashed

[1] See Agricultural Gazette for 1851, p. 186.

[2] See Caird's English Agriculture, 1850-51, p. 270.

[3] Ibid. p. 375.

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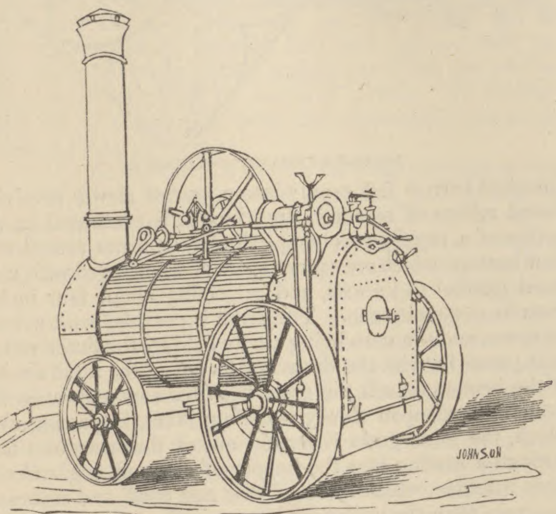
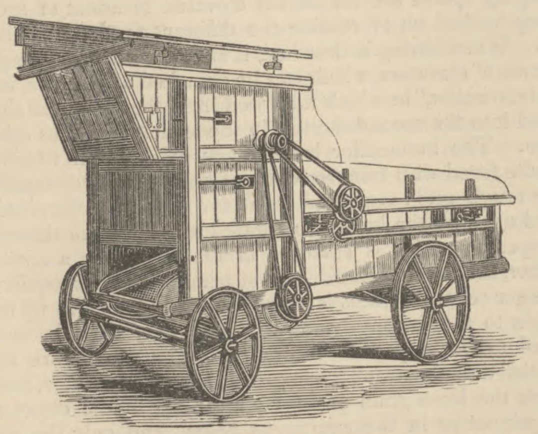
and dressed by well-constructed, steam-propelled machinery, at one-fourth the cost of thrashing by horse power and dressing by hand-fanners. So great indeed is the improvement in steam-engines, and so readily can the amount of power be accommodated to the work to be done, that we find them everywhere superseding the one-horse gin, and even manual labour, for pumping, churning, coffee-grinding, &c. Wherever, then, a thrashing-mill is used at all, it may be safely asserted that, next to water, steam is the cheapest power by which it can be propelled. The *portable* engine is the form which has hitherto found most favour in the southern parts of the kingdom. Mr Pusey thus states the reasons for

Portable *versus* stationary engine.




PORTABLE STEAM-ENGINE. (CLAYTON, SHUTTLEWORTH AND CO.)

which he regards them as preferable to fixed engines,—"If a farm be a large one, and especially if, as is often the case, it be of an irregular shape, there is great waste of labour for horses and men in bringing home all the corn in the straw to one point, and in again carrying out the dung to a distance of perhaps two or three miles. It is therefore common, and should be general, to have a second outlying yard. This accommodation cannot be reconciled with a fixed engine.



PORTABLE THRASHING-MACHINE. (CLAYTON, SHUTTLEWORTH AND CO.)

"If the farm be of a moderate size, it will hardly—and if small will certainly not—bear the expense of a fixed engine: there would be waste of capital in multiplying fixed engines to be worked but a few days in the year. It is now common, therefore, in some counties for a man to invest a small capital in a moveable engine, and earn his livelihood by letting it out to the farmer.

"But there is a further advantage in these moveable engines, little, I believe, if at all known. Hitherto corn has been thrashed under cover in barns; but with these engines and the improved thrashing-machines we can thrash the rick in the open air at once as it stands. It will be said, how can you thrash out of doors on a wet day? The answer is simple. Neither can you move your rick into your barn on a wet day; and so rapid is the work of the new thrashing-machines, that it takes no more time to thrash the corn than to move it. Open-air thrashing is also far pleasanter and healthier for the labourers, their lungs not being choked with dust, as under cover they are; and there is, of course, a saving of labour to the tenant not inconsiderable; but when these moveable steam-engines have spread generally, there will arise an equally important saving to the landlord in buildings. Instead of three or more barns clustering round the homestead, one or other in constant want of repair, a single building will suffice for dressing corn and for chaff-cutting. The very barn-floors saved will be no insignificant item. Now that buildings are required for new purposes, we must, if we can, retrench those buildings whose objects are obsolete. Open-air thrashing may appear visionary: but it is quite common with the new machinery; nor would any one perform the tedious manœuvre of setting horses and men to pull down a rick, place it on carts, and build it up again in the barn, who had once tried the simple plan of pitching the sheaves at once into the thrashing-machine."[1]

To us these reasons are inconclusive. A fixed engine can be erected and kept in repair at greatly less cost than a portable one of the same power. It is much easier to keep the steam at working pressure in the common boiler than in the tubular one, which, from its compactness, is generally adopted in portable engines. It is no doubt very convenient to draw up engine and machinery alongside a rick and pitch the sheaves at once upon the feeding-board, and very pleasant to do this in the sunshine and "caller air," but we should think it neither convenient nor pleasant to have engine and thrashing gear to transport and refix every time of thrashing; to have grain and chaff to cart to the barn, there to undergo a separate process of dressing by some other power; the thrashed straw to convey to the respective places of consumption, and all this in circumstances unfavourable to accurate and cleanly disposal of the products, and excessive exposure to risk of weather. Sudden rain will no doubt interrupt the carrying in of a rick in the one case as the thrashing of it in the other; but there is surely a vast difference betwixt merely re-covering the partially carried rick, having machinery, work-people, and products safely under cover, and engine and people ready by a slight change of gearing for other work, such as bruising, grinding, or chaff-cutting. Mr Favell and others have also now shown, that it is quite as practicable and much less laborious to bring the rick to the engine as to take the engine to the rick.

The fact that in the best modern machines, the grain is not merely separated from the straw, but riddled, winnowed, sacked, and weighed ready for market as the thrashing proceeds, at no more expense of time, fuel, or wages, than by the portable engine is expended on thrashing only, makes it very evident to us that the former is in every point of view the preferable machine. It is urged on behalf of the protable engine that in districts where the farms are generally small, one may serve a good many neighbours. Now, not

[1] Mr Pusey's Report on Implements.—Journal of the Royal Agricultural Society of England, vol. xii., p. 621.

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to dwell on the expense and inconvenience to small occupiers of frequently transporting such heavy carriages, and of having as much of their crop thrashed in a day (there being manifest economy in having at least a day's work when it is employed) as will meet their demands for fodder and litter for weeks to come, we are persuaded that on farms, of even 80 or 100 acres, a compact fixed engine of two or three horse-power will thrash, bruise grain, cut chaff, work a churn, and cook cattle-food, &c. more economically than such work can be done in any other way. It is very usual to find on such farms, especially in dairy districts, an apparatus for cooking cattle-food by steam, or by boiling in a large copper, where as much fuel is used every day, and as much steam generated, as would work such an engine as we have referred to, and do the cooking over and above. Even a small dairy implies a daily demand for boiling water to scrub vessels and cook food for cows. How manifestly economical, then, when the steam is up at any rate, to employ this untiring, obedient agent, so willing to turn the hand of anything, in performing the heavy work of the homestead with a power equal perhaps to that of all the men and horses employed upon the farm.

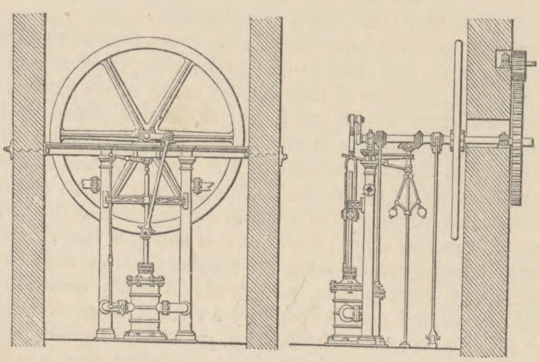
The prices of portable engines by the best makers, are, for 4-horse power, with tubular boiler, four wheels, double shafts, &c. about L.200. For a 6-horse power, from L.250 and upwards.

| | |
|---|---|
| A fixed engine, of the best construction, such as is used in the Lothians, of 4-horse power, can be got for ... ... ... ... ... | L.95 0 0 |
| The building of a brick chimney, and engine-house, setting engine and boiler, and supplying water, costs ... ... ... | L.55 0 0 |
| In all, | L.150 0 0 |

6-horse power L.180. 8-horse power L.205.

Fixed over-head crank steam-engine.

The kind of fixed engine most approved for farm-work in the north of England and south of Scotland is the over-head crank-engine, attached by direct action to the spur-

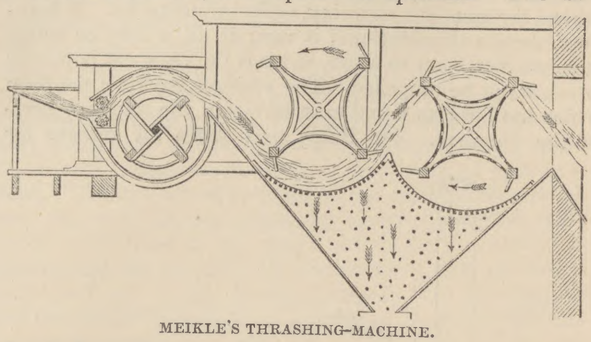


wheel, and sometimes even to the drum-shaft of the thrashing-machine. Their cheapness, simplicity of construction, easy management, and non-liability to derangement, fit them in an eminent degree for farm-work.

(*See article on "comparative advantages of fixed and portable steam-power for the purposes of a farm." By Robert Ritchie, Esq., C.E., Edinburgh, in Transactions of Highland Society for March* 1852, p. 281.)

THRASHING-MACHINE.

It is now 65 years since an ingenious Scotch mechanist, Andrew Meikle, produced a thrashing machine so perfect, that its essential features are retained unaltered to the present day. Indeed, it is frequently asserted that, after all the modifications and supposed improvements of the thrashing machine, which have been introduced by various parties, the mills made by Meikle himself have not yet been surpassed, so far as thorough and rapid separation of the grain from the straw is concerned. The annexed sketch presents a section of Meikle's machine, and explains its operation. The un-



MEIKLE'S THRASHING-MACHINE.

thrashed corn is fed evenly into a pair of slowly revolving fluted rollers of cast-iron, by which it is presented to the action of a rapidly revolving cylinder or drum armed with four beaters, which are square spars of wood faced with iron, fixed parallel to its axis, and projecting about four inches from its circumference. The drum is provided with a dome or cover, and the corn being partly held by the fluted rollers as it passes betwixt the drum and its cover, the rapid strokes of the beaters detach the grain from the ears and throw the straw forward upon slowly revolving rakes, in passing over which, the loose grain is shaken out of the straw and falls through a grating into the hopper of a winnowing and riddling machine, which rids it of dust and chaff, and separates the grain from the unthrashed ears and broken straw, called *roughs* or *shorts*. The grain and roughs are discharged by separate spouts into the apartment below the thrashing loft, where the corn is fed into the rollers, and the thrashed straw falls from the rakes into the straw-barn beyond. Since Meikle's time, further additions have been made to the machinery. In the most improved machines driven by steam or a sufficient water-power, the grain is raised, by a series of buckets fixed on an endless web, into the hopper of a double winnowing machine, by which it is separated into clean corn, light, whites or capes, and small seeds and sand. The discharging spouts are sufficiently elevated to admit of sacks being hooked on to receive the different products as they fall. When barley is thrashed, it is first carried by a separate set of elevators, which can be detached at pleasure, into a "hummeller," in which it is freed from the awns, and then raised into the second fanners in the same manner as other grain. The hummeller is a hollow cylinder, in which a spindle fitted with transverse blunt knives revolves rapidly. The rough grain is poured in at the top, and after being acted upon by the knives, is emitted at the bottom through an opening which is enlarged or diminished by a sliding shutter, according to the degree of trimming that is required. A larger set of elevators is usually employed to carry up the roughs to the feeding-board, that they may again be subjected to the action of the drum. The roughs are not emptied directly on the feeding-board, but into a riddle, from which the loose grain passes by a canvass funnel direct to the winnower in the apartment below, and only the unthrashed ears and short straw are allowed to fall upon the board.

Barley-hummeller.

The alterations that have been made upon the thrashing-machine since Meikle's time chiefly affect the drum. Meikle himself tried to improve upon his beaters by fixing a projecting ledge of iron on their outer edges so as to give them a scutching action similar to that of flax-mills. This strips

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off the grain from oats or barley very well, when thinly fed in; but its tendency is to rub of the entire ears, especially of wheat, and also to miss a portion of the ears, whenever there is rapid feeding in. More recent trials with drums on the scutching principle show it to be on the whole inferior to the plain beater.

Scutching-drum.

We have already referred to the general use of portable thrashing-machines in the eastern counties of England. These, for the most part, have drums with six beaters upon a skeleton frame, which revolve with great rapidity (about 800 times per minute, hence often called high-speed drum), within a concave, or skreen, which encloses the drum for about one-third its circumference. This skreen consists alternately of iron ribs and open wire-work, and is so placed that its inner surface can be brought into near contact with the edges of the revolving beaters, and admits of this space being increased or diminished by means of screws. No feeding-rollers are used with this drum, the unthrashed corn being introduced directly to it.

High-speed drum.

Another form of drum, acting on the same principle as that just referred to, but cased with plate-iron, and having for beaters, eight strips of iron projecting about one-fourth of an inch from its surface, and which works within a concave which embraces it for three-fifths of its circumference, is in use when it is desired to preserve the straw as straight and unbroken as possible. These are made of sufficient width to admit of the corn being fed in sideways, and are called *bolting* machines, from the straw being delivered in a fit state for being at once made up into *bolts* or bundles for market. Although the term *beaters* is retained in describing these drums, it is evident that the process by which the grain is separated from the ears, is rubbing rather than beating. This necessarily requires that only a narrow space intervene betwixt drum and concave, and that the corn be fed in somewhat thinly. Such machines thrash clean, whether the ears are all at one end of the sheaf or not, and deliver the straw straight and uninjured; but it is objected to these by some that they are slower in their operation than the common beating-drum,—are liable to choke if the straw is at all damp, —that the grain is sometimes broken by them,—and that they require greater power to drive them.

Bolting-drum.

Peg-drum.

A further and more recent modification is the peg-drum. In this case the drum is fitted with parallel rows of iron pegs, projecting about $2\frac{1}{2}$ inches from its surface, which in its revolutions pass within one fourth of an inch of similar pegs fixed in the concave, in rows running at right angles to the drum. Great things were at first anticipated from this invention, which, however, it has failed to realise. But iron pegs have more recently been added to the common beater-drum with apparent success. The beaters in this case are made one half narrower than usual, and have stout iron pegs, formed of square rods, driven into their faces, angle foremost, and slightly reflected at the points. These act by a combination of beating and rippling, and are said to thrash clean, and to be easily driven.

There is thus a great variety of thrashing-machines to be found in different parts of the country, the comparative merits of which are frequently and keenly discussed by agriculturists. The extraordinary discrepancies in the amount and quality of the work performed by different machines, and in the power required to effect it, are quite as much due to the varying degrees of skill with which their parts are proportioned and put together, as to varying merit in the respective plans of construction.

In the best examples of six-horse power stationary steam-engines and thrashing machinery, as found in the Lothians, fifty quarters of grain, taking the average of wheat, barley, and oats, are thrashed, dressed, and sacked up ready for market in a day of ten hours, with a consumption of $7\frac{1}{2}$ cwt. of good coals, and a gross expenditure for wages, value of horse-labour, fuel, and wear and tear of machinery, of 9d. per quarter.

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The Royal Agricultural Society of England have done much towards ascertaining the real merits of the various thrashing-machines now in use, by the carefully conducted comparative trials to which they have subjected those which have been presented in competition for their liberal prizes. The accuracy of these trials, and the value of the recorded results, have been much enhanced by the use of an ingenious apparatus invented by Mr C. E. Amos, consulting engineer to the Society, which is figured and described at p. 479 of Vol. xi. of the Society's Journal. A pencil connected with this apparatus traces a diagram upon a sheet of paper recording every variation of the power employed during the experiment to work the machine under trial. For reasons already stated, we regard it as unfortunate that the patronage of this great Society has hitherto been so exclusively bestowed upon portable machines.

### WINNOWING MACHINES.

We have already referred to the fanners, which, except in portable machines, are almost invariably found in combination with thrashing machinery, so as to deliver the grain into the corn-barn in a comparatively clean state; and we have also noticed the further contrivances by which, when there is a sufficient motive power at command, the complete dressing of the grain goes on simultaneously with the thrashing. The winnowers used in such cases do not differ in construction from those worked by hand. Indeed, it is usual to have one at least that can be used in either way at pleasure. In these machines the separation of the clean from the light grain, and of both from dust, sand, and seeds of weeds or other rubbish, is effected by directing an artificial blast of wind upon a stream of grain as it falls from a riddle. There is thus a combination of fanning and sifting, which is used in different degrees according to the views of the mechanist. In some forms of this machine, the benefit of the artificial blast is in a great measure lost through an injudicious excess of sifting apparatus. In the principal corn districts of Scotland, these machines have recently been much improved by the Messrs Elsey from Wisbeach, who lay most stress on the proper management of the fan.

The now frequent use of various kinds of grain in the fattening of live-stock creates a necessity for machines to prepare it for this purpose, either by breaking, bruising, or grinding. A profusion of these, to be worked by hand, is everywhere to be met with. Such machines are always most economically worked by steam or water power. When that can be had, a set of rollers for bruising oats or linseed, and millstones to grind the inferior grain of the farm, form a most valuable addition to barn machinery. Machines for breaking linseed-cake into large pieces for cattle, or smaller for sheep, are now in general use. The breaking is performed by passing the cakes between two serrated rollers, by which it is nipt into morsels. These are usually driven by hand; but it is always expedient to have a pulley attached to them, and to take advantage of mechanical power when available.

Corn-bruiser and grinding-mill.

Cake-crusher.

### CHAFF-CUTTERS.

The use of this class of machines has increased very much of late years. Fodder, when cut into lengths of from half to whole inch, is somewhat more easily masticated, but the chief advantages of this practice are, that it prevents waste, and admits of different qualities—as of hay and straw, or straw and green forage,—being so mixed that animals cannot pick out the one from amongst the other, but must eat the mixture as it is presented to them. Such cut fodder

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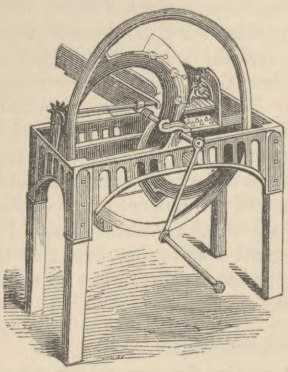
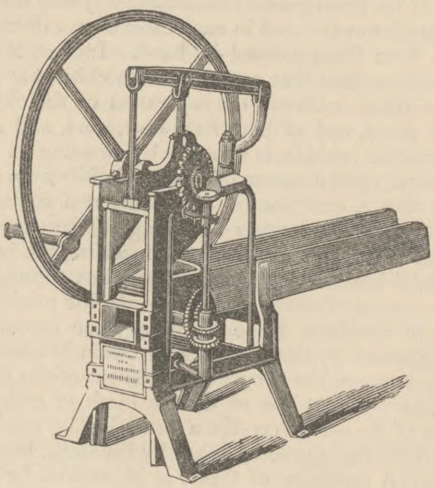
also forms an excellent vehicle in which to give meal or bruised grain, either cooked or raw, to live-stock. This is peculiarly the case with sheep when feeding on turnips, as they then require a portion of dry food; but waste it grievously when not thus prepared. They are constructed on a variety of plans; but the principle most frequently adopted is that of radial knives bolted to the arm of a fly-wheel, which work across the end of a feeding-box fitted with rollers which draw forward the straw or hay, and present it in a compressed state to the action of the knives. A machine on this principle, made by Cornes of Barbridge, has gained the first premium, in its class, at recent meetings of the Royal Agricultural Society of England. Gillets' guillotine chaff-cutter is an exceedingly ingenious and efficient machine, performing its work with great accuracy and without frequent sharpening of its one double-edged knife. These



CHAFF-CUTTER, BY RICHMOND AND CHANDLER.

Guillotine chaff-cutter.

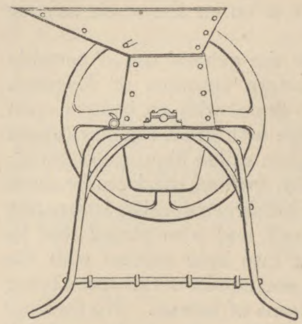


CHAFF-CUTTER, BY GILLET.

machines are most economically worked by the power used for thrashing. The most convenient site for them is in the upper loft of the straw-barn, when the straw can be supplied with little labour, and the chaff either shoved aside or allowed to fall as it is cut, through an opening in the floor, into the apartment below, and at once conveyed to other parts of the homestead. The practice, on some farms where there is a fixed steam-engine is, to thrash a stack of oats in the forenoon, and to cut up the straw, and bruise or grind the grain simultaneously in the afternoon.

### TURNIP-CUTTER.

Cattle and sheep which have arrived at maturity are able to scoop turnips rapidly with their sharp gouge-like front teeth, and so can be fattened on this kind of food without an absolute necessity of slicing it for them. Even for adult animals there is, however, an advantage in reducing turnips to pieces, which they can easily take into their mouths, and at once get between their grinders without any preliminary scooping; but for young stock, during the period of dentition, it is indispensable to their bare subsistence. It is largely through the use of slicing-machines that certain breeds of sheep are fattened on turnips, and got ready for the butcher at 14 months old.



TURNIP-SLICER, (GARDENER'S,) BY SAMUELSON.

Gardener's turnip-cutter.

It seems to be admitted on all hands that Gardener's patent turnip-cutter is the best that has yet been produced for slicing roots for sheep. It is now made entirely of iron, and is an exceedingly useful machine.

In cattle feeding it is not usually thought necessary to divide the roots given to them so minutely as for sheep. A simple machine, fashioned much on the principle of nut-crackers, by which, at each depression of the lever handle, one turnip is forced through a set of knives which divide it into slices each an inch thick, is very generally used in Berwickshire for this purpose. Many persons, however, prefer to have the turnips put into the cattle-troughs whole, and then to have them cut by a simple cross-bladed hand-chopper, which, at each blow, quarters the piece struck by it. The mode of housing fattening cattle largely determines whether roots can be most conveniently sliced before or after being put into the feeding-troughs. A recent writer[1] urges the advantage of rasping or crushing roots into minute fragments, and mixing them with chaff before giving them to cattle, as this not only renders them of easy mastication, but prevents, in wintry weather, the chilling effects of a bellyfull of such watery food as turnips alone. A machine by Moody, resembling a bark mill, is said to per form the crushing very satisfactorily.

### STEAMING APPARATUS FOR COOKING CATTLE FOOD.

We have several times alluded to the cooking of food for cattle. This is performed either by boiling in a common pot, by steaming in a close vessel, or by infusion in boiling water. A variety of apparatus is in use for these purposes. A convenient one is a close boiler, with a cistern over it, from which it supplies itself with cold water by a self-acting stop-cock. This is alike suitable for cooking either by steaming or infusing.

### WEIGHING MACHINES.

It is of course indispensable for every farm to be provided with beam and scales, or other apparatus, for ascertaining the weight of grain, wool, and other commodities, in quantities varying from 1 lb. to 3 cwt. But, besides this, it is very desirable to have a machine by which not only turnips, hay, manures, &c, can be weighed in cart-loads, but by which also the live weight of pigs, sheep, and bullocks, can be ascertained. Such a machine, conveniently placed in the homestead, enables the farmer to check the weighing of purchased manure, linseed-cake, coal, and similar commodities, with great facility. It affords the means of conducting various experiments for ascertaining the comparative productiveness of crops, and the quantities of food consumed by cattle, and their periodic progress, with precision and facility. To persons unable to estimate the weight of cattle

[1] Rev. Mr Huxtable in his "Present Prices."

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by the eye readily and accurately, such a machine is invaluable.

Concluding remarks on implements.

We have thus enumerated, and briefly described, those machines and implements of agriculture which may be held to be indispensable, if the soil is to be cultivated to the best advantage. The list does not profess to be complete; but enough is given to indicate the progress which has recently taken place in this department. We have already referred to this department of the proceedings of the Royal Agricultural Society of England, and would earnestly recommend to all engaged in agriculture, the careful study of the reports on implements contained in the 9th, 10th, 11th, and 12th volumes of their Journal. The care with which they have selected their judges, and the skilful manner in which those entrusted with the difficult and responsible office have discharged their duties, are truly admirable. A few extracts from these reports will serve to show the extent and value of this department of the Society's labours. In the report for 1847, Mr Thomson of Moat-Hall says, " The Society's early shows of implements must be viewed chiefly in the light of bazaars or expositions. Neither stewards nor judges had yet acquired the experience requisite for the adequate discharge of their office, so that such men as Messrs Garrett, Hornsby, Ransome, and a few others, would have laughed in their sleeves had they been told that they could learn anything in the Society's show-yard. In spite, however, of a creditable display on the part of a few leading firms, the majority of the implements exhibited at these early shows were of inferior construction and workmanship, and the general appearance of the exhibitions meagre and unsatisfactory.

" The attention of some of the leading members of the Society (especially of the late lamented Mr Handley), was earnestly directed to the improvement of this department, and they soon perceived that little was gained by collecting implements in a show-yard for people to gaze at, unless an adequate trial could be made of their respective merits. To attain this end great exertions were made, and every improvement in the mode of trial was followed by so marked an increase in the number and merit of the implements brought forward at subsequent shows, as to prove the strongest incentive to further effort.

" At the Cambridge and Liverpool meetings, when these trials were in their infancy, their main attraction consisted of ploughing-matches on a large scale, which gratified sightseers, but gave no results that could be depended upon, and therefore disappointed all practical men. It would occupy time unnecessarily to trace the gradual changes which have led to the discontinuance of these showy exhibitions, and the substitution in their place of quiet, business-like trials in the presence of stewards and judges alone. Suffice it to say, that what they have lost in display, they have gained in efficiency, and consequently in favour with those classes for whose benefit they were designed. At the York meeting, the improved mode of trying the thrashing-machines supplied a deficiency which, until that time, had been much felt, viz., the absence of any means of ascertaining the amount of power expended in working the machines under trial; and it may now be asserted, with some confidence, that, with the exception of an occasional error or accident, the best implements are uniformly selected for prizes.

" It now remains to answer the question proposed for consideration, viz., to what extent the great improvement made of late in agricultural implements is due to the exertions of this Society, and with this view a tabular statement is subjoined, which shows the relative extent and importance of the Society's two first and two last shows of implements:—

| | No. of Exhibitors. | Awards. Money. | Medals. |
|---|---|---|---|
| 1839 Oxford,............ | 23 | £5 | 4 |
| 1840 Cambridge,......... | 36 | 0 | 7 |
| 1848 York,............... | 146 | 230 | 21 |
| 1849 Norwich,............ | 145 | 364 | 13 |

From this it will be seen that at Cambridge, where the trial of implements was confined to one day, and was, in other respects, so immature as to be of little practical value, the number of exhibitors was only thirty-six, and the judges, in whom a certain discretionary power was vested, awarded no money and but seven medals, in consequence of the scarcity of objects deserving of reward; whilst at York, eight years after, when trials lasted several days, and had attained a considerable degree of perfection, the number of exhibitors had increased four-fold. The additional amount offered in prizes at the later meetings has undoubtedly assisted in creating this great increase of competition, but it cannot be considered the principal cause, since the implement-makers are unanimous in declaring that, even when most successful, the prizes they receive do not re-imburse them for their expenses and loss of time. How, then, are the increased exertions of the machine-makers to be accounted for? Simply by the fact that the trials of implements have gradually won the confidence of the farmer, so that, when selecting implements for purchase, he gives the preference to those which have received the Society's mark of approval. This inference is corroborated by the makers themselves, who readily admit that the winner of a prize, for any implement of general utility, is sure to receive an ample amount of orders, and that the award of a medal is worth on an average L.50."

In reporting upon the agricultural implement department of the Great Exhibition, Mr Pusey says, " The yearly shows and trials of the Royal Agricultural Society have certainly done more in England for agricultural machines within the last ten years, than had been attempted anywhere in all former time. . . . . It seems proved that since annual country shows were established by Lord Spencer, Mr Handley, and others yet living, old implements have been improved, and new ones devised, whose performances stand the necessary inquiry as to the amount of saving they can effect. To ascertain that amount precisely is difficult; but, looking through the successive stages of management, and seeing that the owner of a stock-farm is enabled, in the preparation of his land, by using lighter ploughs, to cast off one horse in three, and by adopting other simple tools, to dispense altogether with a great part of his ploughing,—that in the culture of crops by the various drills, horse labour can be partly reduced, the seed otherwise wanted partly saved, or the use of manures greatly economised, while the horse-hoe replaces the hoe at one-half the expense,—that at harvest the American reapers can effect thirty men's work, whilst the Scotch cart replaces the old English waggon with exactly half the number of horses,—that in preparing corn for man's food, the steam thrashing-machine saves two-thirds of our former expense,—and in preparing food for stock, the turnip-cutter, at an outlay of 1s. adds 8s. a-head in one winter to the value of sheep; lastly, that in the indispensable but costly operation of draining, the materials have been reduced from 80s. to 15s.—to one-fifth, namely, of their former cost; it seems to be proved that the efforts of agricultural mechanists have been so far successful, *as in all these main branches of* farming labour, taken together, to effect a saving, on outgoings, of little less than one-half."

Scottish agriculturists, in reading these reports, will probably note with self-gratulation, that some of the improvements referred to as of recent introduction in England, viz. two-horse ploughs and one-horse carts, have long been established among themselves. Indeed, they will find graceful

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notice of the fact on the face of these reports. Unless altogether blinded by prejudice they will, however, see that our brethren south of the Tweed have already outstripped us in many particulars, and that unless our national society, our mechanists, and farmers, exert themselves with corresponding judgment and zeal, we must henceforth be fain to follow, where we at least fancy that we have hitherto been leading. But we have more important motives and encouragements to exertion than mere national emulation. The extent to which the cost of production of farm produce has been lessened by recent improvements on the implements of husbandry, and in the details of farm management, is greater than many are aware of. It seems to be in this direction mainly that we are to look for outgate from our present embarrassments. If by further improvements we are enabled to keep fewer horses, and to get our harvest work accomplished by the ordinary forces required throughout the year, the saving of money and anxiety will be really important. Believing, as we do, that on every farm enormous waste of motive power, mechanical, animal, and manual, is continuously going on through the imperfection of the implements and machines now in use, we would urge upon all concerned to look well to this; for, with all our improvements, there is undoubtedly yet a large margin for retrenchment here.

Besides the bulky and costly implements now enumerated, every farm must be provided with a considerable assortment of hand-implements and tools, all of which it is of consequence to have good of their kind. Although not individually costly, they absorb a considerable capital in the aggregate. When not in use, they require to be kept under lock, and at all times need to be well looked after. Without waiting to describe these in detail, let us now see how the work of the farm is conducted.

## CHAPTER III.

### TILLAGE OPERATIONS.

When the natural green sward, or ground that has been cleared of a cultivated crop, is to be prepared for the sowing or planting of further crops, the plough leads the way in breaking up the compact surface, by cutting from it successive slices, averaging about ten inches in breadth by seven in depth, which it turns half over upon each other to the right-hand side. This turning of the slices or furrows to one side only, renders it necessary to square off the space to be ploughed into parallelograms, half the slices of which are laid the one way and the other half the other, by the going and returning of the plough. These parallel spaces are variously termed *ridges*, *stetches*, *lands*, or *feirings*, which, in practice, vary in width from a few furrows to 30 yards. When very narrow spaces are used, a waste of labour ensues, from the necessity of opening out and then re-closing an extra number of index or guiding furrows; while very wide ones involve a similar waste from the distance which the plough must go empty in traversing at the ends. The spaces thus formed by equal numbers of furrow-slices turned from opposite sides have necessarily a rounded outline, and are separated by open channels. In a moist climate and impervious soil, this ridging of the surface causes rain-water to pass off more rapidly, and keeps the soil drier than would be the case if it was kept flat. Hence the cultivated lands of Great Britain almost invariably exhibit this ridged form of surface. Until the art of under-ground draining was discovered, this was indeed the only mode of keeping cultivated ground tolerably dry. But it is at best a very defective method, and attended by many disadvantages. When land is naturally dry, or has been made so by thorough drainage, the flatter its surface is kept the better for the crops grown upon it. We are not forgetful that there are in various parts of Great Britain, clays so impervious, that probably no amount of draining or disintegration of the subsoil will render it safe to dispense with ridging. These, however, are exceptional cases, and as a rule, such a condition of soil and subsoil should be aimed at as will admit of this rude expedient of ridging being altogether dispensed with. Unless land can absorb the whole rain which falls upon it, its full range of fertility cannot be developed; for the same showers which aggravate the coldness and sterility of impervious and already saturated soils, carry down with them, and impart to those that are pervious ever fresh supplies of genial influences. Instead, then, of this perennial source of fertility being encouraged to run off by surface channels, or to stagnate in the soil and become its bane, let provision be made for its free percolation through an open stratum several feet in thickness, and then for its escape by drains of such depth and frequency as each particular case requires. When this is attained, a flat surface will generally be preserved, as alike conducive to the welfare of the crops, and to the successful employment of machinery for sowing, weeding, and reaping them.

Tillage operations.

Importance of retaining a flat surface.

In all existing treatises on agriculture, we find great stress laid on the proper formation of the ridges, careful cleaning out of the separating channels, or water-furrows, and drawing and spading out of cross-cuts in all hollows, so that no water may stagnate on the surface of the field. As thorough under-draining makes progress, such directions are becoming obsolete. But whether ridging or flat work is used, the one-sided action of the plough renders it necessary, in setting about the ploughing of a field, to mark it off into parallel spaces by a series of equidistant straight lines. Supposing the line of fence, at the side at which he begins, to be straight, the ploughman takes this as his base line; and measuring from it, erects his three or more feiring poles perfectly in line, at a distance from the fence equal to half the width of the ridges or spaces in which it is proposed to plough the field. This operation—called in Scotland *feiring* the land—is usually entrusted to the most skilful ploughman on each farm, and is regarded as a mark of honour. Having drawn a furrow in the exact line of his poles, which practice enables him to do with an accuracy truly admirable, he proceeds, using always the last furrow as a fresh base from which to measure the next one, until the field is all marked off. When this is done, it presents the appearance of a neatly ruled sheet of paper. Besides the poles just referred to, the ploughman is frequently furnished with a cross staff, by means of which he first of all marks off two or more lines perpendicular to the straight side at which he commences, and along these he measures with his poles, which are graduated for the purpose, in laying off his parallel lines. This feiring is only required when a process of fallowing, in preparation for green crop, has obliterated the former ridges. In breaking up clover lea or older sward, the ploughman begins at the open furrows, which afford him a sufficient guide.

In ploughing for a seed-bed, the furrow-slice is usually cut about five inches deep. In the case of lea, it should be turned over unbroken, of uniform thickness, and laid quite close upon the preceding one, so as to hide all green sward. The improved wheel-plough already referred to does this work very beautifully, cutting out the slice perfectly square from the bottom of the furrow, and laying it over upon one corner, so as to leave a triangular space under each slice, forming an air-drain from end to end of the ridge, which aids much in keeping the land dry, and in bringing it sooner into proper condition for harrowing in spring. The perfect

Tillage operations.

uniformity in the width and depth of the slices cut by it, permits the harrow to act equally upon the whole surface. When the slice is cut unevenly, they draw the loosened soil from the prominences into the hollows, so that one part is scraped bare, and the other remains untouched and unbroken. This must necessarily yield a poor seed-bed, and contrasts unfavourably with the uniform tilth produced by harrowing after such work as these wheel-ploughs invariably produce. In the Lothians and west of Scotland, a form of plough is much used for ploughing lea, which cuts out the slice with an acute angle at the land side. This, when turned over, stands up with a sharp ridge, which looks particularly well, and offers a good subject for harrows to work upon. But if a few of these furrow-slices are removed, the firm earth below exhibits the same ribbed appearance as the newly ploughed surface, instead of the clear level sole on which the right-sided slice cut by the wheel-plough is laid over so as to rest upon its lower angle. This ribbing of the unstirred subsoil is exceedingly objectionable in all kinds of ploughing.

In the autumn ploughing of stubble-ground in preparation for the root-crops of the following season, a much deeper furrow is turned over than for a seed-furrow. In ordinary cases, it should not be less than nine inches, while in very many, if ten or twelve can be attained so much the better. In all deep soils, this bringing up and mixing with the surface of fresh material from below, is highly beneficial. It must not, however, be practised indiscriminately. Silicious and peaty soils need compactness, and to have the soil that has been artificially enriched kept a-top. For such deep work as we have noticed above, three or even four horses are frequently yoked to the plough. When a field slopes considerably one way, it is good practice to work the plough down the slope only, and return it to the top empty. A pair of horses working in this way, will turn as deep a furrow, and get over as much ground, as three will do taking a furrow both ways, and with less fatigue to themselves and to the ploughman. After bringing a heavy furrow downhill, they get recruited in stepping briskly back with only the empty plough to draw. This mode of ploughing one furrow *down* the slope, tends less to gather the soil toward the bottom than by using a turn-wrist plough *across* the slope. It is while giving this deep autumn furrow that the subsoil-plough is used. It follows in the wake of the common plough, and breaks and stirs the subsoil, but without raising it to the surface. This is a laborious operation, and engrosses too much of the horse-power of the farm to admit of large breadths being overtaken in any one season. In all indurated subsoils, however, it repays its cost; for when once thoroughly done, it diminishes the labour of ordinary ploughings for several succeeding rotations, aids the drainage, and adds to the fertility of the soil.

The harrow, cultivator, and roller, are all more simple in their action, and easier managed than the plough. Harrowing is most effective when the horses step briskly along. The tines are then not merely drawn through the soil, but in their combined swinging and forward movement, *strike* into it with considerable force. It is with reference to this that a single application of this implement is called a *stroke* of the harrows. Rollers are used to aid in pulverizing and cleaning the soil by bruising clods, and lumps of tangled roots and earth, which the other implements have brought a-top; in smoothing the surface for the reception of small seeds, or the better operation of the scythe and other implements; and for consolidating soil that is too loose in its texture. Except for the latter purpose light rollers are much superior to heavy ones. When it is wanted, for example, to bruise clots of quickens, that the after harrowing may more thoroughly free the roots from the adhering earth, a light cast-iron roller, say of 5 cwt., drawn by one horse, effects this purpose as thoroughly as one double the weight drawn by a pair; and does it, moreover, in much less time, at less than half the expense, and without injuriously consolidating the free soil. These light rollers are conveniently worked in pairs; the ploughman driving one horse and leading the other. With a pair of active horses, and such rollers, a good deal more than *double* the space can be rolled in a day, than by yoking them both to one heavy one of the same length of cylinder. For mere clod-crushing, provided the clods are moist, the Norwegian harrow is superior to any roller: and for tightening a loose surface or checking wire-worm, serrated or smooth-edged discs, such as Crosskill's or Gibson's, are better than smooth cylinders of the same weight, so that the heavy smooth roller, requiring two or more horses to draw it, is superseded by better implements for all purposes where rollers are used at all.

As a general rule, none of these tillage operations can be performed to advantage when the soil is wet. When rain falls inopportunely there is a strong temptation to push on the field operations, before the soil has recovered the proper state of dryness. When this is done the farmer almost invariably finds in the issue that he has made more haste than good speed. Soils with a good deal of clay in their composition are peculiarly susceptible of injury in this way. Nice discrimination is needed to handle them aright. They require, moreover, a full stock of well-conditioned horses, that the work may be pushed rapidly through whenever the tide favours. To manage such soils successfully, especially when root crops are grown, tries the skill of the farmer to the utmost.

### PREPARATION OF THE LAND FOR CROPS.

Beside those simple tillage operations which are necessary in every instance of committing seeds and plants to the earth, there are more costly and elaborate processes of preparation which must be encountered in certain circumstances, in order to fit the soil for bearing cultivated crops. It is now only in exceptional cases that the British agriculturist has to reclaim land from a state of nature. The low-country farmer does occasionally meet with a patch of woodland, a bank covered with gorse or brushwood, which he sets about converting into arable land. It is in the higher districts that, from the facilities now afforded for readily enriching poor soils by portable manures, the plough still frequently invades new portions of muir and bog, and transforms them into fields. The occupiers of land in these upland districts are accordingly still familiar with the processes of paring and burning, trenching, removing earth-fast stones, and levelling inequalities of surface. In breaking up land that has been for a course of years under pasturage, paring and burning is also frequently resorted to in all parts of the country. The grand improvement of all—thorough underground drainage—is common to every district and class of soils. After all these operations have been successfully performed, and the land has been subjected to a continuous course of culture, it is found necessary, from the accumulation of weeds, or undue consolidation of the soil, to subject it from time to time to the process of *Fallowing*. We shall now notice these preparatory operations in order.

*Draining.*—From the moist climate of Britain, draining is undoubtedly the all-important preliminary operation in setting about the improvement of the soil. As this subject is treated of at large in a separate article under the title "Draining,' it is superfluous to enter here into details of the process. The facilities for carrying it out are now very great, from the excellence and cheapness of the tiles or pipes of burnt clay, which have nearly superseded every other material for the purpose of forming underground drains. So recently as

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twelve years ago, when only the common hand-moulded horse-shoe tile was in use, the writer had much difficulty in obtaining these (about $12\frac{1}{2}$ inches long by 3 wide) at 40s. per thousand, and soles at half as much more. Whereas now, beautifully moulded and well-burned pipes of 2-inch bore, and 15 in length, can be had in any quantity at 18s. per thousand. Formerly, when a large receiving or main drain was wanted, the only resource was a costly conduit built with stone; now a strong description of tiles, varying from 3 to 12 inches diameter, to suit any anticipated flow of water, can be had at very moderate prices. This improvment in the quality, and lowering of the cost of draining materials, has arisen not merely from the increased number and better construction of the kilns used in their production, but chiefly from their being moulded by machinery.

Before the introduction of tiles, covered drains were usually made of considerable depth, and were directed rather to the cutting off of springs, and intercepting the flow of water from higher to lower grounds than to the removing of redundant moisture from the whole area of a field. This was provided for by furrows, cross-cuts, and open ditches. With the use of tiles, the system of furrow draining, as it is often called, has rapidly extended. By this plan provision is made over the entire field for carrying off rain underground as fast as it falls. This is done by converting the whole furrows of the field into drains; the deeper main drains occupying the place of the ditches and cross-cuts, the shallower parallel ones that of the ridge furrows. The number of channels for the escape of the water thus remains the same, but instead of being on the surface they are sunk to depths varying from 20 inches to 4 feet, according to the nature of the soil, and are filled with tiles or pipes of a size adapted to the greatest anticipated flow of water. By such a system of draining, not the surface merely, but the entire stratum of soil and subsoil, to the depth of the drains, is at all times kept free from stagnant water and its inseparable evils. For a time these furrow drains were too generally made so shallow as not to secure the full benefits of the system. It is now known that by deeper drainage the temperature of the subsoil is considerably raised, to the great benefit of plants growing above it, and care is therefore taken to make the drains at least three feet in depth.

In executing this work, the first step is to ascertain that there is sufficient outfall to admit of the drains being cut to a proper depth. In a majority of cases, the natural flow of the water determines this point beyond any risk of mistake; but when this is not the case, recourse must be had to the spirit-level, lest money be wasted in making drains that will not run. This work can be carried on at all seasons, but is usually best done in summer or early autumn, and when the land is in grass. The digging is usually paid for by task work, and the setting of the pipes by day's wages. A thoroughly trust-worthy and experienced workman is usually selected for the latter work, with instructions to set no tiles until he is satisfied that the depth of the drains and level of the bottoms are correct. When the soil is returned into the drains, all defects are of course buried, and it therefore behoves the owner or his substitute, whether tenant or bailiff, to exercise a vigilant superintendence over draining operations. Unless carefully executed they cannot be efficient; and without efficient drainage all other agricultural operations are carried on under grievous disadvantages. The extent of land in Great Britain naturally so dry as not to need draining, is very much less than even practical farmers who have not studied the subject are at all aware of.

*Removal of Earthfast Stones.*—Newly reclaimed lands, and even those that have long been under tillage, are frequently much encumbered with earth-fast stones. This is particularly the case in many parts of Scotland. Their removal is always desirable, though necessarily accompanied with much trouble and expense. In our personal practice we have proceeded in this way. In giving the autumn furrow preparatory to a fallow crop, each ploughman carries with him a few branches of fir or beech, one of which he sticks in above each stone encountered by his plough. If the stones are numerous, particularly at certain places, two labourers, provided with a pick, a spade, and a long wooden lever shod with iron, attend upon the ploughs, and remove as many of the stones as they can, while yet partially uncovered by the recent furrow. Those thus dug up are rolled aside upon the ploughed land. When the land gets dry enough in spring, those not got out at the time of ploughing are discovered by means of the twigs, and are now dug up. Such as can be lifted by one man are carted off as they are, but those of the larger class must first be reduced by a sledge hammer. They yield to the hammer more easily after a few days' exposure to drought than when attacked as soon as dug up. Before attempting to break very large boulders, a brisk fire of dried gorse or brushwood is kept up over them until they are heated, after which a few smart blows from the hammer shivers them completely. Portions of otherwise good land are sometimes so full of these boulders, that to render them available, the stones must be got rid of by trenching the whole to a considerable depth. Should ploughing by steam-power ever become general, a preliminary trenching of this kind will in most cases be requisite before tillage instruments thus propelled can be used with safety.

*Paring and Burning* has, from an early period, been resorted to for the more speedy subduing of a rough uncultured surface. It is still the most approved method of dealing with such cases, as well as with any tough old sward which is again to be subjected to tillage. In setting about this operation, which is usually done in March or April, a turf, not exceeding an inch in thickness, is first peeled off in successive stripes by a paring-plough drawn by two horses, or by the breast-plough already described. These turves are first set on edge and partially dried, after which they are collected into heaps and burned, or rather charred. The ashes are immediately spread over the surface, and ploughed in with a light furrow. By this process the matted roots of the pasture plants, the seeds of weeds, and the eggs and larvæ of innumerable insects, are at once got rid of, and a highly stimulating top-dressing is supplied to the land. A crop of turnips or rape is then drilled on the flat, and fed off by sheep, after which the land is usually in prime condition for bearing a crop of grain. This practice is unsuitable for sandy soils, which it only renders more sterile; but when clay or peat prevails, its beneficial effects are indisputable. We shall, in the sequel, give an example of its recent successful application.

Use of levelling-box.

Land, when subjected to the plough for the first time, abounds not unfrequently with sudden hollows and protuberances, which impede tillage operations. These can be compendiously levelled by means of a box shaped like a huge dust-pan, the front part being shod with iron, and a pair of handles attached behind. This levelling-box is drawn by a pair of horses. Being directed against a prominent part, it scoops up its fill of soil, with which it slides along sledge-fashion to the place where it is to discharge its load, which it does by canting over, on the ploughman disengaging the handles.

Straightening crooked ridges.

In all parts of Great Britain, abundance of pasture land, and often tillage land also, is to be met with lying in broad, highly raised, serpentine ridges. These seem to have originated when teams of six or eight bullocks were used in ploughing; and it has been suggested that this curvature of the ridges at first arose from its being easier to turn these

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long teams at the end of each land by sweeping round in a curve than by driving straight out. The very broad headlands found in connection with these curved ridges point to the same fact. A theory still lingers among our peasantry, that "water runs better in a crooked furrow than in a straight one," and has probably been handed down since the discovered awkwardness of curved ridges was first seen to need some plausible apology. These immense, wave-like ridges are certainly a great annoyance to the modern cultivator; but still the sudden levelling of them is accompanied with so much risk, that it is usually better to cut drains in the intervening hollows, and plough aslant them in straight lines, by which means a gradual approximation to a level surface is made. We are at present engaged in preparing for turnips a field which was levelled, by cleaving down the old crooked ridges, upwards of forty years ago, and where every succeeding crop still shows, by alternate curving bands of greater and less luxuriance, the exact site of the crowns and furrows of the ancient ridges.

Trenching.

But for its tediousness and costliness, trenching two or three *spits* deep by spade or fork is certainly the most effectual means for at once removing obstructions, levelling the surface, and perfecting the drainage by thoroughly loosening the subsoil. For the reasons mentioned, it is seldom resorted to on a large scale. It is becoming a more common practice, with careful farmers, to have those patches of ground in the corners, and by the fences of fields, which are missed in ploughing, gone over with the trenching-fork. The additional crop thus obtained may fail to compensate for this hand-tillage, but it is vindicated on the ground that these corners and margins are the nurseries of weeds which it is profitable to invade and abolish.

*Fallowing.*—When, by those operations that have now been described, land has been reclaimed from its natural state, and rendered fit for the purposes of the husbandman, it is everywhere so charged with the germs of weeds, most of which possess in a remarkable degree the power of reproduction and multiplication, that it is only by the most incessant and vigorous efforts that he can restrain them from encroaching upon his cultivated crops, and regaining entire possession of the soil. He can do much towards this by ordinary tillage, and by sowing his crops in rows, and hoeing in the intervals, during the early stages of their growth. But if his efforts are restricted to such measures only, the battle will soon go against him. Besides this, all arable soils in which clay predominates, particularly when undrained, have such a determined tendency to become compact and soured, that under ordinary efforts they fail to yield a genial seed-bed. There is a necessity, therefore, for having recourse, from time to time, to that ameliorating process of lengthened tillage called fallowing. This process begins in autumn, immediately after the removal from the ground of the cereal crop, which had been sown upon the land newly broken up from clover lea, or natural sward, and extends either to the time for sowing turnips and analogous crops in the following spring, or is continued during the entire summer in preparation for autumn-sown wheat. We shall first describe that modification of the fallowing process by which the soil is prepared for the sowing of drilled green crops, and then the more prolonged form of it usually called *summer* or *naked* fallow.

The object aimed at being the thorough disintegration and cleaning of the soil, the usual practice is to begin by ploughing as deeply as is found practicable. This first or autumn furrow is accordingly turned over to a depth of 8 or 9 inches; or by using a stronger plough drawn by three or four horses, it is carried to 12 inches in depth; and in some cases, by following with a subsoil-plough in the wake of the common one, the soil is stirred to the depth of 14 or 16 inches. All cultivators are agreed as to the importance of thus deeply and effectually disintegrating all soils that are naturally dry or thoroughly drained. In the case of undrained lands, and even of very unctuous clays, although well drained, such deep stirring of the soil in autumn does but increase its capacity of retaining the rains of winter, and of being thereby more effectually soured, and is therefore to be avoided. Assuming, however, that we have to do with soil thoroughly drained and moderately friable, it is undoubtedly beneficial to loosen it deeply and thoroughly at this stage. But before this deep ploughing is set about, it will be worth while to consider well its bearing upon the cleaning part of the process. On carefully examining the fields at the time of reaping the grain crops, and from week to week thereafter, the roots of the couch-grass are found at first lying close to the surface; but instantly, on their getting the ground to themselves, they begin to send out fresh fibres, and to push their shoots deeply into the soil. In these circumstances, to proceed at once, according to the customary practice, to plough deeply, allows these weeds much time to increase, while this laborious and tedious operation is going on; and although, when performed, it gives some present check to their progress, by burying them under a mass of loosened soil, it not only increases the difficulty of their after removal, but places them out of the reach of frost, and in the best possible position for pervading the entire soil, on the first recurrence of mild weather. The consequence is, that fallows so treated are invariably found in spring more fully stocked with quickens than they were at the time of the autumn ploughing. The observation of this suggested the practice, now very common in England, of *cleaning fallows in autumn before giving the first deep furrow.* For this purpose, such implements as Biddle's scarifier, or the broad-share paring-ploughs, are set to work as fast as the grain-crops are reaped, and the whole surface is rapidly pared at a depth of two or three inches. This completely loosens the yet shallow-lying roots of the couch-grass, which are then freed from the adhering earth by the harrow and light roller, raked together and burned, or carted off. This pulverizing of the surface-soil, in early autumn, is usually followed by the springing up of an abundant crop of annual weeds, which are thus got rid of by the subsequent ploughing. So great and manifold are the advantages of this modern practice, that in those districts where it is most in use, other autumn work, even wheat-sowing, is comparatively neglected until it is accomplished. When the weeds have been got rid of in this summary and inexpensive manner, deep ploughing is then resorted to with unalloyed benefit.

Autumn cleaning.

In the case of farms that have for a lengthened period been carefully cultivated, the stubbles may be found so clean as not to require their whole area to be scarified in the manner now described. Instead of this, it may suffice to have them carefully examined, and such patches or stray plants of couch-grass, or other perennial weeds, as are met with, forked out. By this means the fallows are kept clean at little expense, and when spring arrives, those repeated ploughings, and other tedious and costly operations, are wholly avoided, in performing which, the condition of the soil is marred, and the best seed-time often missed. When fallows are thus cleaned in autumn, it is highly advantageous to cart on to them at once, and cover in with a deep furrow all the farm-yard dung that is on hand up to the completion of their first ploughing. From the length of time which must elapse before the land can again be touched, it is quite safe, or rather, it is highly advantageous, to apply all the recently made dung, although in a very rough state. In doing this, it is necessary that a person precede each plough, and trim the rank litter into the previous furrow, that it may be properly covered up and re-

Removal of weeds by forking.

Autumn manuring.

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gularly distributed. Unless this precaution is observed, the ploughs are constantly choked and impeded, the manure is drawn together into unsightly hassocks, and the whole operation is imperfectly performed. The recommendations to this practice are, *first*, An important saving of labour, for the manure being carted direct from the yard, &c. on to the land, and evenly spread over it, there is no forming, covering up, and turning, of dunghills, or refilling and carting in spring. This heavy work is accomplished at a season when time is less pressing than in spring, and the sowing of the crop can be proceeded with more rapidly when the time for it arrives, and while weather favours. *Second*, There is a saving of manure by burying it at once in its rough state, instead of first fermenting it in large heaps; and a large portion of the fallow break can thus be dressed with home-made manure. *Third*, The rough dung thus ploughed in decomposes slowly, its virtues are absorbed and retained by the soil, with the whole mass of which it is thoroughly incorporated by the spring tillage, and which, in consequence, is found, after such treatment, in a peculiarly mellow and favourable condition for receiving the seed.

The advantages of autumn cleaning and manuring of land in preparation for green crops are so great that the utmost exertions should be made to secure them. Over a large portion of England the harvest is usually so early as to leave ample time for accomplishing the cleaning process before being arrested by bad weather. From the later harvest-season and more humid climate of Scotland, it is there more difficult to carry it out to the whole extent of the fallow-break; but still, with promptitude and energy, much can be done. One of her shrewd and intelligent sons, Mr Tennant, the inventor of the grubber which bears his name, has, however, introduced a system of autumn tillage, founded upon the same principle, and accomplishing virtually the same end, but less expensive and better adapted to the climate of Scotland than that just described. So soon as the grain crops are harvested, Mr Tennant sets his light grubbers agoing, and by working them over the whole field several times, and in opposite directions, stirs the whole surface soil to the depth of six or eight inches, tears up and brings to the surface all root-weeds, where, after being knocked about and freed from adhering soil by repeated harrowings, they are left for the winter. A field thus treated presents for a time a singularly untidy and unpromising appearance; but the ultimate effects of the practice, as well in the cleaning as the disintegrating of the soil, are very remarkable. When roots of couch-grass, &c. are freed from the soil, and fully exposed to the vicissitudes of the weather, at a season when their vital force is at the lowest point, they are unable to resist its effects, and gradually die. If placed in similar circumstances in spring, with their vital energy in full play, the merest point of a root embedded in, or even in contact with pulverised soil, enables them to push down fresh fibres, to re-establish their connection with the soil, and to grow as lustily as ever. But so completely is the destruction of these pests secured by this simple process of winter exposure, that on the return of spring they may be ploughed in with impunity. Mr Tennant assures us, that ever since he adopted this practice, now twelve years ago, he has been enabled to dispense with the removal of these weeds. Having recently had an opportunity of inspecting his farm, we are enabled to testify to its cleanness and high state of fertility. On this plan, then, the cleaning of fallows is accomplished by tillage operations alone, without any outlay for raking or hand-picking, burning or carting off. Nor is this done at the expense of the pulverising part of the process. On the contrary, Mr Tennant asserts, and we have so far verified his assertion by actual experiment, that by disintegrating the soil in autumn, as is done by this grubbing and harrowing, it receives far more benefit from the alternation of frost and thaw, rain and drought, than when merely ploughed and left lying during winter in compact furrow-slices. This plan affords the same facilities as the other for autumn manuring, by raking off the weeds at once from so much of the fallow-break as it is wished to manure before winter. When the remainder is ploughed in April following, more of it may then have the farm-yard dung applied to it in the same way. Agriculturists owe a large debt of gratitude to Mr Tennant for the invention of his beautifully simple and efficient grubber, and for this scientific application of it to the fallowing process.

Mr Tennant's system of winter-fallowing.

The autumn tillage of the fallows having been accomplished in one or other of the ways described, the land is left untouched till the return of spring. If it is infested by annual weeds, it is expedient, as soon as it is dry enough to bear treading with impunity, to level and stir the surface by a turn of the harrows. This slight moving of the mellowed surface-soil induces the seeds of weeds to germinate more quickly than they would otherwise do, and thus a crop of them is got rid of by the next tilling. This preliminary harrowing is useful also in affording a level course for the tillage implements. By the time that the labour connected with the sowing of spring crops is over, the fallows are usually dry enough to be stirred with safety. This point must, however, be well seen to, as irreparable mischief is often done by going upon them too soon. And now it is, that, instead of rigidly following any customary routine of so many ploughings, harrowings, and rollings, the skilful cultivator will regulate his procedure by the actual circumstances of his soil, and the object which he has in view. What is needed for the successful growth of drilled green-crops, is to have the soil free from weeds, thoroughly disintegrated to the depth of six or eight inches, and yet moist enough to ensure the ready germination of seeds deposited in it. Where such autumn cleaning and manuring, as we have described have been successfully carried out, all that is needed in order to obtain a proper tilth, is to go to work with light grubbers, first in the line of the previous furrows and then across them, and then to harrow, roll, and remove any weeds that have been missed in autumn, after which the soil will be in the best possible condition for drilling. On friable soils, this method of performing the spring tillage by means of the grubber instead of the plough, is perfectly practicable, and has manifold advantages to recommend it. The saving of labour is very great, as a man and pair of horses will more easily grub four acres than plough one acre. Weeds are more easily removed, as the grubber pulls them out unbroken, whereas the plough cuts them in pieces. The soil that has been all winter subjected to the mellowing influences of the weather, and which, in consequence, is in the best possible condition to yield a genial seed-bed, is retained a-top, whereas ploughing buries it and brings up clods in its stead. And lastly, the soil being merely stirred, without having its surface reversed, its natural moisture (*or winter sap*) is retained, whereby the germinating of seeds sown in it becomes almost a certainty. The importance of this last point in the cultivation of such crops as the turnip, whose seeds must usually be sown during hot and dry weather, can scarcely be overrated. This practice is peculiarly appropriate for soils of loose texture, which are invariably injured by repeated ploughings. But it is also resorted to successfully on soils of the opposite extreme. Many farmers in the Lothians now grow abundant and extensive crops of turnips on strong clay soils by spreading a liberal dressing of dung on the stubble in autumn, ploughing it in with a deep furrow, leaving the land untouched until sowing-time has fully arrived, and then stirring the mellowed surface soil by the grubbers, removing weeds,

Substitution of light grubbers for the plough.

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and drilling and sowing at once without any ploughing. When this system is adopted on tenacious soils, it is prudent to operate upon portions of the field in detail; taking in only so much at a time as can be grubbed and drilled the same day, for if rain should intervene betwixt the grubbing and the drilling, the soil would set like mortar, and the tide be lost. When once the ridglets are made up in good condition, they can withstand a fall of rain with comparative impunity; and hence the occurrence of a course of fine weather, when the season is yet too early for sowing, is sometimes taken advantage of by preparing the land and making it up into ridglets, although it should require to remain in this state weeks, or even months, before sowing takes place. In such a case, immediately before sowing, the ridglets are first partially levelled by harrowing lengthwise, in order to loosen the soil and destroy annual weeds, and then again made up by using a double-breasted plough. It is sometimes objected to this system of spring-tillage, that it fails to rid the land of thistles and other tap-rooted weeds; but it is surely easier to fork these out as they appear, than to plough a whole field merely to destroy as many thistles as a man, it may be, would dig up in a day. By taking advantage of the tilth obtained by the action of the elements, instead of first ploughing down the mellowed surface, and then attempting laboriously to reduce the obdurate furrows by mechanical means, skilful and energetic farmers now succeed in preparing even tenacious soils for drilled green-crops, at little expense, and with a good measure of certainty.

On these opposite classes of soils, then—the very loose, and the tenacious—spring tillage, in preparation for root-crops, is performed to better purpose by means of the grubber than the plough. Betwixt these extremes, however, lies the most valuable class of soils—the strong fertile loams—on which the heaviest crops, and best quality of Swedes, are grown. With these it is usually expedient to have recourse to at least one spring ploughing, as soon, but only as soon, as the soil is dry enough to crumble freely to the very bottom of the furrow. As this usually occurs from four to six weeks before the time of sowing the crop, it is advisable to plough the entire field, and leave it so until rain falls, when a moderate use of the grubber, harrows, and light roller, usually suffice to produce a good tilth for ridging. When operations are not thus facilitated by a seasonable fall of rain, it is necessary to proceed somewhat differently. The field is lying as it was left by the plough, with a rough dried surface. If harrowed while in this state, an abundant crop of clods is brought to the surface, which quickly harden, when thus fully exposed to drought. To avoid this inconvenience, the field is *first* rolled with a heavy roller, and then grubbed across the direction in which it was last ploughed. By this means the clods being pressed down amongst the loose earth resist the grubber, and are crumbled by it, instead of being merely raked out and left entire on the surface, as would happen, but for this preliminary rolling. The grubbers are followed closely by harrows and a light roller, and these again by the grubbers; but this time with *seven* tines on instead of five, after which a sufficient tilth is usually obtained. All this is on the supposition that the land is clean when these spring operations are commenced; for should it be otherwise, it is usually better to begin with the grubber on the stale winter furrow, and to get rid of the weeds, before using the plough. Let it ever be borne in mind, that if the soil is cleaned, and sufficiently disintegrated, the less working it gets at this stage the better.

### SUMMER OR NAKED FALLOW.

Having thus described at length that modification of the fallowing process by which the soil is prepared for the sowing of green crops, we shall now, as proposed, speak of that prolonged form of it called a *summer* or *naked* fallow. From the facilities now afforded, by means of tile-training and portable manures, for an extended culture of green crops, this laborious and costly process, which in its day was justly regarded as the very key to good and profitable farming, is now restricted to the more obdurate clay soils, or to cases where draining and other modern improvements are neglected. The manifold advantages of having abundant crops of turnips, or mangel wurzel, instead of naked fallow, sometimes tempt the occupiers of clay soils to push the cultivation of these crops beyond due bounds. We know of cases where, after large expenditure in draining, the cultivation of turnips has been carried to such an extent, and conducted so injudiciously, that the land has got foul and soured, and its gross produce has been reduced below what it was while the land was undrained, and under a regular system of all but exclusive naked fallows. However thoroughly drained, clay soils retain their ticklish temper, and are so easily disconcerted by interference during unfavourable weather, that the preparing of them for the cultivation of root-crops, and still more, the removing of these crops when grown, is at best a hazardous business, and requires to be conducted with peculiar tact. Judicious farmers, who know by experience the difficulties that have to be overcome in cultivating such soils, are of opinion, that all that can yet be ventured upon with safety, is to prolong the period of the naked fallow's recurrence, rather than entirely to dispense with it. After a series of alternate grain and cattle crops, it is accordingly still their practice to wind up with a summer fallow, by which they rectify unavoidable defects in the tillage of preceding years, and put their land in good humour for entering again upon a fresh course of cropping.

This process is begun by a deep ploughing in autumn, in performing which the land is gathered into ridges, that it may be kept as dry as possible during winter. When the more urgent labours of the following spring are so far disposed of as to afford leisure for it, a second ploughing is given to the fallow—usually by reversing the furrows of autumn. This is followed at intervals by two cross-ploughings, which are made to reverse each other, in order to keep the land level. As it is the nature of these soils to break into lumps, under the action of the plough, rather than to crumble down, the clods thus produced get so thoroughly parched in dry weather, that root-weeds inclosed in them are killed by sheer desiccation. To further this cheap mode of getting rid of them, the land is not rolled, but stirred by the grubber and harrow as frequently as possible, so as to expose the clods freely to the drought. We know by experience that fallows can be cleaned effectually by thus taking advantage of the tendency in clay soils to bake excessively under exposure to the hot dry weather which usually prevails in June and July. Should the season happen to be a showery one, this line of tactics must needs be abandoned, and recourse had to the judicious use of the grubber, Norwegian, and common harrow, in order to free the weeds from the soil, and then to clear them off by raking or hand-picking. This is more costly, and, as we believe, less beneficial to the soil than the simple method first noticed, which should therefore be attempted in the first place. As in haymaking, much can here be done in a few favourable days, by keeping grubbers and harrows at work, and turning the clods frequently. When farm-yard dung is to be applied to such fallows, it is desirable that it should be carted on and ploughed in before July expires. In applying it, two methods are followed. That usually adopted is, after marking off the ridges, to put down the dung in small heaps, at regular distances, and forthwith to spread it and plough it in. In the other, the land is formed into ridglets, running diagonally across the

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intended line of the ridges, and the dung is enclosed in them in the manner to be hereafter described in treating of turnip culture. In either way, after the lapse of several weeks, the surface is levelled by harrowing, and the land is gathered into ridges by the last of this series of ploughings, hence called the seed-furrow. When lime is to be applied to such land, this is the stage of the rotation which is usually chosen for doing so. It is spread evenly over the surface, immediately before the last ploughing. In finishing off this fallowing process, it is necessary, on undrained lands, to be careful to clean out the ridge-furrows and cross-cuts, in anticipation of wintry rains. But if such land is worth cultivating at all, it is surely worth draining, and this operation once thoroughly performed, puts an end to all further solicitude about furrows.

## CHAPTER IV.

### SUCCESSION OF CROPS.

There are few agricultural facts more fully ascertained than this, that the growth, year after year, on the same soil, of one kind of plants, or family of plants, and the removal from it, either of the entire produce, or at least of the ripened seeds of such plants, rapidly impairs the general fertility of that soil, and, in particular cases, unfits it for bearing further crops of the kind by which it has been exhausted. The explanation of the causes of this phenomenon belongs to the agricultural chemist, or vegetable physiologist, to whom we willingly leave the task. What we have to do with is the fact itself, and its important bearing on agricultural practice. There is no natural tendency in the soil to deterioration. If at any time, therefore, the earth fails to yield its increase for the use of man, it is owing to his own ignorance and cupidity, and not to any defect in the beneficent arrangements of the Creator. The aim, then, of the agriculturist, and the test of his skill, is to obtain from his farm abundant crops at a remunerative cost, and without impairing its future productiveness. In order to this, two conditions are indispensable; 1st, that the elements of fertility abstracted from the soil by the crops removed from it be duly and adequately restored; and, 2d, that it be kept free from weeds. The cereal grains, whose seeds constitute the staple food of the human family, are necessarily the most important and valuable of our ordinary crops. The stated removal from a farm of the grain produced on it, and its consumption elsewhere, is too severe a drain upon its productive powers to admit of these crops being grown every year on the whole, or greater part of it, without speedily impairing its fertility. Supposing, however, that this waste could be at once repaired by the annual return to the soil of manure equivalent in constituent elements to the produce removed, the length of time which grain crops occupy the soil, and their habit of growth, interpose peculiar difficulties in the way of cleaning it thoroughly, either before they are sown, or while they occupy the ground. Again, although bread-corn is the most important product of our soil, other commodities, such as butcher-meat, dairy produce, vegetables, wool, and flax, are indispensably required. The economical culture of the soil demands the employment of animal power, which, to be profitably used, must be so distributed as to fill up the year. The maintenance of the working cattle, and of other live stock, implies the stated culture of a large amount of herbage and forage. Now, these varied conditions are duly met by cultivating grain and cattle crops alternately, and in about equal proportions. In carrying out these general principles, much discrimination is required in selecting the particular plants best adapted to the soil, climate, and other circumstances, of each farm; and in arranging them in the most profitable sequences. For not only is it necessary duly to alternate grain and green crops, but, in general, there is a necessity, or at least a high expediency, in so varying the species or varieties of the latter class as to prolong, as much as possible, the periodic recurrence of any one of them on the same field. In settling upon a scheme of cropping for any particular farm, regard must be had to its capabilities,—to the markets available for the disposal of its products,—and to the command of manure. When these things have been maturely considered, it is always beneficial to conduct the cropping of a farm upon a settled scheme. The number of men and horses required to work it is regulated chiefly by the extent of the fallow-break, which it is therefore desirable to keep as near to an average annual breadth as possible. When the lands of a farm vary much—as regards fertility, fitness for particular crops, and proximity to the homestead,—they must be so apportioned as to make the divisions allotted to each class of crops as equal as possible, in all respects, taking one year with another. Unless this is done, those fluctuations in the gross produce of farms which arise from varying seasons, are needlessly, it may happen ruinously aggravated; or such an accumulation of labour is thrown on certain years which may prove unfavourable ones as to weather, that the work is neither done well nor in due season. No better rotation has yet been devised for friable soils of fair quality than the well-known four-field or Norfolk system. By this course half the arable lands are in grain crops, and half in cattle crops, annually. It is indeed true, that, in the way in which this course has hitherto been usually worked, both turnips and clover have recurred so frequently (every fourth year) on the same fields, that they have become subject to disease, and their produce excessively precarious. But the excellence of this course is, that its main features can be retained, and yet endless variation be introduced in its details. For example, instead of a rigid one-fourth of the land being each year under turnips, barley, clover, and wheat, or oats, respectively, half only of the barley division is frequently in practice, now sown with clover seeds, and the other half cropped in the following year with beans, peas, potatoes, or vetches. On the same set of fields, coming round again to the same point, the treatment is reversed by the beans, &c. and clover being made to change places. An interval of *eight* years is thus substituted for one of *four*, so far as these two crops are concerned. Italian rye-grass, unmixed with any other plant, is now frequently taken in lieu of clover, on part of the division usually allocated to it, and proves a grateful change both to the land and to the animals which consume it. In like manner, instead of sowing turnips unvaryingly every fourth year, on each field, a portion of the annual division allotted to this crop, can advantageously be cropped with mangel-wurzel, carrots, or cabbages, and taking care to change the site occupied by each when the same fields again come in turn. The same end is even so far gained by alternating Swedish with yellow or globe turnips. It is also found expedient, either systematically or occasionally, to sow a field with clover and pasture grasses immediately after turnips, without a grain crop, and to allow it to remain in pasture for four years. A corresponding extent of the other land is meanwhile kept in tillage, and two grain crops in succession are taken on a requisite portion to equalize the main divisions, both as respects amount of labour and the different staple products. A closer cover of grasses and a better pasture is obtained in this way than by first taking the customary grain crop after turnips; the land is rested and invigorated for future tillage,—the outlay on clover and grass-seeds somewhat diminished,—and the land better managed for the interests of all concerned than by a rigid adherence to the customary rotation. It is common enough for landlords, or their agents, to tie down the ten-

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antry over large estates to the rigid observance of some pet rotation of their own. In an unimproved state of agriculture, and for a tenantry deficient both in capital and intelligence, such trammels, kindly enforced, may be as beneficial to them as to their landlord. But, when the culture of the soil is undertaken by men of good education, who bring to the business ample capital, and skill to use it to the best advantage, such restrictions are much more likely to do harm than good to both parties. It is to be observed, in regard to those restrictive clauses usually inserted in farm-leases,—such as, that two grain crops shall never be taken in immediate succession; that no hay, straw, or turnips, shall be sold from the farm; that only certain limited quantities of potatoes or flax shall be grown; that land shall be two or more years in grass, &c.; that they all proceed on the supposition that the farm is to maintain its own fertility. They obviously do not contemplate the stated purchase of large quantities of guano, bones, and similar extraneous manures, or the consumption by live stock of linseed-cake, grain, or other auxiliaries to the green crops produced on the farm. Now, not only are such clauses incompatible with such a system of farming as we have just now indicated, but their direct tendency, if enforced, is to hinder a tenant from adopting it even when disposed to do so. We hear now-a-days of tenants who are annual purchasers of these extraneous fertilising substances to the extent of 20s. to 30s. worth for every acre occupied by them. To enforce the same restriction on such men as on others who buy none at all, is obviously neither just nor politic; and we believe that any practical farmer, if he had his choice, would rather be the successor of a liberal manurer, however he may have cropped, than of one who has farmed by rule on the starving system. We are quite aware that, in regard to the first-mentioned of these restrictions (viz. that which forbids taking two grain crops in immediate succession), the contrary practice is still asserted by agricultural authorities to be necessarily bad farming. Now, we do not concur with this opinion, but believe, on the contrary, that when land is kept clean, and is as highly manured and well tilled as it must be to grow cattle-crops in perfection, the second successive crop of grain will usually be better than the first, its production nowise injurious to the land, and the practice, *in such circumstances*, not only not faulty, but an evidence of the skill and good management of the farmer. A frequent encomium applied to a particularly well-cultivated farm is, that "it is like a garden." The practice of market-gardeners is also frequently referred to as a model for farmers. Now, the point with them is to have every inch of their ground under crop of some kind at all seasons, and to carry everything to market. Under such incessant cropping, the fertility of the soil is maintained only by ample manuring and constant tillage. By these means, however, it is maintained, and the practice is extolled as the perfection of management. Such a system must therefore be as true in farming as in gardening when the like conditions are observed. Undoubtedly he is a good farmer, who, while keeping his land clean and in good heart, obtains the greatest produce from it at the least proportionate outlay; and it is no valid objection to his practice merely to say, that he is violating orthodox rotations.

Some curious information has been afforded regarding the effects of growing successive crops of one kind of plant on the same field, by two examples of it that have recently attracted much attention. We refer to the experiments of Mr Lawes at Rothamstead, and of the Rev. Mr Smith at Lois Weedon. It is well known that Mr Lawes has now for a number of years devoted a considerable extent of land to the prosecution of a series of interesting experiments, one field being allotted to those upon wheat, another to turnip, and another to beans. One acre in the wheat-field has now borne ten successive crops of wheat without any manure whatever. The land is annually scarified and thoroughly cleaned so soon as the crop is removed, whereupon it is ploughed and again drilled with wheat, which is then hoed in spring. Now with occasional variations due to the character of particular seasons, Mr Lawes finds that the average annual produce of this acre is 16 bushels of grain and 16 cwt. of straw, below which he has as yet failed to reduce it by ten successive crops. His soil is a strong clay loam, resting at a depth of five or six feet upon chalk. In the case of turnips, he has found that when treated in the same way they cease after a few years to grow larger than radishes, nor can he by the application of any amount or variety of manure which he has yet tried, obtain a second successive crop equal to the first. With the wheat, on the contrary, the addition of four cwt. of Peruvian guano at once doubles the produce. Mr Smith's experiments, as is well known, are a revival of Jethro Tull's system of growing wheat continually on the same field, by a plan of alternate strips of wheat and bare fallow, which are made to change places annually. He has so far improved upon Tull's practice, inasmuch as his land is thoroughly drained, and his fallow spaces are deeply trenched every autumn, as well as ploughed and hoed during the growing season. The result is, that his land thus treated, has yielded an average annual produce of 34 bushels per acre for six or seven successive crops. Now it is not our intention to offer any opinion on this as a system of wheat-growing. We refer to it along with Mr Lawes's, for the purpose of shewing that, notwithstanding the prevalent opinion that grain crops exhaust the fertility of soils more rapidly than green crops, this is true only in a very restricted sense. Green crops judiciously interposed do undoubtedly serve a most important purpose in the means which they furnish for maintaining the fertility of a farm, but it is worthy of note, that whereas by the addition of suitable manure, thorough tillage, and diligent removal of weeds, clay soil at least will stand an indefinite succession of grain crops, the same means entirely fail to yield the same results with our most popular green crops. Our personal experience quite accords with this; for we suppose it will be admitted, that the corn crops of the country are at the present day superior both in quality and quantity to these of any preceding period; whereas potatoes, turnips, and clover, which we have so long regarded as our sheet anchor, have become increasingly precarious, and threatened to fail us altogether. We offer these facts for the consideration of those who out-and-out condemn the practice of sowing two white crops in immediate succession. In stating this opinion, we must, however, guard misapprehension. Unless the land is highly manured and kept thoroughly clean, we are just as much opposed to the practice as any one can be; but when mischief is done by it, we believe that it is due rather to the presence of weeds than to the second grain crop. Neither do we plead for the absolute removal of restrictive clauses from farm leases. Human nature being what it is, men who do not see it to be for their own advantage to farm well, will, through ignorance or greed, impoverish their land unless they are restrained. Clauses as to cropping should, however, be prohibitory rather than prescriptive—have reference rather to what is removed from the farm than to what is grown upon it—and they should be contingent upon the other practices of the tenant. So long as he continues by ample manuring and careful tillage to maintain the fertility and general good condition of the farm rented by him, it can be no advantage to his landlord to hinder him from cropping it at his own discretion. It will be seen from these remarks, that we attach more importance to those general principles which should regulate the succession of crops, than to the laying down of formulæ to meet supposed cases. The man who cultivates by mere routine, is unprepared for emergencies, and is sure to lag in the race of improvement; while he who studies principles is still guided by them, while altering his practice to suit changing circumstances. Illustrations of this will be found in our closing notices of the farming of selected districts.

## CHAPTER V.

### MANURES.

In our remarks on tillage operations, and on the succession of crops, we have seen how much the practice of the husbandman is modified by the kinds and amount of manures at his disposal. In describing the crops of the farm and their culture, frequent reference will also necessarily be made to the use of various fertilising substances; and we shall, therefore, before proceeding to that department of our subject, enumerate and briefly remark on the most important of them. In such an enumeration, the first notice is unquestionably due to

*Farm-Yard Dung.*—This consists of the excrements of cattle, their litter, and the refuse of their fodder; usually first trodden down in successive layers, and partially fermented in the farm-yard, and then removed to some convenient place and thrown together in heaps, where, by further fermentation and decay, it is reduced to a dark-coloured, moist, homogeneous mass, in which state it is usually applied to the land. It is thus the residuum of the whole products of the farm, *minus* the exported grain, and that portion of the other crops which, being first assimilated in the bodies of the live-stock, is sold in the form of butcher-meat, dairy-produce, or wool. In applying farm-yard dung to land there is thus a returning to it of what it had previously produced, *less* the above exceptions, and such waste as may occur during the process of decay by gaseous exhalation or liquid drainage. It is obvious that the value of such dung as a fertilising agent must depend much on two circumstances; viz., 1*st*, the nature of the food consumed by the animals whose excrements are mingled with it; and 2*d*, the success with which waste from drainage and exhalation has been prevented. When cattle used during the winter months to be barely kept alive on straw and water, and were confined in an open yard, which, in addition to its own share of rain, received also the drip from the eaves of the surrounding buildings—which, after percolating the litter, flowed unchecked into the neighbouring ditch—it is needless to say that the dung resulting from such a process was all but worthless. It is much to be regretted that, from the faulty construction of farm-buildings, farmers still find it impossible to guard their dung-stores from injury and waste. When cattle-yards are slightly hollowed towards their centre, and the surrounding eaves are spouted, the litter absorbs the whole of the urine and the rain which falls upon the uncovered area, while the treading of the cattle goes far to prevent undue fermentation and escape of gases. The same remark applies still more strongly to covered boxes, the dung resulting from this mode of housing fattening cattle being of the best quality. In the case of byres and stables it is certainly desirable to have a covered depot, into which the litter and solid excrements may be wheeled daily, and to have the urine conveyed by proper drains and distributed over this mass of solid matter. As there is usually more liquid than these can at once absorb, it is well to have a tank at the lowest part of this depot in which to store the surplus, that it may from time to time be returned upon the adjoining mass, or conveyed to heaps in the fields. Advantage is usually taken of frosty weather to cart out to the fallow division of the farm the dung that was accumulated in yards and boxes. It is formed into large square heaps about four feet deep, in situations most convenient for ready application to the land when the season for sowing the crops arrives. It is desirable to prepare a site for these heaps by carting together and spreading down a quantity of earth (or peat, when that can be got), for the purpose of absorbing the ooze from the fermenting mass laid upon it. At the beginning of winter, the loaded dung-carts are driven on to the heaps, and their contents are spread evenly over it, layer above layer, both to equalise the quality of the dung-heap as a whole; and, by the compression thus applied, to prevent a too rapid fermentation. When the heap has attained the requisite bulk, a covering of earth or peat is spread over it to keep it moist, and to prevent the escape of its ammonia. When this home-made manure was the only kind statedly at the command of the farmer, it was considered necessary, and we believe truly, to have it in an advanced state of decomposition before putting it into the turnip-drill. There was a waste of manure by this practice, but unless it was in a state to supply instant nourishment and stimulus to the young turnip plants, the crop was certain to be a deficient one. The application, along with farm-yard dung, of guano, superphosphate of lime, and other portable manures, quite does away with the necessity of having the former much rotted. These concentrated manures stimulate the growth of the plants during their early stage, and put them in the best condition for making gradual use of the slowly dissolving dung. Excessive decomposition of farm-yard dung is now therefore avoided, and pains rather bestowed to improve its quality by protecting it from the weather, and retaining its ammonia and natural juice. The cheapest, and perhaps also the best, way of doing this is to cart the dung direct from the cattle-yards to the fields, and at once to plough it in.

*Liquid Manures.*—We have spoken of the importance of carefully retaining the urine of the housed live-stock, by having it absorbed in the solid matter of the dung-heap, and of collecting the surplus into a suitable tank, where it may be available for moistening the heap from time to time, and especially when about to be applied to the land. A system has, however, recently attracted much notice, by which pains are taken not only to preserve every drop of urine and ooze from dung-heaps, but, as far as practicable, to apply the whole manure produced on the farm in a liquid form. It is in Ayrshire, and especially on the farm of Myremill, that this system has been carried out most fully. Our reference will be best explained by quoting at length from the "Minutes of Information" issued by the General Board of Health regarding sewage manure.

"The next farm visited was in the immediate vicinity of Glasgow, where the supply of liquid manure is derived from another source, and distributed in a different manner. The supply is from a dairy of 700 cows, attached to a large distillery: the entire drainage from the former flows in a full continuous stream into a tank containing 30,000 or 40,000 gallons, whence it is pumped up immediately by a 12-horse power engine, and forced through 4-inch iron pipes, laid about 18 inches under ground, into large vats or cisterns placed on the highest points of the land to be irrigated. From these it descends by gravitation through another system of pipes laid along the ridges of the hills, finding an outlet through stand-cocks placed at intervals, from which it is distributed through moveable iron pipes fitting into each other, and laid along the surface in whatever direction the supply is required. The land thus irrigated consists of three farms lying at some distance apart, the farthest point to which the liquid is conveyed being about two miles, and the highest elevation 80 feet above the site of the tank and engine. The principal use to which the irrigation has been applied has been to preserve the fertility of the pastures, the general appearance of which was at first rather disappointing, but this was explained by the fact that they are fully stocked, and that the cows rush with avidity to those parts that have been last irrigated, and eat them down

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quite bare. As is the case in other instances, however, by far the most profitable application has been found to be Italian rye-grass, of which 15 (Scotch) acres were under cultivation, some with seed supplied by Mr Dickinson, whose successful cultivation of it by similar means near London has long been known. The first cutting of this had yielded about ten tons the acre, the second nine, and the third, which was ready for cutting, was estimated at eight or nine more. Some crops of turnips and cabbages were pointed out to us in a state of vigorous growth, and with more than common promise of abundance; these were raised by a dressing of ashes and refuse (of little fertilising value, having been purchased at 2s. 6d. a ton), conjoined with four doses of liquid, one after the preceding crop of oats had been carried, one prior to sowing, and two more at different stages of growth. The enterprising gentleman who has carried out these works at his own expense, and in spite of the discouragement arising from partial failure in his earlier attempts, though speaking cautiously, as was natural in a tenant on a nineteen years' lease, of the pecuniary results of this undertaking, imparted some facts which leave little doubt that it must have been largely remunerative. Besides maintaining, if not increasing the fertility of the pastures, to which the solid manure from the byres was formerly devoted, at a heavy expense of cartage (the whole of which is now saved), he is enabled to sell all this manure of which we estimated the quantity at about 3000 tons a-year at 6s. a-load. For a good deal of the Italian rye-grass not required for his own consumption, he obtained upwards of 13s. a ton, the profit on which, taking into account the yield before stated, may easily be imagined. Thirteen carts, each containing six barrels of ten gallons each, are used to convey the milk to market, where it is sold at 5d. the Scotch pint, equal to six pints imperial measure. The income from milk would, therefore, be not less than L.43, 6s. 8d. per day, or L.15,816, 13s. 4d. per annum.

"The next place visited was the farm of Myre Mill, near Maybole, in Ayrshire, the property of Mr Kennedy, who adopted and improved on the method of distribution just described. On this farm, about 400 imperial acres of which are laid down with pipes, some of the solid as well as the liquid manure has been applied by these means, guano and superphosphate of lime having been thus transmitted in solution, whereby their value is considerably enhanced. This is especially the case with guano, the use of which is thus rendered in great measure independent of the uncertainties of climate, and it is made capable of being applied with equal advantage in dry as in wet weather. In some respects the farm labours under peculiar disadvantages, as water for the purpose of diluting the liquid has to be raised from a depth of 70 feet, and from a distance of more than 400 yards from the tanks where it is mixed with the drainage from the byres. These tanks are four in number, of the following dimensions respectively:—$48 \times 14 \times 12$; $48 \times 14 \times 15$; $72 \times 14 \times 12$; $72 \times 17 \times 12$. They have each a separate communication with the well from which their contents are pumped up; which are used in different degrees of 'ripeness,' a certain amount of fermentation induced by the addition of rape-dust being considered desirable. The liquid is diluted, according to circumstances, with three or four times its bulk of water, and delivered at the rate of about 4000 gallons an hour, that being the usual proportion to an acre. The quantity to be applied is determined by a float-gauge in the tank, which warns the engineer, whose business it is to watch it, when to cut off the supply, and this is a signal to the man distributing it in the field to add another length of hose, and to commence manuring a fresh portion of land. The pumps are worked by a 12-horse power steam-engine, which performs all the usual work on the farm, thrashing, cutting chaff and turnips, crushing oil-cake, grinding, &c., and pumping. The pipes are of iron; mains, submains, and service pipes, five, three, and two inches in diameter respectively, laid eighteen inches or two feet below the surface. At certain points are hydrants to which gutta-percha hose is attached in lengths of twenty yards, at the end of which is a sharp nozzle with an orifice ranging from one to one and a-half inch, according to the pressure laid on, from which the liquid makes its exit with a jet of from twelve to fifteen yards. All the labour required is that of a man and a boy to adjust the hose and direct the distribution of the manure, and eight or ten acres may thus be watered in a day. There are now 70 acres of Italian rye-grass, and 130 of root crops on the farm. The quantity they would deliver by a jet from a pump worked by a 12-horse steam engine, would be 40,000 gallons, or 178 tons per diem, and the expense per ton about 2d., but a double set of men would reduce the cost. The extreme length of pipe is three-quarters of a mile, and with the hose the total extent of delivery is about 1,900,000 yards, or 400 acres. To deliver the same quantity per diem, by water-carts to the same extreme distance, would be impracticable. One field of rye-grass sown in April, had been cut once, fed off twice with sheep, and was ready (August 20th) to be fed off again. In another, after yielding four cuttings within the year, each estimated at 9 or 10 tons per acre, the value of the aftermath for the keep of sheep was stated at 25s. an acre. Of the turnips, one lot of Swedes dressed with 10 tons of solid farm manure, and about 2000 gallons of the liquid, having six bushels of dissolved bones along with it, was ready for hoeing 10 or 12 days earlier than another lot dressed with double the amount of solid manure without the liquid application, and were fully equal to those in a neighbour's field which had received 30 loads of farm-yard dung, together with 3 cwt. guano and 16 bushels bones per acre; the yield was estimated at 40 tons the Scotch acre, and their great luxuriance seemed to me to justify the expectation. From one field of white globe turnips sown later, and *manured solely with liquid*, from 40 to 50 tons to the Scotch acre was expected. A field of carrots treated in the same manner as the Swedes, to which a second application of liquid was given just before thinning, promise from 20 to 25 tons the acre. Similarly favourable results have been obtained with cabbages; and that the limit of fertility by these means has not yet been reached, was clearly shown in one part of the Italian rye-grass which had accidentally received more than its allowance of liquid, and which showed a marked increase of luxuriance over that around it. The exact increase of produce has not been accurately determined, but the number of cattle on the farm has increased very largely, and by means of the Italian rye-grass at least *four* times as many beasts as before can be kept now on the same extent of land, *the fertility of the land being at the same time increased*. This plant, of all others, appears to receive its nourishment in this form with most gratitude, and to make the most ample returns for it; and great as are the results hitherto obtained, I believe that the maximum of productiveness is not yet reached, and that the present experiment must be carried yet further before we know the full capabilities of this manure. Of one important fact connected with this crop, I am assured, that notwithstanding the rank luxuriance of its growth, animals fed upon it, not only are not scoured, but thrive more than on any other kind of grass in cultivation.

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"Taking into the irrigation account the whole cost of the engine, and the whole of the fuel and wages—although half of these might have been deducted—the following appears to be the capital account and working expenses for fertilising Myre Mill farm:—

| | | | |
|---|---|---|---|
| Tanks complete | £300 | 0 | 0 |
| Steam-Engine | 150 | 0 | 0 |
| Pumps | 80 | 0 | 0 |
| Iron Pipes, laying, and hydrants | 1000 | 0 | 0 |
| Gutta-Percha, distributing pipes, &c. | 56 | 0 | 0 |
| | £1586 | 0 | 0 |
| Annual interest on £1586, and wear and tear, at $7\frac{1}{2}$ per cent. | £118 | 19 | 0 |
| Annual Wages | 104 | 0 | 0 |
| Fuel | 58 | 0 | 0 |
| | £281 | 19 | 0 |

This amount divided by the number of acres, is equal to the annual sum of 14s. per acre.

"I now come to the practical results of so cheap a mode of fertilising land.

"Mr Young informed me that in one of the fields he had

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himself measured the growth of Italian rye-grass, and had found it to be two inches in twenty-four hours; and that within seven months, Mr Kennedy had cut from a field we were passing at the time 70 tons of grass per acre. Where the whole is cut, four or five heavy crops are thus taken; but upon some of the land during the last two years 20 sheep to the acre have been penned in hurdles, and moved about the same field from time to time; after each remove the fluid has been applied, and immediately followed by an abundant growth of food. There is not the slightest appearance of exhaustion in the land,—its fertility appears to increase. I was informed that, before the liquid manure was used, the land would not keep more than a bullock or five sheep to the acre; now it will maintain, if the crops are cut and carried in, five bullocks or twenty sheep to the acre. Some beans, bran, and oil-cake are bought for the stock; but, on the other hand, one-third or more of the farm is kept in grain, notwithstanding the great number of live stock.

"*Canning Park.*—Mr Telfer's farm, near Ayr. This is a small dairy farm of 40 acres, near the level of the sea, and about a mile and a-half west of the town of Ayr. The subsoil is beach gravel with a slight admixture of clay. Water is too abundant. It lies dead within about 20 inches of the surface, and in winter nearer than that.

"No bedding or litter is used here. The cows lie on cocoa-nut mats. The ventilation is perfect; and the air sweeter than in the majority of the dwelling-houses of human beings.

"The following appears to be the cost of carrying out the system at Mr Telfer's farm:—

| | | | |
|---|---|---|---|
| "Tank | £30 | 0 | 0 |
| Engine | 60 | 0 | 0 |
| Iron pipes and hydrants | 100 | 0 | 0 |
| Distributing hose-pipe, &c | 20 | 0 | 0 |
| | £210 | 0 | 0 |

| | | | |
|---|---|---|---|
| "Annual interest on £210, and wear and tear at 7½ per cent | £15 | 15 | 0 |
| Wages and fuel | 11 | 0 | 0 |
| | £26 | 15 | 0 |

"In summer the cows have a quantity of oil-cake, as well as grass; and in winter they have turnips or mangel-wurzel, bean, or barley meal, and cut hay or grass; the whole mess being steamed together. Miss Bell, the cousin of Mr Telfer, manages the dairy, and said that last year the hay bought would amount to from £30 to £40, and she should think the grain to not less than £200. In general terms, the other food is produced upon the farm. As to the produce of grass, which is the chief article, the first cutting during the present year was in the latter end of March about 18 inches thick. The second was from 18 inches to 2 feet thick. The third was from 3 feet to 4 feet 6 inches thick. The fourth nearly the same. The fifth was 2 feet thick; and the sixth, in process of cutting at the time I was there, we measured at 18 inches thick. Taking the mean, where two dimensions are given for the same crop, I find the aggregate depth of grass, grown and cut off this farm within seven months, to be not less than 14 feet 3 inches. All this is, however, eaten upon the premises, and the whole marketable produce of the farm is represented by the milk and butter.

"As to the quantity and value of these, Miss Bell stated, that the previous week the butter was 114 lb. and 120 lb.,—together 234 lb. sold at 1s. per pound. This, she stated, was about the average quantity and price. The amount for butter would therefore be £11, 14s. per week, or per annum L.608, 8s. She informed me farther, that during about eight months in the year, the cold milk realises about the same amount as the butter. In the summer months, during hot weather, the market value of the milk is only about half that of the butter. From these data, the amount for milk sold per annum is £507.

"The total receipts for the two articles of milk and butter amount to £1115, 8s. per annum.

"I only need to add that, previously to the adoption of the present system of farming, these 40 acres of land were barely sufficient to support eight or nine cows, and would have been well let at a rental of 30s. an acre."

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The attention now so generally directed to this subject, and the importance attached to it in many quarters, justify this lengthened quotation, and call for some remarks upon it. We have carefully examined two of the instances referred to in this report, viz., Port Dundas and Myre Mill; and some smaller experiments more cursorily. After doing so we are sorry to say that we have arrived at a very different estimate of this system of manuring from that expressed in the above quotations. We at once, and with pleasure, acknowledge that in so far as concerns the storing up and preparing of the liquid manure, its application to the land, and the production, by means of it, of crops of Italian rye-grass almost surpassing belief in their luxuriance and weight of produce, Mr Kennedy's experiments have been crowned with complete success. The excellence of this grass as food for live stock, and their relish for it is also indisputable. Neither do we dispute the statements of those, who tell us that manure when largely diluted with water, and properly applied in the liquid form, is more beneficial to plants, than in any other way in which it can be presented to them. Admitting all this, the question remains, has it yet been shown that this system can be economically applied to ordinary farms. Data are still wanting from which to answer this question conclusively, but we shall state some of the reasons which constrain us, as presently advised, to do so in the negative.

Supposing an adequate motive power already to exist, and to be partly employed for other purposes, the capital that must be invested in providing the tanks and other apparatus necessary for carrying out this system, amounts to about L.4 per acre over a farm of average extent. If the system be a sound one, the great amount of this outlay cannot fairly be urged as an objection to it. The addition of a permanent rent charge of 5s. per acre to an entire farm, for a benefit which in any one year can be available to but a limited portion of it, is however a serious matter. In each case referred to in the "Minutes of Information," the whole annual charge, whether arising from interest on capital, wear and tear of machinery, or working expenses, is divided by the whole acreage of the farm. In the first seven cases given in the tabular statement,[1] this mode of calculation is correct, as the whole areas do actually benefit each year by the irrigating process. But when we come to those irrigated by machinery, we find that a half or two-fifths only of the land receives the benefits of it in any one year. If the annual charge in this latter class of cases is divided by the acreage actually irrigated, it becomes evident that the expense is double that of the Pusey meadows, and equal to that of the old meadows near Edinburgh, instead of being less as it is made to appear. Again, in estimating the profits, an opposite course is followed. While the charges are made to appear less by spreading them over the whole area of the farm, the enormous produce of grass from the irrigated parts is put prominently forward, and little is said about its produce as a whole. In the dairy cases too, we are told of enormous gross profits, without being pointedly reminded that the larger portion of the keep of the cows, such as distillery offal, bean-meal, hay, and even straw and turnips, is actually purchased; that in this way a quantity of extraneous manure becomes available for the associated farm, sufficient (however applied) to maintain it in a state of fertility; and that there would be handsome profits from the dairy, irrespective of the farm altogether. In fact, town dairies usually

[1] See next Page.

Table No. II., *Shewing Cost, &c., of the Application of Sewerage Waters and Liquid Manures.*

| Name of Place. | No. of English acres. | Mode of Application. | Cost of Works and Apparatus. L. s. d. | Annual Interest, &c., at $7\frac{1}{2}$ per cent. L. s. d. | Annual Working Expenses. L. s. d. | Total Annual Charge per English acre. L. s. d. | OBSERVATIONS. |
|---|---|---|---|---|---|---|---|
| *Edinburgh.* | | | | | | | |
| Craigentinny Meadows. | 63 | Steam-engine, pumps, and open gutters and panes, .... | 2000 0 0 | 150 0 0 | 117 12 0 | 4 4 11 | Average rental upwards of L.16 per English acre. |
| High level. Sea Meadows. | 38 | Gravitation, open gutters & panes, | 700 0 0 | 52 10 0 | 19 17 6 | 1 18 1 | Worthless 25 years ago, now worth about L.520 per English acre. |
| Old Meadows. | 228 | Gravitation, open gutters & panes, | 2700 0 0 | 202 10 0 | 119 5 0 | 1 8 $2\frac{1}{2}$ | Maximum rental, L.25 per English acre. |
| *Nottinghamshire.* | | | | | | | |
| The Duke of Portland. Clipstone Meadows. | 300 | Catchmeadow, gravitation, and open gutters, ................ | 36,000 0 0 | 2700 0 0 | 150 0 0 | 9 10 0 | Previously worth from 3s. to 5s. per acre per annum, now worth upwards of L.12. |
| *Wiltshire.* | | | | | | | |
| Wiley Meadows. | 150 | Beadwork of ridge and furrow, gravitation and open gutters, | 3000 0 0 | 225 0 0 | 52 10 0 | 1 17 0 | Four heavy crops of grass per annum. |
| *Devonshire.* | | | | | | | |
| The Duke of Bedford. Tavistock Meadows. | 90 | Beadwork and catchmeadows, gravitation and open gutters, | 1183 0 0 | 88 14 6 | 67 10 0 | 1 14 $8\frac{1}{2}$ | Land more than quadrupled in value after only 4 years irrigation. |
| *Berkshire.* | | | | | | | |
| Philip Pusey, M.P. Pusey Meadows. | 100 | Catchmeadow, gravitation, and open gutters, ................ | 445 0 0 | 33 7 6 | 37 18 4 | 0 14 3 | Land not previously worth more than 5s. per acre, is now yielding six heavy crops of grass per annum. |
| *Glasgow.* | | | | | | | |
| Mr Harvey's farm. | 508 | Steam-engine, pumps, underground iron main pipes, and iron distributing pipes,...... | 1450 0 0 | 108 15 0 | 240 10 0 | 0 13 9 | 10 feet thick of grass cut from an acre in six months. |
| *Ayrshire.* | | | | | | | |
| Myre Mill farm. | 508 | Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet pipe,... | 1586 0 0 | 118 19 0 | 162 10 0 | 0 11 1 | 70 tons of grass cut from an acre in six months. |
| Canning Park farm. | 50 | Ditto. | 210 0 0 | 15 15 0 | 11 0 0 | 0 10 $8\frac{1}{2}$ | $14\frac{1}{2}$ feet of grass cut in seven months. |
| Leg or Dunduff farm. | 50 | Gravitation, underground iron mains, gutta-percha hose, & jet pipe,........................ | 191 0 0 | 14 6 6 | 3 10 0 | 0 7 $1\frac{1}{2}$ | 12 stacks per annum previously; 80 stacks last year. |
| *Staffordshire.* | | | | | | | |
| The Duke of Sutherland. Hanchurch farm near Trentham. | 83 | Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet pipe,... | 520 13 4 | 39 1 0 | 18 6 0 | 0 13 $9\frac{3}{4}$ | Tanks constructed sufficient for 300 acres. |
| *Lancashire.* | | | | | | | |
| Halewood farm. | 120 | Ditto. Ditto. | 521 12 0 | 39 2 5 | 19 15 2 | 0 9 $9\frac{3}{4}$ | One dressing of liquid equal to 25 or 30 tons of farm-yard manure per acre. |
| *Cheshire.* | | | | | | | |
| Lescard farm. | 150 | Ditto. Ditto. | 672 1 10 | 50 8 0 | 17 11 0 | 0 9 $8\frac{3}{4}$ | A fourth crop of grass being weighed, was found equal to 10 tons per acre. It was the lightest crop cut off the same land. |
| *Glamorganshire.* | | | | | | | |
| Porth Kerry farm. | 50 | Gravitation, underground iron mains, gutta-percha hose and jet pipe,.................. | 300 0 0 | 22 10 0 | 0 10 0 | 0 13 0 | Tanks constructed sufficient for 300 acres. Between 9 and 10 feet of grass cut. |

Manures. have no land attached to them. The cows are maintained solely by purchased food, and the sale of manure, liquid and solid, forms one of the stated items of income. In Mr Harvey's and similar cases, two separate businesses are in fact mixed up, and yet the whole is spoken of in such a way as if the profit was mainly due to the use of liquid manure. Indeed the whole of these "Minutes of Information," issued by the General Board of Health, have an air of special pleading about them, which to us seriously detracts from their value.

The entire annual cost of applying manure in this manner is stated to amount to from 10s. to 14s. per acre for the whole extent of the farm. Now this would suffice to provide annually from 1 to 1½ cwt. of Peruvian guano (even at its present high price) for every acre of the farm, or from 2 to 3 cwt. per acre, if applied, as the liquid is, to the portion under green crop only. The stated application of such a dressing of guano, in separate portions, and during showery weather, will be found to yield results little inferior to those obtained by the use of liquid manure. To do this requires no costly apparatus, or permanent sinking of capital, and its application can be desisted from at any time when found unremunerative. The adoption of this plan of applying the liquid manure of the farm necessarily demands that the whole system of management be accommodated to it. In order to furnish this liquid manure, the whole green crops must, summer and winter, be conveyed to the homestead, and there consumed in such a manner as that the urine and dung of the animals fed upon it may be scoured into the tanks. It is no such easy matter to replenish these tanks as some persons seem to think. When cattle are housed in boxes or properly protected yards, the whole of the urine is absorbed by the litter, and goes to the field in the dung-cart. This is certainly a more expensive way of conveying it to the fields than by pipes. But then, as in the new system, the urine, &c. is diluted with at least three times its volume of water, there are 4 tons of manure to convey on the one plan for one on the other. Even where pipes are used, all the litter, and a portion at least of the dung has still to be carted out, so that no claim of a saving of carriage can validly be put forward on behalf of this system; but its merits must be grounded solely on the superior efficacy of manure, when applied in a liquid instead of a solid form.

In the case of dry and loose soils, the consuming of the turnip crop, by folding sheep upon it, has hitherto been regarded as at once the cheapest way in which it can be converted into wool and mutton, and the land consolidated and enriched, so as to fit it for producing grain and other crops. On tenacious soils, and in a moist climate, which is quite the case at Myre Mill, it is certainly impracticable to pursue this system in winter. It is perhaps also the case that sheep are healthier, fatten more rapidly, and yield more wool, when fed under cover, than when folded on the open turnip field. Admitting all this, however, we are disposed to think that these benefits are better secured by Mr Randell of Chadbury's plan of littering the pens with burnt clay, which keeps the sheep clean, and their feet in good order, and, when mingled with their urine and dung, forms a most valuable manure for any kind of land. Were this carried out by means of moveable covered pens, which could be erected and easily shifted from place to place in the turnip field, the carriage of the turnips and manure would be greatly reduced, especially if accomplished by means of the portable railway.

In the case of dairies near towns, where the cows are largely fed on brewery or distillery offal, and other purchased food, the circumstances are totally different from those of ordinary farms, depending solely on their own resources. The liquid manure that would otherwise run to waste, when thus applied, is so much clear gain, in so far as the value of the increased produce exceeds the cost of application. It may form a wholesome caution to some persons, to mention here that, notwithstanding all that has been written about the success of the spirited operations at Port-Dundas, we were recently told by Mr Harvey, that so dubious is he still about it, that if the thing were to do again, he would rather keep his money in his pocket, and let the urine run into the canal, as formerly. If there is doubt even in such a case, how much more when the manure must virtually be purchased. And this leads us to remark that we have better hopes of the ultimate success of this plan of manuring, when it is restricted to the application of the surplus liquid manure of the homestead to some piece of meadow near at hand, supplementing this supply, when necessary, by dissolving guano in water, and sending it through the pipes. These remarks apply even more strongly to the sewage from towns. The liquid, in this case, is highly charged with fertilising ingredients of the most valuable kind, seeing that it consists largely of night-soil from a population consuming much animal food. With few exceptions, this valuable liquid, which flows in such quantities from all our towns, is not only utterly lost, but is a grievous nuisance, by polluting our streams, and generating disease. In applying it as manure, the expense lies entirely in providing and working the necessary apparatus. In such cases, then, with an unfailing supply of highly fertilising liquid, costing nothing to begin with, there is every inducement to put into operation any plan by which it can be economically applied to field crops. The enhanced value of green forage in the vicinity of towns is an additional motive for attempting this. It is gratifying to think that this important problem (the profitable disposal of town sewage) is in a fair way of being satisfactorily solved. Manures.

The ingenuity and enterprise displayed by Mr Kennedy and others, in their endeavours to cheapen by this means the cost of farm produce, and the frankness and untiring patience with which they have shown and explained their proceedings to the unceasing stream of visitors, which the novelty of the operations has attracted from all parts of the kingdom, and even from foreign countries, are altogether so admirable and praiseworthy, that it requires no slight effort to speak of them otherwise than approvingly. The confidence with which various influential parties are proclaiming the complete success of this scheme of irrigation, and recommending it for general adoption, seems, however, to require that those who have examined it, and arrived at an opposite conclusion, should publicly say so.

It is unreasonable to expect that private parties are to divulge their whole business affairs; and yet, without a full *Dr.* and *Cr.* account for some ordinary arable farm treated on this system, it is impossible to arrive at a sound judgment on its merits. Until this can be done, it would be better to abstain from publishing partial statements, which tend only to mislead the public mind. We offer these remarks in no spirit of hostility to this new system of farming. We shall rejoice unfeignedly to find that our opinion of it is erroneous, and that it really warrants the sanguine expectations which some parties entertain regarding it. We simply maintain that as yet the case is "not proven," and our counsel to those who are disposed to try it is, not to embark in it to an extent that would embarass them, if, as we fear, it should prove a failure.

*Guano.*—Next to farm-yard manure, which must ever be looked to as the chief means of maintaining the fertility of a farm, guano claims our notice. This substance is the dung of sea-fowl, and is found on rocky islets in parts of the world where rain seldom falls. The droppings of the myriads of birds by which such places are frequented, have in many cases been permitted to accumulate during untold ages, and are now found in enormous deposits. The principal supply,

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both for quantity and quality, has hitherto come from the Chincha Islands on the coast of Peru. The introduction of this powerful and exceedingly portable manure has given a prodigious impetus to agricultural improvement. It is but ten years since a few casks of this article were brought to Liverpool from Peru, where it has been known and prized as a valuable manure from the remotest periods. No sooner had its value been discovered by our British agriculturists than the demand for it became most eager, and so greatly has the consumption already increased, that the importation during 1851 reached to 150,000 tons. The price at which it was sold at first was L.20 per ton, from which, with increased supplies it fell to L.11, when the discovery in 1844 of a considerable deposit on the Island of Ichaboe on the coast of Africa at once reduced the price to L.9. To shew the rate and extent of the increase in its consumption, we here give a table of imports.

"A Parliamentary paper issued on the motion of Mr Scholefield shews that the imports of guano were 2881 tons in 1841; 20,398 in 1842; 3002 in 1843; 104,251 in 1844; 283,300 in 1845; 89,203 in 1846; 82,392 in 1847; 71,414 in 1848; 83,438 in 1849; 116,925 in 1850; and 243,016 in 1851."

The Chincha deposit being the property of the Peruvian Government, is sold for their behoof through the medium of one British mercantile firm, Messrs Gibbs, Bright, & Co., and is thus a close monopoly, the holders of which regulate the price and the supply to suit their own interests. The price charged for quantities of 30 tons and upwards has for several years been L.9, 5s. per ton. Were the price lowered to L.5 or L.6 there can be no doubt that the consumption would at once be doubled. Discoveries have recently been made of other deposits on the Peruvian and African coast, and in Australia. The quality of both of the latter is much inferior to that from Peru. It is in a more advanced state of decay, and contains more moisture and sand. The value of that from Peru depends chiefly on the large amount of ammonia (about 18 per cent. in average samples) which it contains. Even at L.9, 10s. per ton, the price at which it is usually retailed, it is the cheapest form in which ammonia can be purchased. Guano is largely used as a manure for most of our field crops, but chiefly for turnips. The quantity applied per acre ranges from two to four cwt. It is most economically used in combination with other manures, as we shall have occasion to show when treating of turnip culture. The dung of birds, from its including both liquid and solid excrements, is superior as a manure to that of quadrupeds. Pigeon's dung has long been in high repute as an excellent fertiliser, and brought a high price in days when portable manures were scarcely to be had. It is now little heard of: Guano, the excrement of fowls which feed upon fish, being superior, weight for weight, and available to every one. The dung of domestic poultry is usually mixed with the general dung heap, but it could be turned to better account if kept by itself. It has been recommended to strew the floors of poultry houses daily with sawdust or sand, and to rake this with the droppings into a heap to be kept under cover and used like guano.

*Bones.*—It is now about forty years since ground bones began to be used by farmers in the east side of England as a manure for turnips. At first they were roughly smashed by hammers and applied in great quantities. By and bye mills were constructed for grinding them to a coarse powder, in which state they continued to be used as a dressing for turnips, at the rate of sixteen to twenty bushels per acre, in all parts of the kingdom and to a very great extent, until the admirable discovery by Baron Liebig of the mode of preparing superphosphate of lime by dissolving bones in sulphuric acid. We shall not attempt to explain on chemical principles the wonderful superiority of this substance over simple bone-dust in promoting the growth of the turnip plant. What we should do indifferently, by borrowing from others, will be found well done by an accomplished chemist in the separate article on Agricultural Chemistry. We can, however, testify from experience, to the important fact that *one* bushel of bone-dust dissolved by a third of its weight of sulphuric acid is superior in manurial value to *four* bushels of simple bone-dust. It is not merely, or even chiefly, in the lessened cost at which an acre of turnips can be manured that this superiority lies, but especially in this, that from the extraordinary stimulus given by superphosphate of lime to newly germinated turnip plants, they usually arrive at the stage when they are fit for thinning in from ten to fifteen days earlier than when sown over farm-yard dung or simple bone-dust, or both combined. This shortening of the critical period during which the attacks of the insignificant but dreaded turnip beetle so often baulk the hopes of the husbandman, is an advantage not easily estimated, and one well fitted to inspire him with confidence in the science to which he owes the discovery, and with grateful respect for the eminent discoverer. This powerful effect in quickening the growth of the young turnip plants is possessed in quite as great a degree by Peruvian guano, when it is supplied with sufficient moisture. In climates and seasons which may be characterised as moist and cool, guano will show best results, whereas in those which are rather hot and dry superphosphate has the advantage. Accordingly we find guano the comparative favourite in Scotland; and its rival in the drier counties of England.

Guano is believed to encourage a great expanse of foliage, and to be more especially suited for early sowings—and superphosphate to influence development of bulb, and to deserve the preference for a later seed time. The obvious inference is that, for the turnip crop at least, these valuable fertilisers should be used in combination; and actual experiment has verified its soundness. The use of them is universal and ever on the increase. They constitute also the standard by which farmers estimate the cost and effects of other purchased manures. The extent to which they are used, their high price, and the facility with which they can be adulterated with comparatively worthless ingredients, have led to almost unparalleled frauds. The adulteration of guano has in fact become a regular trade. Had farmers only their bodily senses to aid them, the detection of this fraud would be difficult—perhaps impossible. Here, however, they can call the chemist to their aid, with the certainty of ascertaining the real character of the articles which they are invited to purchase. If purchasers of guano would but insist in every instance on getting from the seller an analysis by some competent chemist, and along with it a written warrandice that the stock is of the quality therein indicated, detection and punishment of fraud would be easy. In regard to superphosphate of lime, the prudent and economical plan is for the farmer to purchase bone-dust and sulphuric acid and prepare it himself. We have conducted this process for several years past in the following way. A trough was provided 7 feet $\times$ 3·4 $\times$ 2·10, made of $2\frac{1}{2}$ inch deal, strongly jointed and secured at the corners by wooden pegs, as iron nails would be corroded by the acid. This holds conveniently 48 bushels of bones. The heap of bone-dust is then gone over with a barley riddle, and the small dust which passes through this is laid aside to be used as a drying material for the other portion, after it is subjected to the acid. We find that a third part of the bone-dust passes through the riddle. Three bottles, or carboys as they are called, of concentrated acid, averaging 180 lb. each, are then emptied into the trough and mixed with cold water at the rate of $1\frac{1}{2}$ of water, by measure, to 1 of acid. In practice, the water is poured

Adulteration of manures.

Mode of preparing superphosphate of lime.

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in first and then the acid. Into this mixture 48 bushels of bones, previously measured and laid close to the trough, are rapidly shovelled by two labourers, who will do well to be attired in clothes and shoes past spoiling. So soon as the bones begin to be thrown in, violent ebullition commences. By the time that the whole of the bones are thrown in, there will be barely liquid enough to moisten the last of them. The labourers therefore dig down at one end of the trough till they reach the bottom, and then carefully turn back and mix the whole quantity until they reach the other end. The surface is then levelled and covered with a layer of the dry riddlings two inches thick. In this state it is allowed to remain for two days, when the trough is emptied, and the same process is repeated until the whole quantity is gone over. When shovelled out of the trough the bones are found to have become a dark coloured paste, still very warm and emitting a sweetish smell. While one person throws it out, another adds to it its proportion of dry riddlings and mixes them carefully. This mass is heaped up in the corner of a shed, and augmented at each emptying of the trough, until the requisite quantity is obtained. After this the mass is carefully turned over several times, at intervals of five or six days, and is then dry enough for sowing either by hand or machine. Some prefer moistening the bones with boiling water, and then adding pure acid as they are shovelled into the trough; but by first mixing the acid and water there is greater certainty of all the bones being equally acted upon. There is also great convenience in using the finest portion of the bone-dust for drying the other, as suitable material for this purpose is sometimes difficult to procure.

Superphosphate from fossil bones or coprolites.

We have referred to superphosphate of lime, prepared from bones. A new source of supply has, however, been discovered of late years, the extent and importance of which is becoming more apparent as investigation proceeds. We allude to those phosphoric deposits found in such abundance in the crag, and upper and lower green-sand formations in the south of England. The existence of these fossil animal remains was first pointed out by Drs Mantel and Buckland, though it is to Professor Henslow that we are indebted for having called attention to their eminent agricultural value, and described the localities whence they may be most readily obtained. These remains consist of the fractured and rolled bones of sharks, gigantic sea-lizards, and whales, which at one period of our earth's history must have existed in myriads in our oceans and seas. Mixed with these bones are found many fish-teeth and shells of different species, and likewise immense numbers of rolled, water-worn pebbles, which at one period were imagined to be the fossilised excrements of the animals themselves, and were on this account called *coprolites* by Professor Henslow and others. Although this has since been proved a mistake, the name has been adopted and will probably be continued. These fossil bones, and so-called coprolites of the crag are found in enormous quantities on the coasts of Suffolk, Norfolk, and Essex, whence Mr Lawes of Rothamstead obtains nearly the whole of the material which he employs in the preparation of his well known "coprolite manure," or "Lawes' superphosphate." Already, it is believed, several thousands of tons of these fossils in one form or other are annually sold for manure, with a rapidly increasing demand. Those found in the crag formation are exceedingly hard, and require to be ground by powerful machinery, and dissolved in sulphuric acid to render the phosphate of lime available as manure. Fossils, though less abundant in the green-sand, can be reduced to the requisite fineness by simple machinery, and are then fit for agricultural purposes without any chemical preparation. They are found plentifully in the parish of Farnham, so long celebrated for the excellence and abundance of its hops, which are now discovered to be due to the presence in the soil of these fossil remains. The discovery of these *mines* of manure in various parts of our country has been made most seasonably, and may yet prove of immense national importance. When Liebig predicted that, "in the remains of an extinct animal world, England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel," he was regarded by many as merely indulging a fine philosophic fancy; but enough has already been realised to convince the most sceptical of the importance of the data on which he founded his opinion. We have gleaned this information from an article "on the Phosphoric strata of the Chalk Formation," by Messrs Paine and May, in vol. ix. p. 56 of the *Journal of the Royal Agricultural Society of England;* and another in vol. xii. p. 91, by T. J. Herapath, on the "Fossil Bones and Pseudo-Coprolites of the Crag."

Fermented bones.

On mixing a quantity of bone-dust with its own bulk of mould or sand, and wetting the whole with the liquid which oozes from the dung-heap, violent fermentation immediately ensues, dissolving the bones, and making them more readily available for the nourishment of the turnip-crop. Many farmers are so satisfied with this preparation, that they dispense with the acid. This is not judicious, as the superphosphate of lime is a more valuable manure than bones dissolved by simple fermentation.

Bones as a top-dung for pasture land.

Bones are sometimes applied as a top-dressing to grass land with singular success. "This Cheshire practice consists in applying an extraordinary dose of bones to pasture-land. 'For pasture-land, especially the poorer kind,' says Mr Palin, 'there is nothing equal to bone-manure, either as regards the permanency of its effects, or the production of a sweet luxurious herbage, of which all cattle are fond. Many thousand acres of the poor clay soils have been covered with this manure during the last eight or ten years.' The average quantity used is about a ton and a half to the acre; it is therefore a landlord's improvement, on which 7 or 8 per cent. is generally paid. Boiled bones act as long as unboiled bones, retaining the phosphorus, though not so quickly, having lost the animal matter. Boiled bones (1845) cost L.3, 10s. per ton; the outlay then was five guineas per acre, sometimes L.7 or L.8. 'I have known,' says a correspondent, 'many instances where the annual value of our poorest clay-lands has been increased by an outlay of from L.7 to L.8 an acre, at least 300 per cent.; or, in other words, that the land has been much cheaper after this outlay at 30s., than in its native state at 10s. per acre; with the satisfaction of seeing a miserable covering of pink-grass, rushes, hen-gorse, and other noxious weeds exchanged for a most luxuriant herbage of wild clover, trefoil, and other succulent grasses.' Though much of the clover and trefoil may disappear in five or ten years (sometimes they last fifteen years), an excellent herbage remains. Draining, the writer adds, '*may be carried too far* where bones are used, for boned lands suffer by a dry summer. The land should be kept cool.' I have found the same thing on water-meadows. The freer the grass is growing, the more it suffers from drought; and this is natural, for a larger supply of sap is required. This writer adds, 'I have known many a poor, honest, but half-broken man raised from poverty to comparative independence, and many a sinking family saved from inevitable ruin, by the help of this wonderful manure.' Indeed, I believe land, after boning, will keep three cows where two fed before. As to this practice, however, caution is necessary. It seems to belong to cold clays for grass in Cheshire, though on such soil it would hardly answer elsewhere, even for turnips. A Cheshire landlord told me that he had tried it vainly for grass in Suffolk. I know no

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case of its success out of Cheshire, unless in the bordering counties, and have heard some cases of its failure even in those. It will not do, therefore, at all to adopt it hastily. We only know it to have succeeded about Cheshire, which is on the red marls geologically, and on the rainy side of the country, and must remember that it is a costly proceeding, striking in its success, but as yet circumscribed in its practice, and therefore in the proof of its efficacy."[1]

*Rape-Cake* reduced to powder forms an excellent manure for wheat and other crops. It is usually applied at the rate of from four to eight cwt. per acre. The cakes resulting after oil has been expressed from camelina, hemp, and cotton seeds, and from pistachio and castor-oil nuts, from beech, and other mast, all possess considerable value as manure.

All parts of the carcases of animals form valuable manure, and are now carefully used in that way whenever they are unfit for more important uses. The blood and other refuse from shambles and from fish-curers' yards, when mixed with earth and decomposed, make a valuable manure, and are eagerly sought after by farmers to whom such supplies are accessible. In Australia and South America it has long been the practice to slaughter immense numbers of sheep and cattle for the sake of their hides and tallow only, there being no market for them as beef and mutton. To obtain the whole tallow, the carcases are subjected to a process of boiling by steam and afterwards to pressure, and are then thrown aside in great piles. This dried flesh has recently been brought to this country and sold as a manure. A notice and analysis of it, by Dr Anderson, appears in the *Transactions of the Highland and Agricultural Society* for October 1850, p. 367.

The refuse from glue-works; the blubber and dregs from fish-oil; blood that has been used in the process of sugar-refining; the shavings and filings of horn and bones from various manufactures, and woollen rags, are all made available for manure.

*Night-soil* is a powerful manure; but owing to its offensive odour it has never been systematically used in Britain. Various plans are tried for obviating this objection, that most in repute at present being its mixture with charred peat. From the universal use of waterclosets in private dwellings, the great mass of this valuable fertilising matter now passes into sewers, and is carried off by streams and rivers, and is for the most part totally lost as a manure. When sewage water is used for irrigation, as in the neighbourhood of Edinburgh, it is to the night-soil dissolved in it that its astonishing effects in promoting the growth of grass are chiefly due. We have already expressed our views in regard to the use of it in this diluted form of sewage water. That mode of applying it is necessarily restricted to lands in the vicinity of towns. It is therefore much to be desired that a really effective process for preparing it for market in a dry, inodorous state, at a moderate price, and with its virtues unimpaired, should speedily be brought into general operation. The enormous and ever-increasing expenditure on guano, shows how unbounded will be the demand for it when it shall be thus available. The important progress that has recently been made towards the attainment of so desirable a result is shown in a paper by Professor Herapath in No. xxix. of the *Journal of the Royal Agricultural Society*, where he describes the process as carried on at Cardiff Gaol. These operations are well explained in the following letters, addressed by the governor of the gaol and the patentee, in reply to inquiries for further information, to the editor of the *North British Agriculturist* newspaper of 29th September 1852, from which we now quote:—

"*Cardiff Gaol, 20th September* 1852.

Mode of treating night-soil in Cardiff Gaol.

"Sir,—In reply to your letter on the subject of sewage manure, I beg first of all to state that the magistrates' principal object was to do away with the great nuisance arising from the drains emptying into a ditch, from which all the filth of the gaol was conveyed into a thickly populated part of the town.

"The expense of carrying on the drain to the sea was supposed to cost about £2000. This serious outlay induced the magistrates to apply to Mr Higgs, of 69 Lillington Street, Vauxhall, Westminster, who was in possession of a patent for deodorizing sewage, for plans, and the expense of converting the sewage into manure. The building, two sets of pipes (one for diverting the sewage into a large tank, the other for the water which passes from the tanks), sewage tanks, lime tanks, with a large pump, &c. for pumping the sewage into the operating tank, cost £200. The plan fully answers the purposes for which it was intended. The water passes off without any unpleasant smell. The sewage precipitates, and when dry enough it is moulded into bricks, dried and sold at 60s. per ton.

"The whole of the work being done by prisoners makes it all profit, except the lime used for condensing the effluvium. Being unable to furnish you with further particulars, I beg to refer you to Mr Higgs, who will give you every information on the subject. I am not aware that this plan has been tried in any other quarter. John B. Woods."

"69 *Lillington Street, Westminster, 25th Sept.* 1852.

"Sir,—In answer to your letter of the 22d inst., I beg to say it affords me much pleasure in communicating information to you, respecting my invention for collecting the contents of sewers, &c. and producing therefrom a concentrated and inodorous manure. This plan, which was patented in 1846, received the sanction of Parliament in the following session, by the incorporation of a company to carry it into operation in a portion of the metropolis, but which, owing to the commercial depression of that period, was not put into action; however, trial works were erected at Northumberland Wharf, Charing Cross, and carried on for the space of four months, which realized the most sanguine expectations which had been formed. These works were visited by the officers of the commissioners of sewage, and the secretary of the General Board of Health, who reported most favourably thereon; shortly after, the visiting justices of the county of Glamorgan, finding that the drainage of Cardiff Gaol was complained of, as being inimical to the healthy condition of a hamlet called New Town, through which it passed, resolved to try its efficacy; they therefore erected at Cardiff Gaol the works to which your letter refers. These were finished, and began to work on 25th October 1849, and have continued in operation ever since. That they have given satisfaction, you will see in a testimonial given by Walter Coffin, Esq., now M.P. for Cardiff.

"'As one of the visiting justices of the County Gaol at Cardiff, I am happy to be able to testify that Mr Higgs' method of disinfecting the sewage of the prison has been eminently successful, by removing the great evils attendant on improper drainage. The sewage thus disinfected becomes a portable and very powerful manure, as attested by the farmers who have tried it. (Signed) Walter Coffin.'

'*Cardiff*, 14*th August* 1851.

"Mr Wood also writes:—'Having watched the progress of Mr Higgs' patent for disinfecting sewage, and turning the same to a profitable purpose, I beg to express my entire concurrence in Mr Coffin's statement. (Signed) John B. Woods,
'Gov. of the County Gaol at Cardiff.'

"Before I give you a brief detail of the method, I beg to say that it is not intended to disinfect or deodorize matter which has already passed into a state of decomposition, such as the contents of old privies or cesspools, but it is intended to precipitate and collect the contents of current sewers, and to prevent that decomposition, so detrimental to the healthy state of the atmosphere, wherever it may take place.

"You will by this perceive that it is intended to preserve

[1] Article by Mr Pusey. See *Journal of Royal Society of England*, vol. xi. p. 409.

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the manure in its integrity, till decomposition takes place in the soil, where its fertilising effects are very powerful.

"The *modus operandi* is as follows:—

"The sewage matter intended to be operated upon is received into one or more tanks, as the case may require; at the same time a stream of milk-of-lime is caused to flow in and mix with the sewage—this, at once, as soon as the tank is full, and the fluid at rest, causes the precipitation of all the organic matter with the phosphates, urates, sulphates, &c. contained in the fluid, with the expulsion of the ready formed ammonia, if there be any. This altogether, with any other effluvium that may be disengaged, escapes by a pipe (the tank being closely covered), and passes through a convoluted chamber, where it is fixed by chemical agents, so that not an atom is lost. After the matter in the tank has been suffered to rest for about an hour, the supernatant water may be let off, quite clear and inodorous, and the pulpy manure, in another hour, dried by an apparatus and rendered fit for market.

"This may be accomplished at something less than £1 per ton, and you see it fetches at Cardiff £3 per ton; and from its effects it is calculated to fetch much more, for its efficiency is quite equal to the best guano.

"The agent by which this is in most cases accomplished, lime, is well known to be a most excellent fertiliser, as has been so well shown by Professor Johnston in his work on that subject, so that in this method nothing is added to the manure of a worthless or mischievous character; but the fertilising principles of the sewage, including its nitrogenous matter, are so well fixed, that last year Captain Buller, an excellent agriculturist of Devonshire, systematically tried it against guano, at £9, 10s. per ton, and pronounced in its favour, notwithstanding that the sewage had been collected as long ago as 1847.

"W. Higgs."

If the premium of L.1000 and the Gold Medal of the Society, recently offered by the Council of the Royal Agricultural Society to the discoverer of a manure equal to Peruvian Guano, to be sold at L.5 per ton, and procurable in unlimited quantities, is won at all, it seems likely that the material will be obtained from the contents of our sewers.

*Sea-weed.*—Along our sea-board large supplies of valuable manure are obtained in the shape of drifted sea-weed. This is either applied as a top-dressing to grass and clover, ploughed in with a light furrow, for various crops, or mixed in dung-heaps. It requires to be used in large quantities per acre—from 40 to 60 loads—and is evanescent in its effects. Grain grown on land manured with sea-weed, is generally of fine quality and is in repute as seed corn.

*Crops of Buckwheat, Rape, Vetches,* and *Mustard,* are sometimes ploughed in, while in a green, succulent state, to enrich the land. It is however more usual to fold sheep on such crops, and so to get the benefit of them as forage, as well as manure to the land. The leaves of turnips are frequently ploughed in after removing the bulbs, and have a powerful fertilising effect.

*Lime.*—Besides manures of an animal and vegetable origin, various mineral substances are used for this purpose. The most important and extensively used of these is lime. In the drier parts of England it is not held in much esteem, whereas in the western and northern counties and in Scotland, its use is considered indispensable to good farming. Experienced farmers in Berwickshire consider it desirable to lime the land every 12 years, at the rate of from 120 to 200 bushels of the unslacked lime per acre. It is found especially beneficial in the reclaiming of moory and boggy lands, on which neither green nor grain crops thrive until it has been applied to them. Its use is found to improve the quality of grain, and to cause it in some cases to ripen earlier. It facilitates the cleaning of land; certain weeds disappearing altogether for a time after a dressing of lime. It is the only known specific for the disease in turnips called "fingers and toes," on which account alone it is frequently used in circumstances which would otherwise render such an outlay unwarrantable. The practice, still frequent, of tenants at the beginning of a 19 years' lease, liming their whole farm at a cost per acre of from L.3 to L.5, proves conclusively the high estimation in which this manure is held. The belief—in which we fully concur—is however gaining ground, that moderate and frequent applications are preferable to these heavy doses at lengthened periods.

Carbonate of lime.

Modes of application.

When bare fallowing was in use, it was commonly towards the close of that process that lime was applied. Having been carted home and laid down in large heaps, it was, when slaked, spread evenly upon the surface and covered in by a light furrow. It is now frequently spread upon the autumn furrow preparatory to root crops, and worked in by harrowing or grubbing, and sometimes by throwing the land into shallow ridglets. Another method much used, is to form it into compost with decayed quickens, parings from road-sides, and margins of fields, &c. which, after thorough intermixture by frequent turnings, is spread even evenly upon in grass. A cheap and effectual way of getting a dressing of such compost thoroughly comminuted and incorporated with the surface soil, is to fold sheep upon it, and feed them there with turnips for a few days. The value of such compost is much enhanced by mixing common salt with the lime and earth at the rate of *one part* of salt by measure to *two parts* of lime. A mixture of these two substances in these proportions prepared under cover, and applied in a powdery state, is much approved as a spring top-dressing for corn-crops on light soils. In whatever way lime is applied, it is important to remember that the carbonic acid, which has been expelled from it by subjecting it in the kiln to a red heat, is quickly regained from the atmosphere, to which therefore it should be as little exposed as possible before applying it to the land. A drenching from heavy rain after it is slaked is also fatal to its usefulness. Careful farmers therefore guard against these evils by laying on lime as soon as it is slaked; or when delay is unavoidable, by coating these heaps with earth, or thatching them with straw. In order to reap the full benefit of a dressing of lime it must be so applied as, while thoroughly incorporated with the soil, to be kept near the surface. This is more particularly to be attended to in laying down land to pasture. This fact is so well illustrated by an example quoted in the last edition of this work that we here repeat it.

"A few years after 1754," says Mr Dawson, "having a considerable extent of outfield land in fallow, which I wished to lime previous to its being laid down to pasture, and finding that I could not obtain a sufficient quantity of lime for the whole in proper time, I was induced, from observing the effects of fine loam upon the surface of similar soil, even when covered with bent, to try a small quantity of lime on the surface of this fallow, instead of a larger quantity ploughed down in the usual manner. Accordingly, in the autumn, about twenty acres of it were well harrowed in, and then about fifty-six Winchester bushels only, of unslaked lime, were, after being slaked, carefully spread upon each English acre, and immediately well harrowed in. As many pieces of the lime, which had not been fully slaked at first, were gradually reduced to powder by the dews and moisture of the earth,—to mix these with the soil, the land was again well harrowed in three or four days thereafter. This land was sown in the spring with oats, with white and red clover and rye-grass seeds, and well harrowed without being ploughed again. The crop of oats was good, the plants of grass sufficiently numerous and healthy; and they formed a very fine pasture, which continued good until ploughed some years after for corn.

"About twelve years afterwards I took a lease of the hilly farm of Grubbet, many parts of which, though of an earthy mould tolerably deep, were too steep and elevated to be kept in tillage. As these lands had been much exhausted by cropping, and were full of couch-grass, to destroy that and procure a cover of fine grass, I fallowed them, and laid on the same

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quantity of lime per acre, then harrowed and sowed oats and grass-seeds in the spring, exactly as in the last-mentioned experiment. The oats were a full crop, and the plants of grass abundant. Several of these fields have been now above thirty years in pasture, and are still producing white clover and other fine grasses: no bent or fog has yet appeared upon them. It deserves particular notice, that more than *treble* the quantity of lime was laid upon fields adjoining of a similar soil, but which being fitter for occasional tillage, upon them the lime was ploughed in. These fields were also sown with oats and grass-seeds. The latter throve well, and gave a fine pasture the first year; but afterwards the bent spread so fast, that in three years there was more of it than of the finer grasses."

The conclusions which Mr Dawson draws from his extensive practice in the use of lime and dung, deserve the attention of all cultivators of similar land.

Conclusions as to the effects of lime and dung.

"1. That animal dung dropped upon coarse benty pastures produces little or no improvement upon them; and that, even when sheep or cattle are confined to a small space, as in the case of folding, their dung ceases to produce any beneficial effect after a few years, whether the land is continued in pasture or brought under the plough.

"2. That even when land of this description is well fallowed and dunged, but not limed, though the dung augments the produce of the subsequent crop of grain, and of grass also for two or three years, that thereafter its effects are no longer discernible either upon the one or the other.

"3. That when this land is limed, if the lime is kept upon the surface of the soil, or well mixed with it, and then laid down to pasture, the finer grasses continue in possession of the soil, even in elevated and exposed situations, for a great many years, to the exclusion of bent and fog. In the case of Grubbet-hills, it was observed, that more than thirty years have now elapsed. Besides this, the dung of the animals pastured upon such land adds every year to the luxuriance, and improves the quality of the pasture, and augments the productive powers of the soil when afterwards ploughed for grain; thus producing, upon a benty outfield soil, effects similar to what are experienced when rich infield lands have been long in pasture, and which are thereby more and more enriched.

"4. That when a large quantity of lime is laid on such land, and ploughed down deep, the same effects will not be produced, whether in respect to the permanent fineness of the pasture, its gradual amelioration by the dung of the animals depastured on it, or its fertility when afterwards in tillage. On the contrary, unless the surface is fully mixed with lime, the coarse grasses will in a few years regain possession of the soil, and the dung thereafter deposited by cattle will not enrich the land for subsequent tillage.

"*Lastly*, It also appears from what has been stated, that the four-shift husbandry is only proper for very rich land, or in situations where there is a full command of dung; that by far the greatest part of the land of this country requires to be continued in grass two, three, four, or more years, according to its natural poverty; that the objection made to this, viz. that the coarse grasses in a few years usurp possession of the soil, must be owing to the surface soil not being sufficiently mixed with lime, the lime having been covered too deep by the plough." (*Farmer's Magazine*, vol. xiii. p. 69.)

Marl.

Our remarks hitherto have had reference to carbonate of lime in that form of it to which the term *lime* is exclusively applied by farmers. But there are other substances frequently applied to land which owe their value chiefly to the presence of this mineral. The most important of these is marl, which is a mixture of carbonate of lime with clay, or with clay and sand, and other compounds. When this substance is found in the proximity of, or lying under, sandy or peaty soils, its application in considerable doses is attended with the very best effects. The fen lands of England, the mosses of Lancashire, and sandy soils in Norfolk and elsewhere, have been immensely improved in this way. In Lancashire, marl is carried on the mosses by means of portable railways at the rate of 150 tons, and at a cost of about L.3 per acre. In the fens long trenches are dug, and the subjacent marl is thrown out and spread on either side at an expense of 54s. per acre. By this process, often repeated, of *claying* or *marling*, as it is variously called, the appearance and character of the fen lands have been totally changed; excellent wheat being now raised, where formerly only very inferior oats were produced. As the composition both of peat and of clay marl varies exceedingly, it is always prudent, either by limited experiment, or chemical analysis of both substances, to ascertain the effect of their admixture. Lime is always present in those cases which prove most successful; but an overdose does harm.

*Shell-Marl.*—Under some mosses and fresh water lakes extensive deposits of shell-marl are frequently found. It contains a larger per-centage of lime than clay-marl, and must be applied more sparingly.

*Chalk.*—Throughout the extensive chalk districts of England, the practice of spreading this substance over the surface of the land, has prevailed from the remotest times. In the case of the Lincolnshire Wolds, once as celebrated for desolate barrenness as they now are of high culture and smiling fertility, chalking was one important means of bringing about this wonderful improvement, as it still is in maintaining it. "The soil being but a few inches in depth, and often containing a large proportion of flints, naturally possesses very little fertility—often being a light sand, not strong enough naturally to grow turnips—so that the farmers were at first obliged to *make* a soil, and must now maintain its new-born productiveness. The three principal means by which this is done, are the processes of *chalking*, and *boning*, and *manuring with sheep*. A dressing of 80 or 100 cubic yards per acre of chalk is spread upon the land, and then a crop of barley is obtained, if possible, being sown with seeds for grazing. The seeds are grazed with sheep two years, the sheep being at the same time fed with oil-cake; and then the land will be capable of producing a fine crop of oats. Bones are also used frequently for the barley crop, and when they first came into use were thrown upon the land in a chopped state, neither broken nor crushed, and as much as 40 or even 50 bushels per acre. The boning and sheep-feeding are in constant operation, but chalking is required only at intervals of a few years. On the western side of the Wold district, wherever the chalk adjoins the white or blue marl, an extensive application of it is made to the surface. Thus immense quantities of earth and stone have been added by manual labour and horse-carriage to the thin covering of original soil; and, besides this, the soil is being continually deepened by deep ploughing, the chalk fragments thus brought to the surface crumbling into mould."[1]

In Dorsetshire "it is usual to chalk the land once in twenty years, the sour description of soil being that to which it is found most advantageous to apply it. The chalk is dug out of pits in the field to which it is applied, and it is laid on sometimes with barrows, but chiefly with the aid of donkeys. The first method costs 40s. an acre, the last 35s. when hired donkeys are used; 20s. to 25s. where the donkeys are the property of the farmer. The chalk is laid on in large lumps, which soon break down by the action of frost and exposure to the weather. Chalk is occasionally burnt and applied as lime, in which state it is preferred by many farmers, notwithstanding the additional cost of the burning."[2]

*Shell-Sand and Limestone Gravel.*—On the western shores

[1] Farming of Lincolnshire, by John Algernon Clarke. *Journal of Royal Agricultural Society*, vol. xii. p. 331.

[2] See Caird's *English Agriculture* 1850 and 1851, p. 61.

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of Great Britain and Ireland are found great quantities of sand mixed with sea-shells in minute fragments. This calcareous sand is carried inland considerable distances and applied to the land as lime is elsewhere. Limestone gravel is also found in various places and used in the same way.

*Sulphate of Lime or Gypsum* is considered an excellent top-dressing for clover and kindred plants. It is thought by some, that the failure of red clover is to be accounted for, by the repeated crops of that plant having exhausted the gypsum in the soil. Its application has been followed by favourable results in some cases, but has yet quite failed in others. It is applied in a powdered state at the rate of *two* or *three* cwt. per acre when the plants are moist with rain or dew.

*Burnt Clay.*—Thirty years ago, burnt clay was brought much into notice as a manure, and tried in various parts of the country, but again fell into disuse. It is now, however, more extensively and systematically practised than ever. Frequent reference to the practice is to be found in the volumes of the *Journal of the Royal Agricultural Society of England.* This burning of clay is accomplished in several ways. Sometimes it is burnt in large heaps or clamps containing from 80 to 100 cart-loads. A fire being kindled with some faggots or brushwood, which is covered up with the clay, taking care not to let the fire break out at any point, more fuel of the kind mentioned, or dross of coals, is added as required, and more clay heaped on. A fierce fire must be avoided, as that would make the clay into brickbats. A low, smothered combustion is what is required; and to maintain this a good deal of skill and close watching on the part of the workman is necessary. A rude kiln is sometimes used for the same purpose. Either of these plans is suitable where the ashes are wanted at a homestead for absorbing liquid manure, &c.; but for merely spreading over the land, that called clod-burning is preferable, and is thus described in volume viii. page 78, of the *Royal Agricultural Society's Journal*:—" Roll and harrow, in dry weather, till the majority of clods are about the size of a large walnut; nothing so good as the clod-crusher to forward this operation: when perfectly dry, collect them into rows about six yards apart, with iron-teethed rakes; take a quarter of a whin faggot, or less, according to size, previously cut into lengths by a man with an axe; place these pieces about four yards apart in the rows, cover them with clods, putting the finest mould upon the top of the heap, to prevent the fire too quickly escaping; observe the wind, and leave an opening accordingly; having set fire to a long branch of whin, run from opening to opening till two or three rows are lighted, secure these, and then put fire to others; keeping a man or two behind to attend to the fires and earthing up till the quantity desired may be burned, which will generally take four or five hours, say from 25 to 35 loads per acre of 30 bushels per load.

" This work is often put out to a gang of men at about 10s. per acre for labour, and the whins cost 4s. 6d. per acre, not including the carting.

" When the heaps are cold, spread and plough in. The great advantage of burning clods in these small heaps in preference to a large one, is the saving of expense in collecting and spreading; there is much less red brick earth, and more black and charred; no horses or carts moving on the land whilst burning, and a large field may be all burned in a day or two, therefore less liable to be delayed by wet weather. In the heavy land part of Suffolk, the farmers purchase whins from the light land occupiers, and often cart them a distance of fourteen or sixteen miles, when there is no work pressing on the farm. These are stacked up and secured by thatching with straw, that they may be dry and fit for use when required. Bean straw is the next best fuel to whins or furze, and it is astonishing to see how small a quantity will burn the clods, if they are of the proper size and dry. Observe, if the soil is at all inclined to sand, it will not burn so well. I will here mention, that I often sift and store up a few loads of the best blackened earth to drill with my turnips, instead of buying artificial manure, and find it answers remarkably well, and assists in maintaining the position that a heavy land farm in Suffolk can be farmed in the first rate style without foreign ingredients."

Manures.

Burnt clay.

Its value as an absorbent of liquid manure.

Burnt clay is an admirable vehicle for absorbing liquid manure. A layer of it in the bottom of cattle boxes does good service, at once in economising manure, and yielding to the cattle a drier bed than they would otherwise have until the litter has accumulated to some depth. Valuable results have also been obtained by using it for strewing over the floors of poultry-houses, and especially of pens in which sheep are fed under cover. In the latter case, it is mixed with the excrements of the sheep as they patter over it, and forms a substance not unlike guano, nor much inferior to it as a manure. As an application to sandy or chalky soils, it is invaluable. It is mainly by this use of burnt clay, in combination with fattening of sheep under cover, that Mr Randell of Chadbury has so astonishingly increased the productiveness of his naturally poor clay soil. A Berwickshire proprietor, himself a practical farmer, who visited Mr Randell's farm in the summer of 1852, thus writes:—" I have visited most of the best managed farms in England, at least those that have so much of late been brought under general notice; but without exception, I never saw land in the splendid condition his is in. The beauty of the system lies in the cheap method he has imparted to it this fertility, and in the manner in which he keeps it up. A large part of the farm consisted, fourteen years ago, of poor clay, and was valued to him at his entry at 7s. 6d. per acre. It is now bearing magnificent crops of all kinds, the wheat being estimated to yield from 6 to 7 quarters per acre.

" Mechi has enriched Tiptree-heath, it is true; but then it is effected at a cost that will make it impossible for him to be repaid. Mr Randell, on the other hand, has adopted a course that is nearly self-supporting, his only cost being the preparation of the clay. The great secret of his success lies in his mode of using it; and as I never heard of a similar process, I will briefly explain to you how it is done:—His heavy land not permitting him to consume the turnip and mangel crops in the ground, he carts them home, and feeds his sheep in large sheds. They do not stand on boards or straw, but on the burnt clay, which affords them a beautiful dry bed; and whenever it gets the least damp or dirty, a fresh coating is put under them. The mound rises in height; and in February, when the shearlings are sold (for the sheep are only then twelve months old), the mass is from 7 to 8 feet deep. He was shearing his lambs when I was there, as he considers they thrive much better in the sheds without their fleeces. They are half-bred Shropshire Downs; and at the age I mention, attain the great weight of 24 lb. per quarter.

" I walked through the sheds, but of course they were then empty. I saw the enormous quantity of what he called his ' home-made guano,' the smell from it strongly indicating the ammonia it contained. He had sown his turnips, and other green-crops with it, and what remained he used for the wheat in autumn. He assured me he had often tested it with other manures, and always found 10 tons of the compound quite outstrip 4 cwt. of guano, when they were applied to an acre of land separately. Burned clay I never saw used before in this manner, and I felt very much interested in the plan he pursued."

*Charred Peat* has been excessively extolled for its value as a manure, both when applied alone, and still more in com-

Manures.

bination with night-soil, sewage water, and similar matters, which it dries and deodorises. So great were the expectations of an enormous demand for it, and of the benefits to result to Ireland by thus disposing of her bogs, that a royal charter was granted to a company by whom its manufactures has been commenced on an imposing scale. This charcoal is doubtless a useful substance; but Dr Anderson has recently proved that peat, merely dried, is a better absorber and retainer of ammonia than after it is charred. There seems much risk, therefore, of this peat-charcoal sharing the fate of so many other schemes for benefiting Ireland.

*Soot* has long been in estimation as an excellent top-dressing for cereal crops in the early stage of their growth, and for grasses and forage plants. It is applied at the rate of 15 to 30 bushels per acre. On light soils the addition of 8 or 10 bushels of salt to the above quantity of soot is said to increase materially its good effect. This mixture trenched, or deeply ploughed in, is also recommended as one of the most powerful of all manures for carrots.

In *London Labour and the London Poor* we find the following statistics as to metropolitan soot:—

| | Bush. of Soot per annum. |
|---|---|
| "53,840 houses, at a yearly rental above £50, producing six bushels of soot each per annum, | 323,040 |
| 90,002 houses, at a yearly rental above £30 and below £50, producing five bushels of soot each per annum.................................... | 450,010 |
| 163,880 houses, at a yearly rental below £30, producing two bushels of soot each per annum, | 337,760 |
| Total number of bushels of soot annually produced throughout London, | 1,100,810 |

The price of soot per bushel is but 5d., and sometimes 4½d., but 5d. may be taken as an average. Now, 1,000,000 bushels of soot at 5d., will be found to yield £20,833, 6s. 8d. per annum."[1]

*Salt.*—Muriate of soda or common salt has often been commended as a valuable manure, but has never been used in this way with such uniform success as to induce a general recourse to it. We have already spoken of it as forming a useful compound with lime and earth. It can also be used beneficially for the destruction of slugs, for which purpose it must be sown over the surface, at the rate of *four* or *five* bushels per acre, early in the morning, or on mild, moist days, when they are seen to be abroad. It is used also to destroy grubs and wireworm, for which purpose it is sown in considerable quantity on grass land, some time before it is ploughed up. It can be used safely on light soils, but when clay predominates, it causes a hurtful wetness, and subsequent incrustation of the surface. Its application in its unmixed state as a manure, is at best of doubtful benefit; but in combination with lime, soot, nitrate of soda, and perhaps also superphosphate of lime, it appears to exert a beneficial influence.

*Cubic Saltpetre*, or *Nitrate of Soda*, has now become one of our staple manures. The fertilising power of common saltpetre or nitrate of potass has been known from the earliest times, but its high price has hitherto hindered its use as a manure, except in the form in which it is obtained as refuse from the gunpowder mills. The cubic nitre is brought from Peru, where there are inexhaustible supplies of it. The principal deposits of nitrate of soda are in the plain of Tamarugal, at a distance of 18 miles from the coast. The beds are sometimes 7 or 8 feet in thickness, and from these it is quarried with perfect ease. It is not found in a perfectly pure state, but contains a mixture of several substances, chiefly common salt. To fit it for certain uses in the arts it is subjected to a process of purification by boiling and evaporation. As no fuel is to be found in that arid country, English coals are used, which are conveyed from the coast to the works on the back of mules, and the purified nitrate brought back in the same manner. As nitrate of soda is now invariably mixed with twice its weight of common salt before being used as a top-dressing for grain-crops, the purifying process seems altogether a redundancy, so far as its agricultural use is concerned. Were it brought to us just as it is quarried, and were it conveyed to the coast in wheel-carriages by a good road or railway, instead of miserable back-loads by mules, there seems no reason why we should not have it in abundant supplies, and at a third of the price which we have hitherto paid, viz., at from L.6 to L.7, instead of from L.16 to L.20 per ton. As cubic nitre and guano contains very nearly the same per-centage of nitrogen (the element to which the fertilising power of all manures is mainly due), it may seem surprising that the former should ever be used in preference to the latter. In practice, however, it is found that when applied as a top-dressing in spring, the former frequently yields a better profit than the latter; and hence the importance to farmers of getting it at a more reasonable price. Nitrate of soda is used as a manure for grain and forage crops. It is now extensively used in Norfolk, and elsewhere, as a top-dressing for wheat. For this purpose it is applied at the rate of 84 lb. per acre, in combination with 2 cwt. of salt. The nitre and salt are thoroughly mixed, and carefully sown, by hand, in two or three equal portions, at intervals of several weeks, beginning early in March, and finishing by the third week in April. If nitre alone is used, it has a tendency to produce over-luxuriance, and to render the crop liable to lodging and mildew. But the salt is found to correct this over-luxuriance, and a profitable increase of grain is thus obtained. Mr Pusey[2] informs us that an application of 42 lb. of nitrate of soda, and 84 lb. of salt per acre, applied by him to ten acres of barley that had been injured by frost, had such an effect upon the crop, that he had *seven* bushels more grain per acre, and of better quality, than on part that was left undressed for comparison. These seven bushels per acre were attained by an outlay of 6s. 4d. only. This nitre is also applied with advantage to forage crops. Mr Hope, Fenton Barns, East Lothian, states that he finds the use of it as a top-dressing to clover, at the rate of one cwt. of nitrate and two of guano per acre, profitable. Its beneficial effects are most apparent when it is applied to light and sterile soils, or to such as have been exhausted by excessive cropping.

*Artificial Manures.*—Besides those substances, the most important of which we have now enumerated, which are available as manure in their natural state, there are a variety of chemical products, such as salts of ammonia, potash, and soda, copperas, sulphuric and muriatic acid, &c. which, in combination with lime, guano, night-soil, and other substances, are employed in the preparation of manures, with a special view to the requirements of particular crops. In some cases these preparations have been eminently successful, in others but doubtfully so. Many failures are probably due to the spuriousness of the article made use of; as it is known that enormous quantities of worthless rubbish have, of late years, been sold to farmers, under high-sounding names, and at high prices, as special manures. We would recommend to those who desire information regarding the preparation and use of such compounds, to study the article on Agricultural Chemistry, by Mr Lawes of Rothamstead, in the *Journal of the Royal Agricultural Society of England*; the accounts of

[1] *Farmer's Magazine* for March 1852, p. 254.

[2] *Journal of Royal Agricultural Society*, vol. xiii. p. 349.

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experiments, with special manures in the *Transactions of the Highland and Agricultural Society of Scotland;* articles on these topics in *Morton's Cyclopedia;* and that by Dr Anderson in the present work. Those who wish to apply such artificial compounds to their crops, will do well to purchase the ingredients where they are likely to get them genuine, and to mix and prepare them for themselves.

In applying these concentrated manures, those only of a slowly operating character should be used in autumn or winter, and at that season should invariably be mixed with the soil. Those in which ammonia abounds should, in spring, also be mixed with the soil when sowing the crops to which they are applied. When used for top-dressing growing crops, they should not be applied until spring-growth has commenced, and only in wet weather.

## CHAPTER VI.

### GRAIN CROPS.

Pursuing the plan announced at the outset, we have now to speak of field crops, and shall begin with the cereal grasses, or white-corn crops, as they are usually called by farmers.

*Wheat.*—It is unnecessary to dwell upon the value of this grain to the farmer and to the community. It constitutes emphatically our bread-corn—our staff of life. While its increased consumption is on the one hand an indication of an improved style of living among the general population, its extended culture points, on the other, to an improving agriculture, as it is only on soils naturally fertile, or that have been made so by good farming, that it can be grown with success. Wheat is sown both in autumn and spring, from which circumstance attempts have been made to classify its varieties, by ranging them under these two general heads. This distinction can only serve to mislead; for while it is true that there are varieties respectively best adapted for autumn and spring sowing, it is also true that a majority of the kinds most esteemed in Britain admit of being sown at either season, and in practice are actually so treated. It is not our intention to present a list of the varieties of wheat cultivated in this country. These are very numerous already, and are constantly being augmented by the accidental discovery of new varieties, or by cross-impregnation, artificially brought about for this purpose. The kinds at present in greatest repute in Scotland are the hardier, white wheats; among which Hunter's white still retains the first place. There are many kinds which, in favourable seasons, produce a finer sample: but its hardiness, productiveness, and excellent milling qualities, render it a general favourite both with farmers and millers. Its most marked characteristic is, that in rubbing out a single ear, part of the grains are found to be opaque and white, and others flinty, and reddish coloured, as if two kinds of wheat had been mixed together. Selections from Hunter's wheat have been made from time to time, and have obtained a measure of celebrity under various local names. The most esteemed of these is the Hopeton wheat. On very rich soils, both of these varieties have the fault of producing too much straw, and of being thereby liable to lodge. Hence, several new kinds with stiffer straw, and consequent lessened liability to this disaster, are now in request in situations where this evil is apprehended.

Varieties of wheat.

*Fenton Wheat*, possessing this quality in an eminent degree, and being at the same time very productive, and of fair quality, is at present extensively cultivated. It has the peculiarity of producing stems of unequal height from the same root, which gives a crop of it an unpromising appearance, but has perhaps to do with its productiveness. The red-straw-white and Piper's thick-set, are in estimation for the same properties as the Fenton. Piper's is said to be shortest and stiffest strawed wheat in cultivation. It is a yellow-grained and rather coarse variety, but exceedingly productive. It has recently been introduced into Scotland under the name of Protection Wheat. The red-chaff white is productive, and yields grain of beautiful quality, but it requires good seasons, as it sheds its seeds easily and sprouts quickly in damp weather. The Chiddam, pearl, white Kent, and Talavera have each their admirers, and are all good sorts in favourable seasons; but in Scotland, at least, their culture is attended with greater risk than the kinds previously named; they require frequent change of seed from a sunnier climate, and are only adapted for dry and fertile soils with a good exposure. As red wheats usually sell at from 2s. to 4s. less per quarter than white wheats of similar quality, they are less grown than heretofore. But, being considered more hardy and less liable to mildew than the finer white wheats, they are still grown in soils more or less adapted for them. Some of these red wheats are, however, so productive that they are preferred in the best cultivated districts of England. Spalding's Prolific holds a first place among these; being truly prolific, and producing grain of good quality. In Scotland, it shews a tendency to produce a rough quality of grain. The Northumberland red and the golden creeping are there in estimation; the former being well adapted for spring sowing, and the latter for poor soils and exposed situations. A red bearded variety, usually called April wheat, from its prospering most when sown in that month, is sometimes grown with advantage after turnips, when the season is too advanced for other sorts; but it seems only doubtfully entitled to a preference over barley in such circumstances. The list now given could easily be extended; but it comprises the best varieties at present in use, and such as are suited to the most diversified soils, seasons, and situations, in which wheat can be grown in this country.

Red wheats.

In regard to all of them it is advantageous to have recourse to frequent change of seed, and in doing this to give the preference to that which comes from a soil and climate better and earlier than those of the locality in which it is to be sown. Every farmer will find it worth his while to be at pains to find out from whence he can obtain a change of seed that takes well with his own farm; and having done so to hold to that, and even to induce his correspondent to grow such sorts as he prefers, although he should have to pay him an extra price for doing so. An experienced farmer once remarked to the writer, that by changing his seed he got it for nothing; that is, his crop was more abundant by *at least* the quantity sown, from the single circumstance of a suitable change of seed. In fixing upon the kind of wheat which he is to sow, the farmer will do well to look rather to productiveness than to fine quality. For however it may gratify his ambition to shew the heaviest and prettiest sample in the market, and to obtain the highest price of the day, no excellence of quality can compensate for a deficiency of even a few bushels per acre in the yield. It is of importance too, to have seed-corn free from the seeds of weeds, and from other grains, and to be true of its kind. Farmers who are systematically careful in these respects, frequently obtain an extra price for their produce, by selling it for seed-corn to others; and even millers give a preference to such clean samples. But there are seeds which no amount of care or accuracy in dressing can remove from seed-corn—viz., those of certain parasitical fungi, which must be got rid of by a different process. The havoc caused to wheat crops by Bunt, Black-ball, or Pepper-brand (*Uredo caries* or *Tilletia caries*) before the discovery of the mode of preventing it by steeping the seed-corn in some acrid or caustic bath, was often ruinous. The plan at first most usually adopted

Advantage of a change of seed.

Steep or bath for seed-wheat

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was to immerse the seed-wheat in stale chamber-lie, and afterwards to dry it by mixture with quick-lime. This pickle, as it is called, is usually efficacious; but the lime vexes the eyes, and excoriates the hands and face of the sower, or clogs the hopper of the sowing machine, and has therefore been superseded by other substances. Blue vitriol (sulphate of copper) is as good as anything for this purpose, and is used in the following manner. A solution is prepared by dissolving powdered sulphate of copper in water, at the rate of *two* ounces to a pint for each bushel of wheat. The grain is emptied upon a floor; a little of it is shovelled to one side by one person, while another sprinkles the solution over it, and this process is continued until the whole quantity is gone over. The heap is then turned repeatedly by two persons working with shovels opposite to each other. After lying for a few minutes, the grain absorbs the moisture, and is ready for sowing either by hand or machine. The season for wheat-sowing extends from September to April, but ordinarily that succeeds best which is committed to the ground during October and November. When summer-fallows exist, the first sowings are usually made on them. It is desirable that the land neither be wet nor very dry when this takes place, so that the precise time of sowing is determined by the weather; but it is well to proceed as soon after 1st October as the land is moist enough to insure a regular germination of the seed.

Time of sowing.

Sowing on clover lays.

Over a large portion of England, wheat is the crop usually sown after clover or one year's "seeds." In such cases the land is ploughed in the end of September, immediately harrowed, and wheat sown upon it by a drilling machine. On loose soils the land-presser is frequently used to consolidate the soil and to form a channel for the seed, which in such cases comes up in rows, although sown broad-cast. It is more usual, however, first to level the pressed furrows by harrowing, and then to use the drill; by means of which, various portable manures are frequently deposited along with the seed-corn. The sowing of wheat after clover, or "seeds," as now described, is rarely practised in Scotland, where it so invariably fails as to show that it is unsuited to our northern climate. It is here not unusual, however, to plough up such land in July or August, and to prepare it for wheat-sowing by what is called *rag-fallowing*. After the first ploughing, the land is harrowed lengthwise, so as to break and level the surface of the furrows and close the interstices without tearing up or exposing any green sward. It is then allowed to lie for ten or fourteen days to allow the herbage to die, which it soon does at this season when light is thus excluded from it. A cross-ploughing is next given, followed by repeated grubbings, harrowing, and rollings, after which it is treated in all respects as a summer fallow.

Rag-fallowing.

The fallow and clover leas being disposed of, the land from which potatoes, beans, peas, or vetches, have been cleared off will next demand attention. When these crops have been carefully horse and hand hoed, all that is required is to clear off the haulm, to plough and sow. If the land is not clean, recourse must be had to a short fallowing process, before sowing wheat. For this purpose the surface is loosened by the grubber, the weeds harrowed out and raked off, after which the land is ploughed and sown. On soils well adapted for the growth of beans and wheat, viz., those in which clay predominates, any lengthened process of autumn cultivation is necessarily attended with great hazard of being caught by rain, to the loss of seed-time altogether. Every pains should therefore be taken to have the land so cleaned before-hand, that these unseasonable efforts may be dispensed with; and to have the sowing and harrowing to follow so closely upon the ploughing, as to diminish to the utmost the risk of hindrance from wet weather. As the crops of turnips, mangel, or carrots arrive at maturity and are either removed to the store-heap or consumed by sheep where they grow, successive sowings of wheat can be made as the ploughing is accomplished, and as the weather permits. It is to be noted, however, that it is only on soils naturally dry, or made so by thorough draining, and which are also clean, and in a high state of fertility, that wheat-sowing can be continued with advantage during the months of December and January. If the whole of these conditions do not obtain, it is wiser to refrain until February or March. When these late winter sowings are made, it is of especial importance to sow close up to the ploughs daily, as a very slight fall of rain will, at this season, unfit the land for bearing the harrows. This sowing and harrowing, in detail, is the more easily managed, that in the circumstances cross-harrowing is neither necessary nor expedient. Under the most favourable conditions as to weather and drainage, soils with even a slight admixture of clay in their composition will at this season plough up somewhat clammy, so that cross-harrowing pulls the furrows too much about, and exposes the seed, instead of covering it more perfectly. Two double tines of the harrows *lengthwise*, is as much as should be attempted at this season.

Sowing after green crops.

Spring wheat.

The sowing of spring-wheat is only expedient on dry and fertile soils with a good exposure. Unless the whole conditions are favourable, there is much risk of spring-sown wheat being too late to get properly ripened, or well harvested. On the dry and fertile soils in the valley of the Tweed, where the entire fallow break is sown with turnips, and where consequently it is difficult to get a large breadth cleared in time for sowing wheat in autumn, it is the practice to sow it largely in February and March, and frequently with good success. Many judicious farmers are, however, of opinion that, taking the average of a twenty years' lease, barley is a more remunerative crop than spring-sown wheat, even under circumstances most favourable to the latter. When it is resolved to try it, a very full allowance of seed should be given—not less than *three* bushels per acre, and $3\frac{1}{2}$ will often be better. If the plants have room they will tiller; and thus the ripening of the crop is retarded, the risk of mildew increased, and the quality of the grain deteriorated. As much seed should therefore be sown as will yield plants enough to occupy the ground fully from the first, and thus remove the temptation to tillering. By such full seeding a fortnight is frequently gained in the ripening of the crop, and this as frequently makes all the difference betwixt a remunerative crop and a losing one.

Thick and thin seeding.

Much controversy has taken place of late years about the quantities of seed-wheat which should be used per acre. The advocates of thin-seeding have been so unguarded and extravagant in their encomiums of their favourite practice, some of them insisting that anything more than a few quarts per acre does but waste seed and lessen the produce—that many persons have been induced to depart from their usual practice to their serious cost. It is true that with land in a high state of fertility, and kept scrupulously clean by frequent hoeings, a full crop of wheat may be obtained from *half* a bushel of seed per acre, provided that it is sown in September, and deposited regularly over the surface. But what beyond a trifling saving of seed is gained by this practice? And at what cost and hazard is even this secured? It is a mere fallacy to tell us, as the advocates of excessively thin seeding so often do, that they obtain an increase of so many hundred-fold; whereas, thick seeders cannot exceed from twelve to twenty fold, when after all the gross produce of the latter may exceed that of the former by more than the quantity of seed saved, with less expense in culture, less risk from accidents and disease, an earlier harvest and a better quality of grain. Such a crowding of the ground with plants as prevents the proper development of the ear is of course to be avoided; but the most experienced growers of

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wheat are convinced of the benefit of having the ground fully occupied at the time when active spring growth begins. This is secured by using two bushels per acre for the sowing, made early in October, and by increasing this quantity at the rate of half a peck per week until three bushels is reached, which may be held as the maximum. Less than this should not be used from the middle of November to the end of the season. These are the quantities to be used in broad-cast sowing; when drilling or dibbling is resorted to, two-fifths less seed will suffice. In Scotland, at least, often-repeated trials have shewn that larger crops are obtained by broad-casting than by drilling. The latter mode is however to be preferred wherever the land is infected by annual weeds, which can then be got rid of by hoeing. When clover and grass-seeds are sown with the grain crop it is believed also that they thrive better from the grain being sown in rows, probably because in this case light and air are less excluded from them. It is believed also that in highly-manured soils of a loose texture grain deposited somewhat deeply in rows is less liable to lodge than when sown broad-cast and shallower. When drilling and hoeing are resorted to, the latter is effected most cheaply and effectively by using Garret's horse-hoe. The mere stirring of the soil is considered by many farmers to be so beneficial to the wheat crop that they use the horse-hoe irrespective of the presence of weeds. Others are of opinion that, apart from the destruction of weeds, hoeing is injurious to grain crops, alleging that the cutting of their surface roots weakens the stems and increases their liability to fall over. Carefully conducted experiments are required to settle this point. We have no personal experience bearing upon it beyond this, that we have repeatedly seen a wheat crop much benefited by mere harrowing in spring. It is always useful to roll wheat, and indeed all cereal crops, in order to facilitate the reaping process although no other benefit should result from it. When the plants have been loosened by severe frosts, or are suffering from the attacks of wire-worms, the use of Crosskill's roller is usually of great benefit to the crop.

Broad-cast *versus* drilling.

Tull's system revived by Mr Smith of Lois Weedon.

A plan of growing wheat year after year on the same field without the use of manure has been practised for several years past by the Rev. Mr Smith of Lois Weedon, Northamptonshire, and detailed by him in the pages of the *Royal Agricultural Society's Journal*, and in a pamphlet which has now had a very extensive circulation. His plan is to a certain extent a revival of that of Jethro Tull; but with this important difference, that whereas Tull occupied his ground with alternate double rows of wheat a foot apart, and vacant spaces five feet wide, which were carefully cultivated by ploughings and horse-hoeings repeated at intervals, from the springing of the wheat until midsummer, Mr Smith introduces two important elements in addition, viz., thorough draining and trenching the vacant spaces in autumn so as to bring portions of subsoil to the surface. A field treated on this system consists of alternate strips of wheat and bare fallow, which are made to exchange places year by year, so that each successive crop occupies a different site from its immediate predecessor. It has also the benefit of the fresh soil brought up by the previous autumn's double-digging, which is subsequently mellowed and pulverised by lengthened exposure to the atmosphere, and by frequent stirrings. The produce obtained by Mr Smith from his acre thus treated has been very nearly 34 bushels each year for five successive years. At first he restricted himself to the employment of manual labour, but he has since invented a set of implements for sowing, covering in, rolling, and hoeing his crops by horse labour. We give in his own words his directions for carrying out this system, what he believes to be the advantages of it, and the cost of thus cultivating an acre.

"I suppose, at the outset, the land intended for wheat, to be wheat land; having besides a fair depth of staple, and a subsoil, as will generally, though not universally, be the case, of the same chemical composition with the surface. I suppose it dry; or drained three feet deep *at least;* well cleaned of weeds; the lands cast; and the whole tolerably level.

"1. First of all, then, plough the whole land, when dry, one inch deeper than the used staple. If it turn up cloddy, bring the clods down with the roller or the crusher. Let this be done, if possible, in August. Harrow deep; so as to get five or six inches of loose mould to admit the presser. Before sowing wait for rain. After the rain wait for a fine day or two to dry the surface. With this early commencement a week or two is of no material importance compared with that of ploughing dry and sowing wet.

"As early as possible, however, in September, get in your seed with the presser-drill; or with some implement which forms a firm-bedded channel in which to deposit the seed, grain by grain, a few inches apart. Cover over with the crusher or rough roller.

"2. When the lines of wheat appear above ground, guard against the rook, the lark, and the slug; a trite suggestion, but ever needful, especially here. And now, and at spring, and all through summer, watch for the weeds, and wage constant warfare against them. The battle may last for a year or two, or in some foul cases even more; but, in the end, the mastery, and its fruits, without fail, will be yours.

"3. The plant being now distinctly visible, dig the intervals two spits deep; increasing the depth, year after year, till they come to twenty or twenty-four inches. Bring up at first only four, or five, or six inches, according to the nature of the subsoil, whether tenacious, or loamy, or light. To bring up more at the outset would be *a wasteful and injurious expense.*

"The digging is done thus: Before proceeding with the work, a few cuts are made within three inches of the wheat, the back of the spade being towards the rows. A few double spits, first of all, at the required depth, are then thrown out on the headland, and there left for the present. After this, as the digging proceeds, the staple is cast to the bottom, and the subsoil thrown gently on the top. This process is carried on throughout the whole interval; at the end of which interval, just so much space is left vacant as was occupied by the soil thrown out at the beginning of it. In commencing the second interval at that finished end, the earth is thrown out as at first, not on the headland, however, but into the vacant space of the first interval. And so on all over the acre.

"4. Late in winter, and early in spring watch your opportunity, in dry weather, before the roots of the plant are laid bare, to press them with the crusher.

"5. In the spring, and early summer, stir the spaces between the rows as often as the surface becomes crusted over; and move the settled intervals four or five inches deep, with the common scarifier, set first of all about 28 inches wide; reducing the width till it come by degrees to 24 and 18 inches. Continue the process, if possible, at the last-named width, up to the time of flowering in June.

"These operations are indispensable to full success; and happily can be carried on at little cost. For, while the intervals of each acre can be scarified in 50 minutes, the horse-hoe implement, covering two lands at once, can stir between the rows in 25.

"6. Immediately the crop is carried, clean the intervals, and move them with the scarifier in order to *sow*, without delay, the shed grains. When these vegetate and come up into plant, move the intervals again, five or six inches deep, and so destroy them. After that, level with the harrow implement, and the land is ready for the drill.

"If anything occur to prevent the sowing early in September, and to drive you to the end f October, set the drill for a thicker crop. But, if possible, sow early. For this reason. Tillered wheat has a bad name. But that has reference only to wheat which has tillered late in the spring. And certainly, in that case, there is the fear of danger to the crop and danger to the sample. For, supposing no mildew to fall on it, even then the plant ripens unevenly; the early stems being ready for the sickle, while the late grown shoots have scarcely lost

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their verdure. But if mildew come when the stem is soft and succulent and porous, instead of being, as it should be at that time, glazed and case-hardened against its attacks, the enemy enters in and checks the circulating sap; and the end is, blackened straw, light ears, and shrivelled grain. Therefore, sow early. Let the plant tiller before winter. Give every stem an equal start at spring; and then, with a strict adherence to rule, there need be no alarm as to the result, subject only to those visitations from which no wheat on any system, in the same description of soil, and under the same climate, is secure." (See pamphlet, *Word in Season*, p. 36.)

"The advantages of the system of corn-growing which I have described are principally these. First, while one crop of wheat is growing, the unsown intervals of the acre are being fallowed and prepared for another. This the farmer well knows to be of infinite moment, meeting, as it does, one of the greatest difficulties he has to contend with. Next, upon this half-portion of the acre, tilled as I describe, there is a yield equal to average crops on a whole acre. Then, for half the portion of an acre, there is, of course, only half the labour and half the expense of an entire acre required for cultivation. And lastly, the hand-labour required finds constant employment for the poor."—(*Ibid.*, p. 17.)

"After harrowing, and cleaning, and levelling the whole, I marked out the channels for the seed with my *presser implement*, which is drawn with one horse, and presses two lands at once. My scheme of implements, to be complete, embraced a drill, which was to act immediately behind the presser-wheels, and to drop seed by seed into the hard channels. The spindle of the presser was to turn the drill-wheels, and the boxes were to be made removeable. Being unable to accomplish this in time for this year's sowing, I had the seed, as heretofore, dropped by hands, and covered over by rollers.

"These rollers form the *roller implement* in the same frame, and are managed thus: the three-wheeled pressers are removed from their sockets, and in their place two rough rollers formed of several wheels on the self-cleaning principle, are introduced, and cover over two lands at once.

"The portion of the field thus seeded will lie in this firm but rough state till spring time. Then, when the rollers have been applied again to keep the roots of the plant well in their place, they too will be removed from the frame, and light wheels and hoes will be attached; forming the *horse-hoe implement*, for hoeing and stirring between the wheat.

"There is yet one other use for the implement frame. The intervals of the wheat having been trenched in autumn, and well and frequently stirred by the common scarifier at spring, are shut out by the wide-spreading wheat-plant in June from all further processes till the crop is cut and carried. They are then to be moved and levelled by the common one-horse scarifier, for seed-time. After this will follow the harrow. The hoes will be removed from the frame, and two small harrows will be attached, to cover two lands at once; and with this implement the horse will walk on the stubble-land, between what before were the intervals; and the cycle of operations is now complete.

"In all these operations (excepting in that of scarifying), the sown lands, and lands about to be made ready for sowing, are untouched by the foot of man or horse.

"The time occupied in scarifying the land is about an hour the acre; in heavily pressing the channels for the seed, half-an-hour; in the other operations about 20 or 25 minutes."—(Pp. 25-26.)

"The presser-drill, spoken of in p. 25, is completed, and I now sow the four acres in 90 minutes, timed by watch; being at the rate of 18 or 20 acres a day in a day of 8 hours, with a horse of average power and speed.

"It has been thought advisable to keep the drill in its own frame,—devoting another frame to the roller-wheels or crusher, the hoes, the scarifiers, and harrows; all of which are made removeable, and which, with the exception of the spade, the hand-hoe, and the common scarifier for stirring the intervals, perform the whole cycle of operations for cultivating the land for wheat."—(Pp. 33-34.)

"I have only to shew now, by my fresh balance-sheet, how, with suitable implements, on wheat-land, the whole scheme I propose is economical, as well as easy and expeditious.

| | £ | s. | d. |
|---|---|---|---|
| "One double-digging in autumn, | £1 | 10 | 0 |
| Three stirrings with scarifier at spring (6d.), | 0 | 3 | 0 |
| One ditto with scarifier and harrow implement, before sowing, | 0 | 1 | 0 |
| Two pecks of seed (5s. the bushel), | 0 | 2 | 6 |
| Pressing and drilling, | 0 | 1 | 0 |
| Rough rolling, | 0 | 0 | 6 |
| Four hoeings between wheat with horse-shoe implement (6d.), | 0 | 2 | 0 |
| Bird-keeping, | 0 | 2 | 0 |
| All the operations from reaping to marketing, | 1 | 2 | 0 |
| Rates, taxes, and interest, | 0 | 10 | 0 |
| Total amount of outlay, | £3 | 14 | 0" |

"The produce, supposing it equal to that of former years, in round numbers, would be:—

| | £ | s. | d. |
|---|---|---|---|
| "Four quarters and two bushels of wheat (at 40s.), | £8 | 10 | 0 |
| One ton and 12 cwt. of straw (at £2 the ton), | 3 | 4 | 0 |
| | £11 | 14 | 0 |
| Deduct outlay, | 3 | 14 | 0 |
| Total amount of profit, | £8 | 0 | 0" |

—(*Ibid.*, p. 30.)

Public attention has more recently been directed to this system of wheat culture by a lecture on Tull's husbandry, delivered by Professor Way, at a council meeting of the Royal Agricultural Society of England, and by the animated discussion which followed; when several gentlemen who had visited Mr Smith's farm bore testimony to the continued excellence of his crops, and intimated that they and others had begun to test the system upon their own farms. If such a practice can indeed be pursued on the generality of clay-soils, then the puzzling problem of how to cultivate them with a profit is solved at once. It is impossible that practical farmers should regard otherwise than with incredulity a system which so flatly contradicts all existing theory and practice. The facts submitted to them by Mr Smith being beyond challenge, they will, in the meantime, hold to the belief that there is some peculiarity in the soil at Lois Weedon which enables it to sustain, as yet, such heavy and continued demands on its fertility; and that the issue, there and elsewhere, must ere long be utter sterility. For our own part, believing that we have exceeding much to learn in every department of agriculture, we cannot thus summarily dispose of these facts. We simply accept them as true, and leave the exposition of them to *experience*, whose verdict we await with much interest.

Mr Lawes' experiments.

But Mr Smith is not the only person who has furnished us with information regarding the continuous growth of wheat for a series of years on the same soil. Mr Lawes, at Rothamstead, in Herts, so well known by his interesting papers on agricultural chemistry in the *Royal Agricultural Society's Journal*, has furnished some facts in connection with the culture of wheat on clay soils, to which farmers were little prepared to give credence. Mr Caird, who visited Rothamstead early in 1851, thus refers to this subject in his valuable work:—

"On a soil of heavy loam, on which sheep cannot be fed on turnips, 4, 5, and 6 feet above the chalk, and therefore uninfluenced by it, except in so far as it is thereby naturally drained, *ten* crops of wheat have been taken in succession, one portion always without any manure whatever, and the rest with a variety of manures, the effects of which have been carefully observed. The seed is of the red cluster variety, drilled uniformly in rows at 8 inches apart, and two bushels to the acre, hand-hoed twice in spring, and kept perfectly free from weeds. When the crop is removed the land is scarified with Bentall's skimmer, all weeds are removed, it is ploughed once, and the

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seed for the next crop is then drilled in. During the ten years, the land, in a natural state, without manure, has produced a uniform average of 16 bushels of wheat an acre, with 100 lb. of straw per bushel of wheat, the actual quantity varying with the change of seasons between 14 and 20 bushels. The repetition of the crop has made no diminution or change in the uniformity of the average, and the conclusion seems to be established, that if the land is kept clean, and worked at proper seasons, it is impossible to exhaust this soil below the power of producing 16 bushels of wheat every year.

" But this natural produce may be doubled by the application of certain manures. Of these, Mr Lawes' experiments led him to conclude that ammonia is the essential requisite. His conclusions are almost uniform, that no organic matter affects the produce of wheat, except in so far as it yields ammonia ; and that the whole of the organic matter of the corn crop is taken from the atmosphere by the medium of ammonia. There is a constant loss of ammonia going on by expiration, so that a larger quantity must be supplied than is contained in the crop. For practical purposes, 5 lb. of ammonia is found to produce a bushel of wheat, and the cheapest form of ammonia at present being Peruvian guano, 1 cwt. of that substance may be calculated to give 4 bushels of wheat. The natural produce of 16 bushels an acre may therefore be doubled by an application of 4 cwt. of Peruvian guano. To this, however, there is a limit,—climate. Ammonia gives growth, but it depends on climate whether that produce is straw or corn. In a wet cold summer, a heavy application of ammonia produces an undue development of the circulating condition of the plant, the crop is laid, and the farmer's hopes are disappointed. Seven of corn to ten of straw is usually the most productive crop ; five to ten seldom yields well. The prudent farmer will therefore regulate his application of ammonia with a reference to the average character of the climate in which his farm is situated.

" The practical conclusion at which we arrive is this, that in the cultivation of a clay-land farm, of similar quality of soil to that of Mr Lawes', there is no other restriction necessary than to keep the land clean. That while it is very possible to reduce the land by weeds, it is impossible to *exhaust* it (to a certain point it may be *reduced*), by cleanly cultivated corn crops. That it is an ascertained fact that wheat may be taken on soils of this description (provided they are manured) year after year with no other limit than the necessity for cleaning the land, and that may best be accomplished by an occasional green crop—turnip or mangold, as best suits—at great intervals, the straw being brought to the most rotten state, and applied in the greatest possible quantity to insure a good crop, which will clean the land well. If these conclusions are satisfactorily proved, the present mode of cultivating heavy clays may be greatly changed, and the owners and occupiers of such soils be better compensated in their cultivation than they have of late had reason to anticipate." (Caird's *English Agriculture*, in 1850 and 1851, pp. 460-462.)

It is certainly curious to observe, that the addition of 4 cwt. of guano brings up the produce of Mr Lawes' acre from its average annual rate of 16 bushels, under its reduced normal state, to very nearly the same as Rev. Mr Smith's acre under his system of alternate strips of corn and summer fallow.

Average yield of wheat.

From information carefully gathered, Mr Caird gives it as his opinion, that the average produce of wheat per acre in 26 of the 32 counties of England visited by him is $26\frac{2}{3}$ bushels, or 14 per cent. higher than it was estimated at in the same counties by Arthur Young 80 years before. Were the country generally anything like as well cultivated as particular farms that are to be met with in all parts of it, we should have the present average increased by at least 8 bushels per acre.

*Barley.*—In Great Britain, barley is the grain crop which ranks next in importance to wheat, both in an agricultural and social point of view. Its use as bread-corn is confined to portions of the lowlands of Scotland, where unleavened cakes, or " bannocks o' barley meal," still constitute the daily bread of the peasantry. It is more largely used in preparing the " barley broth" so much relished by all classes in Scotland. To fit the grain for this purpose, it is prepared by a peculiar kind of mill, originally introduced from Holland by Fletcher of Saltoun, in which a thick cylinder of gritty sandstone is made to revolve rapidly within a case of perforated sheet-iron. The barley is introduced betwixt the stone and its case, and there subjected to violent rubbing until first its husk, and then its outer coatings are removed. It is, however, in the production of malt liquor and ardent spirits, and in the fattening of live stock, that our barley crops are chiefly consumed. We have no doubt that it would be better for the whole community if this grain were more largely used in the form of butcher-meat, and greatly less in that of beer or whisky. It has been customary for farmers to look upon distillation as beneficial to them from the ready market which it affords for barley, and more especially for the lighter qualities of this and other grain crops. But this is a very short-sighted view of the matter ; for careful calculation shows that, when the labouring man spends a shilling in the dram-shop, not more than a penny of it goes for the agricultural produce (barley), from which the gin or whisky is made ; whereas, when he spends the same sum with the butcher or baker, nearly the whole amount goes for the raw material, and only a fraction for the tradesman's profits. And not only so, but the man who spends a part of his wages upon strong drink, diminishes, both directly and indirectly, his ability to buy wholesome food and good clothing ; so that, apart from the moral and social bearings of this question, it can abundantly be shown that whisky or beer is the very worst form for the farmer in which his grain can be consumed. Were the L.50,000,000 at present annually spent in Great Britain upon ardent spirits (not to speak of beer), employed in purchasing bread, meat, dairy produce, vegetables, woollen and linen clothing, farmers would, on the one hand, be relieved from oppressive rates, and, on the other, have such an increased demand for their staple products, as would far more than compensate for the closing of what is, at present, the chief outlet for their barley.

Wastefulness of brewing and distilling.

There are many varieties of barley in cultivation, and some of them are known by different names in different districts. Those most esteemed at present in Berwickshire and neighbouring counties, are the chevalier, the annat, and the common early long-eared. The chevalier produces the finest and heaviest grain, weighing usually from 54 lb. to 56 lb. per bushel, and is in high estimation with maltsters. It is also tall and stout in the straw, which is less liable to lodge than that of the common barley ; and when this accident does happen, it has the valuable property of not producing aftershoots or greens. It requires about fourteen days longer than the common-early to reach maturity, but as it admits of being sown earlier than the latter sort, this is in practice no drawback to it. The annat barley resembles the chevalier in its leading features, but is yellower in its complexion, and not quite so round in the grain. It ripens a few days earlier than the chevalier, and in our own experience is more productive. The common-early is more liable than those just noticed to suffer from over-luxuriance. It is generally used for the latest sowings, on those portions of land from which the turnip crop has been longest in being removed.

Varieties of barley.

In the elevated or northern parts of the kingdom, four-rowed barley, usually called *Bere* or *Bigg* is cultivated, as it is more hardy, and ripens earlier than the two-rowed varieties. A new variety called Victoria Bere is said to be so productive, and to yield such a heavy sample, as to be worthy of cultivation even in lowland districts.

Bere or Bigg.

Barley delights in a warm, friable soil, and thrives best when the seed is deposited rather deeply in a tilthy bed. Being the grain crop best adapted for succeeding turnips

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that have been consumed by sheep-folding, advantage must be taken of favouring weather to plough up the land in successive portions, as the sheep-fold is shifted. So much of it as is ploughed before 1st February will usually get so mellowed by the weather as to be easily brought into suitable condition for receiving the seed. In Scotland, the usual practice is to sow broad-cast on this stale furrow, and to cover the seed by simple harrowing. A better way is first to level the surface by a stroke of the harrows, and then to form it into ribs *twelve* inches apart, by such an implement as has been described, when speaking of Tennant's grubber. Over this corrugated surface the seed is sown broad-cast, and covered by another turn of the harrows. The ribbing loosens the soil, gives the seed a uniform and sufficient covering, and deposits it in rows. The only advantage of such ribbing over drilling is, that the soil is better stirred, and the seed deposited more deeply, and less crowded than is done by the ordinary drills. It is certainly of great advantage to have the seed-corn deposited in narrow lines, so far as the working of the horse-hoe is concerned; but we are convinced that stiffer stems, larger ears, a more abundant yield, and a brighter sample are likely to be obtained when the seed is loosely scattered in a channel 3 or 4 inches wide than when crowded into a narrow line. This grain is now sown considerably earlier than heretofore. When the soil is enriched by plentiful manuring, its temperature raised by thorough draining, and the climate and exposure favourable, it should be sown as early in March as possible, and will often do remarkably well although sown in February. This early sowing counteracts that tendency to over-luxuriance, by which the crop is so often ruined in fertile soils. It is chiefly owing to this early sowing (although aided by the use of hummelling machinery) that the average weight of barley is so much greater now than it was twenty years ago. From 53 lb. to 54 lb. per bushel is now about the average weight in well-cultivated districts; while 57 lb. and 58 lb. is by no means rare. The produce per acre ranges from 36 to 60 bushels; 44 bushels being about the average. The quantity of seed used per acre, is from $2\frac{1}{2}$ to 3 bushels, for broad-cast sowing, and about a third less when drilled. As already remarked in regard to wheat, it is well, as the season advances, to avoid, by a fuller allowance of seed, the temptation to excessive tillering, and consequent unequal and later ripening.

*Oats.*—Over a large portion of England oats are grown only as provender for horses, for which purpose they are fully ascertained to be superior to all other grains. Except, therefore, on fen-lands, and recently-reclaimed muiry soils, the cultivation of oats in south Britain bears a small proportion to the other cereals. It is in Scotland, "the land o' cakes," that this grain is most esteemed, and most extensively cultivated. Considerably more than half of the annual grain crops of Scotland consists in fact of oats. The important item which oatmeal porridge forms in the diet of her peasantry, and of the children of her other classes, has something to do with this extensive culture of the oat; but it arises mainly from its peculiar adaptation to her humid climate. As with the other cereals, there are very numerous varieties of the oat in cultivation. In Messrs Lawson's *Synopsis of the Vegetable Products of Scotland*, it is said (Div. i. p. 80.) "Our collection comprises nearly sixty varieties, about thirty of which are grown in Scotland; but of these not more than twelve are in general cultivation. These twelve varieties enumerated in the order of their general cultivation, are, the Potato, Hopetoun, Sandy, Early-Angus, Late-Angus, Grey-Angus, Blainslie, Berlie, Dun, Friesland, Black Tartarian, and Barbachlaw." The first four kinds in this list are those

Varieties in cultivation.

chiefly cultivated on the best class of soils. It is to the produce of these that the highest market prices usually have reference. The weight per bushel of these sorts usually runs from 42 lb. to 46 lb. From 50 to 60 bushels per acre is a usual yield of oats. The two last-named kinds are chiefly esteemed for their large produce, and adaptation to inferior soils; but being of coarse quality, they are chiefly used for provender. A variety which stands the winter is now frequently grown in England, for the double purpose of first yielding a seasonable supply of green food to ewes and lambs in early spring, and afterwards producing a crop of grain. It has already been stated that, in Scotland, wheat does not prosper when sown after clover or pasture; but with the oat it is quite the reverse, as it never grows better than on land newly broken up from grass. It is, accordingly, almost invariably sown at this stage of the rotation. The land is ploughed in December or January, beginning with the strongest soil, or that which has lain longest in grass, that it may have the longest exposure to the mellowing influences of wintry weather. In March or April, the oats are sown broad-cast on this first ploughing, and covered in by repeated harrowings. These are given lengthwise until the furrows are well broken down, for if the harrows are worked across the ridges, before this is effected, they catch hold of the edges of the slices, and partially lifting them, permit the seed-corn to fall to the bottom, where it is lost altogether. As it is only when a free tilth is obtained that the crop can be expected to prosper, care must be taken to plough early and somewhat deeply, laying the furrows over with a rectangular shoulder; to sow when the land is in that state of dryness that admits of its crumbling readily when trode upon, and then to use the harrows until they move smoothly and freely in the loose soil, two or three inches deep. The Norwegian harrow is an important auxiliary to the common ones in obtaining this result. When wild mustard and other annual weeds abound, it is advisable to drill the crop and to use the horse-hoe. When the land is clean, the general belief in Scotland is that the largest crops are obtained by sowing broad-cast. When the latter plan of sowing is adopted, from 4 to 6 bushels per acre is the quantity of seed used. The latter quantity is required in the case of the Hopetoun and other large-grained varieties. The condition of the soil as to richness and friability must also be taken into account in determining the quantity of seed to be used. When it is in high heart and likely to harrow kindly, a less quantity will suffice than under opposite conditions. In breaking up a tough old sward, even six bushels per acre may be too little to sow. The following very interesting experiment bearing on this point was recently made in Fifeshire. "Mr Gulland, Wemyss, offered a sweepstakes in 1850, that 4 bushels of oats, sown per Scotch acre, in poor land, would yield a better produce than 8 bushels sown under similar conditions. The late Mr Hill, maintaining the contrary, accepted the sweepstakes, and a number of others took up the same. Experiments were made by Mr Dingwall, Ramornie, and Mr Buist, Hattonhill. . . . :—

"In Mr Buist's experiments,

"4 bush. sown yielded 28 bush. per acre, 34 lb. per bush.
8 bush. sown yielded 36 „ „ $34\frac{1}{4}$ lb. „

"In Mr Dingwall's experiments,

4 bush. sown yielded 45 bush. per acre, $38\frac{1}{2}$ lb. per bush.
8 bush. sown yielded 49 „ „ 39 lb. „ "[1]

The advocates for thin seeding will of course regard even the least of these quantities as foolishly redundant. It is quite true, that if the land is in good heart, the crop will ultimately stand close to the ground from a very small seeding; but it will take two or three weeks longer to do this than if the

[1] *Agricultural Gazette*, 20th November 1852.

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land had been fully stocked with plants from the first, by giving it seed enough. In our precarious climate, where a late harvest and bad crops usually go together, it is of the utmost importance to secure early, uniform, and perfect ripening; and as liberal seeding tends directly to promote such a result, practical farmers will do well to take care how they omit such a simple means of attaining so important an end. We believe that it is on the principle now indicated that the superior result, both as respects quantity and quality of produce, in the double-seeded lots in the experiments now cited, is to be explained.

Change of seed.

As with wheat, the vigour and productiveness of the oat is much enhanced by frequent change of seed. Our agricultural authorities usually assert that the change should, if possible, always be from an earlier climate and better soil. This is undoubtedly true as regards high-lying districts; but with a good soil and climate, we have always seen the best results with seed from a later district.

Manures for oat crop.

On poor hard soils it is usually remunerative to apply a cwt. of guano per acre to the oat crop; sowing it broadcast, and harrowing it in, along with the seed. As much additional produce is thus ordinarily obtained as more than pays for the manure, and the land is, in all respects, left in better condition for the succeeding green crop. In the case both of very light and strong clay soils, we have obtained excellent results by applying a liberal dressing of farm-yard dung, in autumn, to grass-land about to be broken up for oats. By using, in this way, the dung produced during the summer months, we have obtained abundant crops of oats from portions of land which, but for this, would have yielded poorly; and, at the same time, by applying the bulky manure at this stage of the rotation, instead of directly for the succeeding green crop, an important saving of time and labour has been effected, as we shall have occasion to notice when treating of turnip-culture.

Diseases.

When the young oat plants have pushed their second leaf, it is always beneficial to use the roller, as it helps to protect the crop from the evil effects of drought, and facilitates the reaping of it. The oat frequently suffers much from a disease called "segging" or "tulip root," which appears to be caused by the presence of a maggot in the pith of the stems close to the ground. On land which is subject to this disease, it is advisable not to sow early. A dressing of lime is also believed to be serviceable as a preventative. On muiry soils, this crop is also not unfrequently lost by what is called "*slaying.*" This seems to result from the occurrence of frosty nights late in spring when the crop is in its young stage, and which, when grown on such soils, it cannot withstand. The best remedy is to improve the texture of the soil by a good coating of clay.

*Rye.*—The extensive cultivation of this grain in any country being alike indicative of a low state of agriculture, and of a poor style of living among its peasantry, it must be regarded as a happy circumstance, that it has become nearly obsolete in Great Britain. It is still occasionally met with in some of our poorest sandy soils, and patches are occasionally grown elsewhere for the sake of the straw, which is in estimation for thatching—for making bee-hives, and for stuffing horse-collars. Its cultivation as a catch crop, to furnish early food for sheep in spring, is on the increase.

### LEGUMINOUS CROPS.

The only members of this family statedly cultivated for their grain are beans and pease. Before the introduction of clover and turnips these legumes occupied a more important place in the estimation of the husbandman than they have done since. Indeed, in many districts naturally well adapted for the culture of turnips, that of beans and pease was for a time all but abandoned. Recently, however, increasing precariousness in the growth of clover, and even of turnips, where they have been sown on the same ground every fourth year for a lengthened period, has compelled farmers to return to the culture of beans and pease for the mere purpose of prolonging the intervals in the periodic recurrence of the former crops. But it is found, in regard to the bean itself, in districts where it has long occupied a stated place in rotations of six or seven years, that its average produce gradually diminishes. We have thus an additional illustration of the importance of introducing as great a variety of crops as possible into our field culture. It is on this principle that beans and pease are now again extensively cultivated on dry friable soils. Winter beans, or pease of some early variety, are generally preferred in such cases. The grain of these legumes, though partially used for human food, is chiefly consumed by horses and by fattening cattle and sheep. Being highly nutritious, they are well adapted for this purpose. By growing beans on a limited portion of the land assigned to cattle crops, a larger weight of beef and mutton can be produced from a given number of acres, than by occupying them wholly with roots, forage, and pasturage. Several varieties of field beans are cultivated in Great Britain; such as the common horse bean, the tick, the Heligoland, and the winter bean. The latter was introduced into England about the year 1825, and there rises steadily in estimation. It has been tried in many parts of Scotland and proves quite hardy, but is objected to from the exceeding shortness of its straw. But for this, it is a valuable acquisition, as it ripens so much earlier than the spring-sown varieties. Beans are either sown broad-cast, dibbled in narrow rows, or drilled at intervals varying from a foot to 27 inches. The last is undoubtedly the best method; regard being had both to the amount and quality of produce, and to the effects of bean culture on the after crops. Beans should never be sown on land that is foul. By diligent horse and hand hoeing, land that is clean to begin with, can be kept so under beans, and left in fine condition for carrying a white corn crop; but in opposite circumstances it is sure to get into utter confusion. It is found advisable therefore to take beans after the white crop that has succeeded roots or a bare fallow. In Berwickshire, where a five years' course, consisting of turnips, wheat or barley, two years seeds, and oats has long prevailed, beans are now not unfrequently introduced by substituting them for the second year's grass. A four years' course with beans instead of a portion of the seeds is certainly preferable. In cultivating this crop, the land is ploughed with a deep furrow in autumn, a dressing of dung being first spread over the surface and turned in by the plough. As soon in March as the state of the land admits, it is stirred by the cultivator, harrowed, and formed, by a single turn of the common plough, into shallow drills twenty-seven inches apart. Ten or twelve such drills being formed to begin with, the seed is scattered broad-cast, at the rate of 3 bushels per acre, by a sower who takes in six of these drills at a time, and gives them a double cast. The beans either roll into the hollows as they fall, or are turned in by the ploughs, which now proceed to open, each a fresh drill, in going down the one side of the working interval, and to cover in a seeded one in returning on the other side. If tares are cultivated on the farm, it is usual to sow a small quantity (say a peck per acre) amongst the beans, on which they are borne up and so ripen their seeds better, and yield more abundantly, than when trailing on the ground. When the crop comes to be thrashed, the tares are easily separated from the beans by sifting. Ten days or so after sowing, the drills are harrowed down; and, if the land is cloddy, it is smoothed by a light roller. If showers occur when the bean plants are appearing above ground, or shortly after, the harrows are used again with the best effect in pulverising the

Grain Crops.

Winter bean.

Time and manner of sowing.

Mixture with vetches.

Culture.

Grain Crops.

soil and destroying newly-sprung weeds. A horse and hand hoeing is then given, and is repeated if weeds again appear. When the plants have got about 6 inches high, it is beneficial to stir the soil deeply betwixt the rows by using Tennant's grubber, drawn by a pair of horses. For this purpose the tines are set so close together as to clear the rows of beans, and the horses are yoked to it by a main tree, long enough to allow the horses to work abreast in the rows, on either side of the one operated upon. The soil is thus worked thoroughly to the depth of 6 or 8 inches, without reversing the surface and exposing it to drought, or risk of throwing it upon the plants. Just before the blooms appear, some farmers pass a bulking-plough betwixt the rows, working it very shallow, and so as merely to move the surface-soil towards the plants. This may do good; but a deep earthing up is hurtful. When the blooms open, all operations should cease, as otherwise, much mischief may be done. Such an amount of culture may be thought needlessly costly and laborious; but unless a bean crop is kept clean, it had better not be sown. And it is to be remembered that the benefit of this careful tillage is not confined to it, but will be equally shared in by the wheat crop that follows. The culture of winter beans differs only in this; that they require to be sown as early in autumn as the removal of the preceding grain crop admits of.

*Pease* are sown in circumstances similiar to those just detailed; but they are better adapted than beans to light soils. They too are best cultivated in rows of such a width as to admit of horse-hoeing. The early stage at which they fall over, and forbid further culture, renders it even more needful than in the case of beans to sow them only on land already clean. If annual weeds can be kept in check until the pease once get a close cover, they then occupy the ground so completely, that nothing else can live under them; and the ground, after their removal, is found in the choicest condition. A thin crop of pease should never be allowed to stand, as the land is sure to get perfectly wild. The difficulty of getting this crop well harvested renders it peculiarly advisable to sow only the early varieties.

Bean straw as fodder.

In Scotland the haulm of beans is esteemed an excellent fodder for horses and other live stock; whereas in England it is thought unfit for such a use. The reason of this appears to be, that in the southern counties beans are allowed to stand until the leaf is gone, and the stems blackened before reaping; whereas in Scotland they are reaped so soon as the eye of the grain gets black. When well got, the juices of the plant are thus, to some extent, retained in the haulm, which, in consequence, is much relished by live stock, and yields a wholesome and nutritious fodder.

The cereals and legumes now enumerated, constitute the staple grain-crops of Great Britain. Others are grown occasionally, but more for curiosity than profit. Zealous attempts were made by the late William Cobbett to introduce *maize* or *Indian corn* as one of our regular crops. It has been conclusively proved that none of its varieties, yet tried, can be ripened in the ordinary seasons of this country. It has indeed been suggested that it might form a useful addition to our garden vegetables—using it, as it is done in America, by cooking the unripe cobs; and also that we might grow it beneficially as a forage crop. *Lentiles* have recently been grown in different parts of the country; but both of these grains can be imported of better quality, and at less cost, than they can be grown at home.

Maize.

Lentiles.

There is great inducement to agriculturists to endeavour more earnestly to obtain improved varieties of grain by cross-impregnation of existing ones. Something has already been accomplished in this direction; but only enough to show what encouragement there is to persevere. Whenever the same skill and perseverance are directed to the improvement of field crops, that our gardeners are constantly exerting, with such astonishing results, on fruits, flowers, and vegetables, we may anticipate a great increase of produce, not only from the discovery of more fruitful varieties, but of such as possess a special adaption to every diversity in the soil and climate of our territory.

### HARVESTING OF GRAIN CROPS, AND THEIR PREPARATION FOR MARKET.

Reaping with the sickle.

Several distinct modes of reaping grain are in use. The most ancient, and still the most common is by the sickle or reaping-hook, which is used either with a smooth or serrated edge. The latter was at one time preferred, as by it the work was performed most accurately. The smooth-edged instrument is, however, now the favourite, as it requires less exertion to use it, and the reaper can, in consequence, get through more work in a day; and also, because in using it the grain is less compressed, and consequently dries faster when made into sheaves. In some parts of England the crops are reaped in a method called *fagging* or *bagging*. The cutting instrument used is heavier, straighter, and broader in the blade than the common reaping-hook. The workman uses it with a slashing stroke, and gathers the cut corn as he proceeds by means of a hooked stick held in his left hand. It is a similar process to the mode of reaping with the Hainault scythe,—an instrument which has been tried in this country, but never adopted to any extent. The common scythe, especially with that form of handle known as the Aberdeen handle or *sned*, is very extensively used for reaping grain in all parts of the kingdom. Indeed the practice of mowing grain has been increasing of late years, and would extend more rapidly, but for the greater difficulty of finding good mowers than good reapers. A greater amount of dexterity is required to cut grain well by the scythe than by the sickle. The difficulty lies not in making smooth and clean stubble, but in so laying the swathe as to admit of the corn being sheaved accurately. When the mower lays his swathe at right angles to his line of progress, and the gatherer is skilful and careful, corn may be handled as neatly in reaping by the scythe as by the sickle. When the crops are not much laid or twisted, mowing is somewhat the cheapest of these modes of reaping. Its chief recommendation, however, is that mown sheaves dry most quickly, and suffer least from a drenching rain. This arises from the stems being less handled, and so forming an open sheaf, through which the wind penetrates freely. Tightly-bound sheaves are always difficult to dry. If it be true that we have at last got a really effective reaping-machine, it is probable that corn cut down by it will also possess this property of rapid drying.

Fagging.

Mowing.

In Berwickshire and adjoining counties, the reaping of the crops has hitherto been accomplished by employing, at days' wages, such a number of reapers as suffices to cut down the crops on each farm in from twelve to twenty days. The rate of wages paid to reapers for a number of years has ranged from 2s. to 2s. 6d. each *per diem*, with victuals in addition, costing about *eightpence* for each person. In marshalling the band, two reapers are placed on each ridge of 15 feet in breadth, with a binder to each *four* reapers, and a steward, or the farmer in person, to superintend the whole. When the crop is of average bulk, and lies favourable for reaping, each *bandwin*, or set of *four* reapers and a binder, clear *two* acres in a day of *ten* hours; but $1\frac{1}{4}$ to $1\frac{1}{2}$ acres only, if it is bulky and lodged. The cost of reaping by this method is therefore from 7s. 6d. to 12s. per acre. With such a reaping-machine as Bell's, cutting, say eight acres *per diem*, and requiring in all ten persons (five men and five women or stout lads), to attend to and clear up after it, at an average wage, including victuals, of 2s. 6d. each; and allowing

Grain Crops.

Reaping by machinery.

3s. *per diem* to cover tear and wear, and interest on its prime cost, there seems a reasonable prospect of a goodly portion of our future crops being reaped for about 3s. 6d. per acre. The labour of the horses employed in working the reaper is not included in this estimate, as at this season they would otherwise be idle, and yet eating nearly as much food as when at work. There would thus be a saving in actual outlay of 4s. per acre. But this is the least important view of the matter. On a Berwickshire farm producing 200 acres of crop, there are usually at least six pairs of horses kept, with a resident population, sufficient to yield about thirty persons (including women and youths), available for harvest labour. The stated forces of such a farm will therefore suffice to man *two* reaping-machines, and leave ten persons still available for opening up fields, clearing corners, and reaping such portions as the machines cannot deal with. In unfavourable seasons, one machine only might be able to work with twenty persons using the scythe or sickle. In either way the crop could be cut down in from ten to fifteen days with little or no extraneous aid; whereas, to accomplish it in the same time by hand labour only, from fifty to sixty persons are required. The rapidity and accuracy with which the sowing of grain is now accomplished, frequently issues in the whole crops of a wide district being simultaneously ready for the sickle. The consequence is, that the supply of labourers proves insufficient—there is a scramble to get them—the rate of wages becomes exorbitant, employers are fain to submit to much sauciness and turbulence; and all the while the crops are suffering from over-ripening and are exposed to shaking winds. Great then will be the boon to farmers, if, by means of this invention, they can bring their own heavy cavalry into the field—dispense with the services of mercenaries,—reduce their actual outlay, and yet shorten the period and lessen the risk of the harvesting process. The call for reaping-machines is now, therefore, more urgent than ever. Perhaps we might add, it is only now that our agriculture has made sufficient progress in other respects to be ready to gear on to such machinery when presented to us.

When grain is fit for reaping.

It is now agreed on all hands that grain should be reaped before it becomes what is called *dead* ripe. In the case of wheat and oats, when the grains have ceased to yield a milky fluid on being pressed under the thumb-nail, and when the ears and a few inches of the stem immediately under them have become yellow, the sooner they are reaped the better. Barley requires to be somewhat more matured. Unless the pink stripes on the husk have disappeared, and the grain has acquired a firm substance, it will shrink in drying, and be deficient both in weight and colour. When allowed to stand till it gets curved in the neck, the straw of barley becomes so brittle that many ears break short off in the reaping; and it suffers even more than other grain-crops under a shaking wind.

Different modes of stooking sheaves.

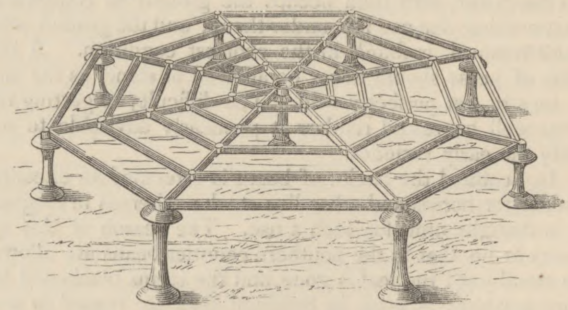
It is of great consequence to see that corn is dry when it is tied up in sheaves; that these are not too tightly bound, and that every sheaf is kept constantly on foot. From the increased demand for harvest labourers, and the rapidity with which operations must be carried forward, stooking is not now performed with the same accuracy that it was wont to be. There is therefore the greater need for employing a person to review the stooks daily, and keep every sheaf erect. It was formerly the practice in Scotland to set up oats and barley in full stooks of twelve sheaves each, viz., five pairs and two hood-sheaves. These hood-sheaves are an excellent defence when wet weather sets in, but they retard the drying of the corn in fine weather, and there are now few binders who can set them up so as to stand securely. It is better, therefore, to aim at rapid drying, and, for this purpose, to have the sheaves small individually, and to set but *four* or *six* of them together. Large sheaves are worse to dry than small ones, not only from their greater bulk, but from their being almost invariably tighter bound. The utmost vigilance is required on the part of farmers to avoid this fault.

Reaping of beans or pease.

Beans and pease are reaped by the sickle. The former are usually not bound into sheaves at once, but left prostrate in handfuls for a few days until they have withered a little. They are then sheaved, and bound with ties of twisted straw, which must be provided beforehand. In stacking beans, the tops of the sheaves are kept outwards, as by this means fewer pods are exposed to the weather, or to the depredations of fowls, &c., than when the butts are to the outside. Pease are rolled into wisps as they are reaped. and afterwards turned daily until they are fit to carry. When stacked, they must instantly be thatched, as they take in wet like a sponge.

Carrying in stacking grain crops.

It requires no little discrimination to know when sheaves are dry enough to keep in a stack. The farmer finds it for his profit to consult his most intelligent and experienced labourers on this point. On thrusting the hand into a sheaf sufficiently dried, there is a lightness and kindliness to the touch not easily mistaken when once understood. Whenever this is ascertained, the crop is carried with the utmost possible despatch. This is best accomplished by using one-horse carts, and by building the sheaves into round stacks of *ten* or *twelve* loads each. Very large stacks are for ostentation, not for profit. The labour of pitching up the sheaves to them is needlessly great; corn is much sooner in a state to keep in small stacks than in large ones, and sooner gets into condition for market; the crop is more accessible for thrashing in *ten*-load quantities than in huge ricks, and the crop of different fields and kinds of grain more easily kept separate.



YOUNG'S STACK-STOOL.

Stack stools.

It is always desirable to have the stacks built upon frames or stools elevated 18 or 20 inches from the ground. Besides the security from vermin thus attained, there is a free admission of air to every part, particularly when aided by a triangle of rough timber in the centre, which speedily insures thorough dryness in the whole stack. When stacks are built upon the ground, with a mere bedding of straw under them, the grain from the basement tiers of sheaves is often lighter by several pounds per bushel, than that from the rest of it. A farmer who has his rick-yard fully furnished with these frames, can often carry his crop without risk,—when, if built on the ground, it would inevitably heat,—and have the grain in condition for market earlier by months than in the latter case. We have elsewhere noticed a recent, but, perhaps, too costly improvement upon these stack-frames, viz., to have them mounted on wheels and set on rails, so that such stacks can be moved entire to the barn-door, when about to be thrashed.

Thatching stacks.

As the stacks are built, they are thatched without delay. For this purpose, careful farmers provide beforehand ample stores of thatch and straw ropes. The thatch is not elaborately drawn, but merely straightened a little as it falls from the thrashing-mill, tied into large bundles, and built up into stacks, where

Root Crops.

it gets compressed, and so lies more evenly than if used direct from the mill. A good coating of such thatch secured by straw ropes, interlacing each other in chequers, forms a secure and cheap covering, easily put on by ordinary farm-labourers; and possessing, with all its roughness, an air of unpretending rustic neatness, which harmonises well with surrounding objects, and which we greatly prefer to the elaborate ricks of the southern counties with their shaved sides, combed thatch, and weather-cock-a-peak. Apart from its cost, the shaving of stacks is objectionable, as they then suffer more from a beating rain or snow-drift, than when the natural roughness is left upon them, on the same principle that a coarse, shaggy topcoat shoots off wet, better than a smooth broadcloth.

With proper machinery propelled by steam or water, the thrashing and dressing of grain is a simple and inexpensive process. As grain is now universally sold with a reference to its weight per bushel, its relative value depends much upon its dryness and thorough freedom from chaff, dust, light grain, and seeds of weeds. Farmers who are systematically careful in the cultivation, harvesting, thrashing, and dressing of their crops, can always command the best prices of the day. In preparing a parcel of grain for market, it is a good plan to measure a few sacks very carefully, ascertain the average weight of these, and then fill every remaining sack to that weight exactly.

## CHAPTER VII.

### ROOT CROPS.

*Potato.*—The events of the past seven years render it necessary to regard this root somewhat differently than was warranted by its previous history. Its value, as an article of food, relished alike by prince and peasant, its easy culture, its adaptation to a very wide diversity of soil and climate, and the largeness of its produce, justly entitled it to the high esteem in which it was universally held. Like many other good gifts, it was, however, grossly abused, and diverted from its legitimate use. From an agreeable, wholesome addition to the daily food of the community, advantage was taken of its amazing productive powers, to put it in place of "the staff of life." In Ireland, and the Highlands of Scotland, the people already in a painfully degraded condition, and contented to exist with potatoes as their sole food from year's end to year's end, took occasion, from its very productiveness, under the rudest culture, to subdivide their lands, and marry prematurely, with reckless improvidence, and amid an ever-deepening degradation. We know now, from the utter prostration and helplessness into which this wretched population was at once thrown by the memorable potato disease, the terrible penalty which this abuse of "a good gift" has brought directly on the miserable sufferers, and indirectly on the whole community. It will be well if the stern lesson, enforced by famine and pestilence, have the effect of leading to a better social condition. Viewed in this light, the potato disease may yet prove a blessing to the nation. Its continued prevalence, although in a mitigated form, cannot well be regarded otherwise, when we remember the frantic eagerness with which the Irish peasantry replanted their favourite root on the first indication of its returning vigour, and the desperate energy with which they cling to it under repeated disappointments. Apart from this specialty, the precarious health of this important esculent is much to be regretted. It seems contrary to analogy to suppose that it is likely either to be entirely lost, or to manifest a permanent liability to this disease. It seems more natural to suppose that, by and by, this disease will disappear, or that some efficient remedy for it will be discovered. Railways now afford great facilities for transporting this bulky commodity at little expense to great distances, and thus render the market for it available to a wider district, and would, but for the disease, insure its more extended cultivation.

Effects of the "potato disease."

The varieties of the potato, whether for garden or field culture, are exceedingly numerous, and admit of endless increase by propagating from seeds. It would serve no useful purpose to enumerate here even a selection from the sorts in use in different parts of the country. In Messrs Lawson's *Synopsis of the Vegetable Products of Scotland*, a description of 175 kinds is given, to which the reader is referred for particulars. When the crop is grown for cattle food, bulk of produce will be the primary consideration; but for sale or family use, flavour, keeping quality, and handsome appearance, as well as good yield, will be particularly attended to. Exemption from disease is now a momentous consideration, whatever the use for which it is grown. There is this difficulty, however, connected with selections on the score of healthiness, that while in each season since the disease broke out, certain varieties have escaped, it is observed, from year to year, that the exempted list varies; certain kinds that had been previously healthy becoming as obnoxious to disease as any, and others in a great measure escaping that had suffered much before. Indeed, certain parties, from observing that diseased tubers left in the ground have produced healthy plants in the following season, have been induced purposely to plant diseased potatoes, and with good results. This, however, is probably due to the mere fact of their being kept in the earth.

Varieties exceedingly numerous.

In field culture, the potato is frequently grown on a portion of the fallow break; but its appropriate place in the rotation is that usually assigned to beans, with which, in an agricultural point of view, it has many features in common, and in lieu of which it may with advantage be cultivated. As the potato requires to be planted as early in spring as the weather will admit of, thus leaving little opportunity for cleaning the land, and as its mode of growth forbids any effective removal of root-weeds by after culture, it is peculiarly necessary to have the land devoted to this crop cleaned in autumn. Winter dunging facilitates the planting, and is otherwise beneficial to the crop by producing that loose and mellow condition of the soil in which the potato delights. The quality of the crop is also believed to be better when the dung is thoroughly incorporated with the soil, than when it is applied in the drill at the time of planting. A liberal application of manure is necessary if a full crop is expected. The rank growth thus induced renders it, however, more obnoxious to the murrain, and hence at present it is more prudent to aim rather at a sound crop than an abundant one, and for this purpose to stint the manure. When it is applied at the time of planting, the mode of procedure is the same as that which will presently be described in the section on turnip culture. The potato sets are prepared a few days before they are expected to be needed. Tubers about the size of an egg do well to be planted whole; and it is a good plan to select these when harvesting the crop, and to pit them by themselves, that they may be ready for use without further labour. The larger tubers are cut into pieces having at least one sound eye in each, although two are better. It is of great consequence to have seed-potatoes stored in a cool and dry pit, so that if possible they may be prepared for planting before they have begun to shoot. If there has been any heating in the pit, the potatoes are found to be covered by a rank crop of shoots, which are necessarily rubbed off, and thus the most vigorous eyes are lost, and much of the substance which should have nourished the young plant utterly wasted. A sufficient number of dormant eyes are no doubt left, but from the comparatively ex-

Preparation of the soil.

Preparation of the sets.

Root Crops.

hausted state of the tubers, these produce stems of a weaker and more watery character, and more liable to disease than those first protruded. To avoid these evils, gardeners are at pains to invigorate their seed potatoes and husband their whole powers for early and vigorous growth by *greening* them in autumn, storing them in a cool place with a current of air passing through it, and then in early spring exposing them to light on a floor, whence they are carefully removed and planted with their short, thick, *green* shoots unbroken.[1] Neither the *greening* nor the sprouting under cover and in the light, can ordinarily be practised on the scale on which the field culture of the potato is conducted. But the important feature in it, viz., so treating potatoes intended for seed that the crop shall be produced from the first and most vigorous shoots, and that these shall obtain the full benefit of the natural pabulum stored up for their use in the parent tuber, should be carefully considered and imitated if possible in field culture.

The report of the meeting of the Edinburgh Botanical Society, on 8th January 1852, bears that "Professor Simpson communicated the results of some experiments made by himself and Mr Stewart relative to the growth of alpine plants after having been kept artificially covered with snow in an ice-house for many months. Seeds and plants when kept in this way during winter, and then brought into the warm air of summer, germinate and grow with great rapidity. Mr Stewart had also made experiments with animals, and he found that the chrysalis so treated produced a moth in eleven days after being brought into the atmosphere, while other chrysalis of the same moth did not do so for three or four months after. In arctic regions the rapid growth of plants during the short summer was well known. Professor Simpson alluded to the importance of similar experiments being made on the different kinds of grain. He referred to the rapidity of harvest in Canada and other countries where the cold lasted for many months, and he was disposed to think that if grain was kept in ice-houses during the winter, and sown in spring, there might be an acceleration of the harvest."[2]

This suggestion for the treatment of seed corn is certainly deserving of trial. But the known difficulty of hindering the premature germination of potato sets in the ordinary method of storing them, seems to point to them as the peculiarly appropriate subjects of such an experiment.

Potato drills should not be less than 30 inches wide, nor the sets less than 10 or 12 inches apart in the rows. The usual practice is to take the sets to the field in sacks, which are set down at convenient distances for replenishing the baskets or aprons of the planters. When a large breadth is to be planted, a better way is to have the sets in carts, one of which is moved slowly along in front of the planters. A person is seated in the cart, who has by him several spare baskets which he keeps ready filled, and which are handed to the planters in exchange for empty ones as often as required. This greatly economises the time of the planters, and admits of a greater amount of work being accomplished by them in a day. Single-bout drills are quite sufficient so far as the success of the crop is concerned. Where neatness is much studied, a double-bout certainly makes a nicer finish, but as the drills should be partially levelled by a turn of the drill-harrows about ten or fourteen days after planting, as weather admits, very short time is allowed for admiring the trigness of the work; and the extra labour thus expended can certainly be more profitably employed at this busy season. So soon as the young potato plants are fairly above ground, the drill-grubber should be set to work and followed up without delay by hand-hoeing. Mr Wallace, North-Berwick-Mains, a most successful cultivator of potatoes, has for many years taken off all the shoots, save one, from the potato sets as they appear above ground, and the prunings are used in filling up blanks; the result has been, that the produce of the solitary stem is both larger and of more equal size and quality than when the shoots are all left. A turn of the horse-hoe and another hand-hoeing after a short interval are usually required, after which the common practice is to earth up the rows by the double mould-board ploughs. There is reason to believe that this latter practice usually does harm, rather than good. It no doubt prevents the uppermost tubers from getting greened by exposure to the light, but it is believed that the injury inflicted on the roots which spread into the intervals betwixt the rows far more than counterbalances any benefits that result or have been supposed to result from this earthing up. After the plants are a foot high, a slight stirring of the surface to keep down weeds is all the culture that is admissible consistently with the well-doing of the crop. When the crop is matured, which is known by the decay of the tops, and the firmness of the epidermis when the tubers are forcibly rubbed by the thumb, advantage is taken of every dry day in harvesting the crop. For small plots, the fork is certainly the most efficient implement for raising the tubers; but on the large scale when expedition is of such consequence, they are always unearthed by the double mould-board plough. Alternate rows are split open in the first instance, and then the intervening ones, as the produce of the first is gathered. When a convenient breadth has thus been cleared, a turn of the harrows is given to uncover such tubers as have been hid from the gleaners at the first going over. In Kincardineshire, this work is now accomplished by attaching to the common plough a crescent-shaped share about 18 inches broad, with four stout prongs, each a foot in height, welded to its upper surface, and set at an angle of 45° to the sole of the plough. This being worked directly under the row of potato plants, unearths the tubers, and spreads them on the surface by one operation. The potatoes are gathered into baskets from which they are emptied into carts and conveyed at once to some dry piece of ground, in which they are piled up in long narrow heaps and immediately thatched with straw. The base of the heaps should not exceed a yard in width, and should be raised above the surface level rather than sunk below it as is very usually done. As the dangers to be guarded against are *heating* in the first instance and frost ultimately, measures must be taken with an eye to both. The crop being put together in as dry and clean a state as possible, and covered with as much straw as will shoot off rain and protect from any early frost, is allowed to lie for three or four weeks. By this time the mass will have become considerably drier, and as weather admits, the whole is now turned over and shook in a riddle wide enough to pass dirt and small tubers: diseased roots are then carefully removed, and the sound ones formed into a heap as before, with a row of drain tiles laid along the centre of the base. A good covering of straw is then put on and coated over two or three inches thick with earth, care being taken to leave a chimney every two yards along the ridge. By thus keeping the heaps dry and cool, and secure from frost, it is usually possible, even yet, to preserve potatoes in good condition till spring. Such diseased ones as have been picked out, either at the first gathering or at the turning of the heaps, can be used for feeding cattle or pigs. The fact that pigs fatten, apparently, as well on diseased potatoes when cooked by steaming or boiling, as

[1] See a Pamphlet *On the Cultivation of the Potato* by Mr James Cuthill, Market-Gardener, Camberwell, London, which should be studied by every grower of potatoes.

[2] *Gardener's Chronicle*, 31st January 1852.

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on sound ones, is certainly a very important mitigation of this dreaded calamity. There are several varieties of the potato, such as "lumpers," "cups," "mangel-wurzel potato," &c., which, although unfit for human food, are much relished by cattle, and which from their abundant produce, healthiness and great fattening quality are well deserving of being more generally cultivated for the purpose of being used in combination with turnips and other substances in the fattening of cattle. The turnip crop of 1851 was nearly as much diseased as the potato crop, and as one remedy against "fingers and toes" in the former, is to let longer intervals of time intervene before their recurrence in the same field; and as it has been ascertained that an acre each of beans, potatoes, and turnips, will produce more beef than three acres of turnips alone, it is worthy the consideration of those concerned whether it would not be prudent to substitute a crop of these coarser potatoes for a portion of their turnip crop on fields or parts of fields that have borne diseased turnips in previous rotations.

*Turnips.*—The introduction of turnips as a field crop constitutes one of the most marked epochs in British agriculture. To the present day no better criterion exists by which to estimate its state in any district, or the skill of individual farmers, than the measure of success with which this or other root crops is cultivated. We have already, in our section upon fallowing, described in detail the process of preparing the soil for drilled green crops. Referring the reader to what is there said, we now proceed with our description of turnip culture.

Manure for turnip.

Previous to the introduction of bone-dust and guano, farm-yard dung formed, in the majority of cases, the only available manure for the turnip crop. It was almost invariably formed into heaps in the field to which it was to be applied, and repeatedly turned, as great stress was laid on having it well rotted. The introduction of these invaluable portable manures has, however, not only immensely extended the culture of the turnip; but has materially modified the course of procedure. On the first introduction of bone-dust, the practice was to use the fold-yard dung, as far as it would go, and to apply bone-dust alone, in quantities of from sixteen to twenty bushels per acre, to the remainder of the crop. Guano, too, for a time, was used to some extent on the same principle; but now it is most satisfactorily proved, that whereas very good crops of turnips can be obtained by manuring either with dung alone, at the rate of from fifteen to twenty tons per acre, or bones alone, at the rate of sixteen to twenty bushels, or guano alone, at the rate of three to four cwt., much *better* crops can be obtained by applying to each acre its proportion of each of these kinds and quantities of manures. A portion of the bones is now usually applied in the form of superphosphate of lime; and as this substance, and also guano, have a remarkable power of stimulating the growth of the turnip in its earliest stage, forcing it to the state fit for thinning from ten to fourteen days earlier than heretofore, there is now no occasion for the dung being in the advanced state of decomposition that was formerly found necessary. When farm-yard dung alone was used, it behoved to be in a soluble state, ready to furnish nourishment to the plant from the beginning. But in bringing it to that state, a considerable loss is sustained by fermentation, and its bulk is so much reduced, that it becomes difficult to distribute evenly the allowance which would be available for each acre, in order to give the whole crop a share of it. This, however, it is most desirable to do, as good farm-yard manure contains in itself the whole elements required by the crop. And hence an additional reason for the plans of applying farm-yard dung, which have already been noticed. If that made during the previous summer has been applied in autumn to the lea before ploughing for oats, as far as it will go, and another portion of the contemplated turnip break dunged before the winter furrow, with all that has been made up to that time, and the future accumulations up to April formed into heaps, to be applied in the drills for the latest sowings, the manure produced on the farm may be made to go over nearly the whole breadth under root crops.

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In proceeding to sow those portions that were dunged before the oat crop, and on the stubble, all that is required, is to form the drills, and apply the guano or bones, or mixture of both, by hand. In doing this, ten or twelve drills are set out the evening before, that all may be ready for a good start. The light manure is taken to the field in carts, which are unyoked at convenient distances for replenishing the aprons of the young persons (one for each plough) who distribute it along the drills. The sowers of the manure being started on the outside drills, the ploughmen proceed to open fresh ones inside in going, and to cover in the manure by reversing the first formed ridglets as they return. The seed-machine, sowing two rows at a time, follows close up to the ploughs, and thus the work goes rapidly on, each plough getting over from $2\frac{1}{2}$ to 3 acres a-day. When farm-yard dung is applied at the time of sowing, the process is the same, except that the drills must be opened somewhat deeper, and that the dung-carts, followed by an adequate number of spreaders, precede the sowers of the light manures. In filling the dung-carts, one able-bodied labourer is required for each plough employed in drilling; and where these amount to three, six spreaders are required to distribute it evenly along the drills. In some districts the double-breasted plough is used in forming the drills and covering in the dung. In the hands of a skilful ploughman, that implement does certainly make neater work to look at; but so far as the success of the crop is concerned, the common swing-plough is preferable, for in covering in with it, the earth is made to run over the top of the ridglet, by which means the clods fall into the hollow, and the finest of the mould is left on the top, where the seed is to be deposited. With the double mould-board this cannot so well be done, and the consequence is, that a groove is formed on the top of the ridglet, in which the small dry clods, carried up by the tail of the mould-board, are left, forming the worst possible bed for the seed. In parching weather, it is usual to pass a light roller over the drills, immediately after sowing, to retain the moisture, and insure germination. The seed is deposited near the surface, half an inch of mould being a sufficient covering. The quantity sown is 2 lb. per acre of globe or yellow turnip seeds, and 3 to 4 lb. of Swedes. Care must be taken that the seed is fresh, so as to have a vigorous and thick plant. Thick sowing increases the difficulty of thinning out the plants, but it hastens their growth, and diminishes the risk of failure from the depredations of the turnip beetle. The time of sowing in the south of Scotland extends from the middle to the end of May for Swedes, and thence to the middle of June for yellows and globes. A partial sowing of yellow or globe is however made by careful stockmasters before sowing the Swedes, to be ready for use by the end of August or beginning of September, when pasturage fails. Sowings of early varieties such as the stubble turnip and certain yellow kinds, are also made after winter tares or other catch crops, until the middle of July; but later than this they cannot be sown in Scotland with advantage, unless for the production of a crop of seed. The average weight per acre of Swedes may be stated at 18 tons, and of turnips at 22 tons, although double these rates have occasionally been obtained. Recent experiments go to show that with liberal manuring and early sowing, the weight of the crop is considerably increased by thinning out the plants at wider intervals than has hitherto been customary. The usual practice in Scotland has been to sow in

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ridglets 27 inches apart, with 9 or 10 inches betwixt the plants. Recent experiments establish the fact that with 15 inches from plant to plant, much larger bulbs and a greater acreable produce are obtained. As it is ascertained that in the case of Swedes the largest bulbs are also the best in quality, it is of the greater consequence to allow them ample room.

Thinning turnips.

The thinning is commenced as soon as the rough leaf is fairly developed. Previous to this operation the horse-hoe is worked betwixt the rows for the double purpose of destroying weeds and facilitating the operation of thinning. When the plants have rallied after the thinning, and begun to grow rapidly, the usual practice has been to turn a furrow from either side of them into the middle of the interval by a one-horse plough, and then to level this down by a turn of the horse-hoe. A great improvement on this practice is to use Tennant's grubber instead, adjusted for drill work in the manner already described. By thus using a strong implement drawn by two horses, the soil in the intervals betwixt the rows can be stirred a foot deep if required, without any risk of hurting the young plants, and this too is accomplished by a single operation. A second hand-hoeing is then given, which usually completes the after culture. It was formerly the invariable practice to finish off by passing a double mould-board plough betwixt the rows, which was called *setting up*. On dry soils this is not only useless, but positively hurtful to the crop; and those so wet as to require it are unfit for the profitable cultivation of turnips at all.

The nature of the soil will usually determine the mode of consuming the crop. On all loose, dry soils, feeding off by sheep is the most profitable plan; whereas on deep, strong loams it is advisable to withdraw the whole and eat them by cattle, as, unless in very favourable weather, when even a fourth is fed off by sheep, the extra manuring does not compensate to the after crops for the injury which they usually sustain from the treading and poaching. On the poorest class of light soils, the whole crop should if possible be consumed where it grows by sheep; but on those of a better description, a third, a half, or two-thirds may be withdrawn for the feeding of cattle according to circumstances. Whatever the proportion left on the ground, care is taken to regulate the intervals so as to distribute the treading and droppings of the sheep as equally as possible over the field.

The management of the turnip crop, so as that it may be supplied to the live stock in the best possible condition during the entire season is a point of the greatest importance. The portion that is to be used as cattle food is removed from the ground as soon as the crop has sufficiently matured, and before the time when drenching rains and severe frosts may ordinarily be looked for. The best way of preserving them is by storing in long narrow heaps on a dry and sheltered situation open to the sun, and covering them with a good coating of straw, secured by straw-ropes. The thatch of the corn-stacks that are thrashed in autumn is usually reserved for covering turnip heaps. After 1st November it is well to make diligent use of every favourable hour in thus securing the turnip crop. In corroboration and further illustration of this important point, we here engross an interesting communication recently received from Mr Archibald Hepburn, Whittingham Mains, East Lothian:—

"Mr Buist (Lord Haddington's factor) is compelled by reason of the game on the home-farm to store all his turnips except a few required for sheep. He sows very early in May, chiefly Swedes; stores in October; leaves the roots on; makes the heaps oblong, about 5½ feet by 4; thatches with ten inches of straw; turns the heaps, and rasps off the shoots in March. I have myself kept Skirving's purple-top yellow good in this way from November till the middle of May.

"Mr Cuthbertson, Greendykes, East Lothian, farms a clay-soil, which, although furrow-drained, and in very high condition, is, according to old preconceived ideas, ill adapted for the turnip husbandry; but by good management, few farmers succeed better in obtaining heavy crops of turnips. Of late years he has sown *nothing* but Skirving's purple-top yellow at the rate of *five pounds* per Scotch acre; commencing the sowing late in April, and finishing his whole *break* about the middle of May, weather permitting. Early in September he commences drawing and storing a proportion of each field, leaving the remainder to be consumed on the ground by sheep, which are folded on without delay; and the whole breadth left for that purpose is consumed, and wheat sown throughout November.

"The leaves of the turnip are chopped off about one inch from the bulb, and the tap-root is merely cleared of earth, particular care being taken to store the turnip when *quite dry* and free from frost. If it is necessary in clearing a field to cart off the bulbs when wet with rain, they are stored in a separate heap for early eating. Those carried in the above mentioned good condition are stored in long heaps, 20 feet broad at the base, and about 5½ or 6 feet high, and that in a roof-like fashion. The heaps are thatched with straw to the depth of about 10 inches, and secured with straw-ropes. The contents are never disturbed until they are required for daily consumption. The turnips are found to be excellent food for cattle, so late as the beginning of June. This most excellent practice and its happy results cannot be too widely known. Mr Cuthbertson used to store his yellow turnips according to Mr Buist's plan, but prefers these enormous heaps."

The difference both to the cattle and to the land betwixt the plan of having turnips stored in dry weather without poaching the fields and securing clean and fresh food in all weathers, and the other of bringing in only a few days' supply at a time, and so being often compelled to go upon the land when soaked with rain or bound with frost, and feeding the cattle with miry or frozen turnips, can scarcely be computed. The careful farmer will never feel at ease until his winter's provision is safe in the store-heap. The portion to be fed off by sheep must necessarily be treated in a different manner. What is to be used after Christmas can be very readily defended against frost, by earthing up in the drills with the common plough. But as what is to be consumed by the young sheep must be pulled and trimmed at any rate, in order to be sliced, the best way is to throw the turnips into heaps at regular distances, and cover them first with the greens, and then with a thin coating of earth. By this means the turnips are kept from running to stems, and the sheep get them clean and fresh whatever the state of the weather.[1] The same end is secured by opening a trench by a bout of the common plough, into which the turnips from two drills on either side are laid in regular order with their tops uppermost, and the earth turned over upon them by reversing the course of the plough. When wanted for use, they are again unearthed by means of the plough. The feeding qualities of turnips are so seriously impaired by exposure to frost, even when they escape actual destruction, that the expense of securing them by one or other of these methods, is always amply repaid. In very mild winters again, storing is equally effective in preventing the virtues both of the turnips and the soil from being wasted by the pushing of the seed stems. Such precautions are so usually omitted,

Preserving turnip for sheep feeding.

[1] During the unusually wet winter of 1852–3, we stored a large quantity of turnips and Swedes, intended for cattle food in this way. The trimming and storing was carried on every dry day, and the carting postponed until the occurrence of frost or drought admitted of its being done without injury to the land.

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and the loss thereby sustained is so serious, that it would be well for all who question the utility of the practice to satisfy themselves regarding it in some such way as this. Let two portions of a turnip field, as equal in all respects as possible, be selected, and let the crop from one of them be in December put into small store heaps or buried in the earth, and let the other remain on the ground untouched till the middle of March. Let a lot of sheep which have received the same previous treatment be then equally divided and fed respectively on these several portions for three or four weeks, and their weights ascertained before and after the trial. Let both portions be afterwards sown with barley under like circumstances, and the produce accurately ascertained. Assuming that an average amount of frost occurs, and that the unstored turnips have begun to push their seed stems when the sheep are put upon them, our personal experience warrants us in anticipating a difference of at least *six* bushels of barley per acre, and *two* lb. of mutton per sheep in favour of the portion on which the turnips are stored.

Diseases.

The turnip is liable in the early stages of its growth to the attacks of various insects. The most formidable of these enemies is the *turnip beetle*, which frequently settles upon the plant so soon as they appear above ground, in such numbers as totally to destroy the whole of them. The best way of guarding against these nimble adversaries, is to endeavour, by careful preparation of the soil, liberal manuring and thick seeding to secure a thick plant and rapid growth, for whenever the rough leaf is expanded, the risk from this quarter is over. From time to time the young turnip plants are assailed by the larvæ of certain butterflies and moths, which sometimes appear in such numbers as to cause serious alarm, but ordinarily their attacks occasion but a slight check to the growth of the crop.

"Fingers and toes."

A far more formidable evil is the disease called "fingers and toes," which, although long known, seems to be steadily extending, and has been wider spread and more virulent in the turnip crop of 1851 than in any previous year. This truly formidable disease sometimes shews itself by the time that the plants are ready for thinning, but more usually it is about the stage when the second hoeing is given that unmistakable indications of its presence are observed. The crop appears in high health, and is making rapid growth, when, suddenly under hot sunshine, numbers of the plants are seen to droop with flaccid leaves; and examination being made, it is found that the disease has already made serious progress. In some cases it is chiefly confined to the taproot, which is distorted with knobby excrescences. In others, the roots present a thickened, palmated appearance, giving rise to the popular name for the disease, "fingers and toes," while in others the lateral roots expand into glandular-looking tubers, which frequently appear partially above ground at distances of several inches from the central stem. For a time all these forms of the excrescences present a smooth healthy looking skin, yielding no trace of the presence of insects of any kind, either externally or internally. By and by the skin cracks over the excrescences, which speedily assume a gangrenous appearance. Indeed, the whole symptoms present a striking analogy to cancer in the animal system. By the time that the healthy plants are approaching near to maturity, the most diseased ones have usually lost all resemblance to turnips, and there remains on the land a substance like rotten fungus. In very bad cases, whole acres together are found in this state, with here and there a sickly distorted turnip still shewing a few green leaves. At other times a few only of the plants are wholly destroyed; the field, to a casual observer, looking not much amiss, though a closser inspection proves that the general crop is of stunted growth, with few plants entirely free from the disease. Such partially diseased roots are not absolutely rejected by sheep, but they are evidently unpalatable and innutritious, while the crop as a whole is more speedily consumed than its general appearance would lead one to expect. When this disease appears on farms that have previously been exempt from it, it is usually confined for a year or two to small patches, which, however, in the absence of remedial measures, steadily and rapidly extend, not only on the recurrence of a turnip crop on the same fields, but over the other parts of the farm. Indeed, there are not wanting indications of its being propagated by contagion; as, for instance, when tainted roots are carted into pastures, and the disease shews itself most in those places where they have been consumed, when, in course of rotation, the field comes afterwards to bear a turnip crop. When they are consumed by cattle in fold-yards, the dung may be the medium of contamination, on the supposition that this conjecture is well-founded. Ploughing land in a wet state evidently aggravates the disease. We know of one instance where a strip down the middle of a field was ploughed in autumn while soaked by rain, on which wet ploughed portion the turnips were evidently more diseased than over the rest of the field. In another instance which came under our personal observation, a ditch running along part of the top of a field, of upwards of 50 acres, was scoured in spring, and the mud spread back over the headland. The whole field was, in the same season, sown with turnips, which proved an excellent crop, entirely free from "fingers and toes," with the exception of that portion of headland on which the mud was spread, where every plant was diseased. Although wholly in the dark as to the nature and propagation of this disease, it is well to know that the judicious application of lime is a certain remedy. In order, however, to its efficacy, it must be applied in a *powdery state* after the autumn ploughing, and immediately incorporated with the soil by harrowing; or else as a compost with earth, spread on the lea, before breaking up for oats. We know from experience, that a very moderate dose (say four tons of unslaked shells), applied in this way will suffice as a prevention from this disease. It is on light soils that its ravages are most frequently experienced, and to these heavy doses of lime are unsuitable. Indeed, whether for promoting the general fertility of soils, or for warding off the attacks of this disease, moderate applications of lime every *twelve* years or so, seem preferable to heavier dressings at longer intervals. Beneficial effects are said to have been observed from the use of salt when scattered on the surface early in spring, and when applied in the drill in mixture with guano at the time of sowing the turnips. Substituting potatoes or some other crops for one round, so as to prolong the interval betwixt the recurrence of turnips to *eight* years instead of *four*, is said to be a certain remedy.

Beneficial effects of lime.

*Mangel-Wurzel.*—This root has been steadily rising in estimation of late years. It is peculiarly adapted for those southern parts of England where the climate is too hot and dry for the successful cultivation of the turnip. A competent authority declares that it is there easier to obtain thirty tons of mangel than twenty tons of Swedes, and that it is not at all unusual to find individual roots upwards of twenty lb. in weight. In Scotland it is just the reverse, it being comparatively easy to grow a good crop of Swedes, but very difficult to obtain twenty tons of mangel. This plant is very susceptible of injury from frost, and hence in the short summer of Scotland it cannot be sown so early nor be left in the ground so late as would be requisite for its mature growth. These difficulties may possibly be got over, either by the selection of hardier varieties or by more skilful cultivation. Its feeding quality is said to be superior to that of the Swede, it is much relished by live stock—pigs especially doing remarkably well upon it—and it has the very important property of keeping in good condition till midsummer if required. Indeed, it is only after it has been some months in the store heap that it becomes a palatable and safe food for cattle. It is moreover exempt from the attacks of the turnip beetle. On all these accounts, therefore, it is peculiarly valuable in those parts of Great Britain where peculiarity of climate renders it strong precisely where the turnip is defective.

Up to the act of depositing the seed, the processes of preparation for mangel are identical with those described for the turnip; winter dunging being even more appropriate for the former than for the latter. The ridglets being formed 28 inches apart, and charged with a liberal allowance of dung and guano, the seeds are deposited along the top, at the rate of about 4 lb. per acre. The common drilling machines are easily fitted for sowing its large rough seeds. The after culture is also identical with that of the turnip. The plants are thinned out at distances of not less than 15 inches apart. Transplanting can be used for the filling up of gaps with more certainty of success than in the case of Swedes. Several varieties of the plant are cultivated, such as, the yellow, the long-red, and the orange-globe. The crop requires to be secured in store heaps as early in autumn as possible, as it is easily injured by frost. The following graphic description of this process by Mr Morton of Whitfield, appeared in the *Agricultural Gazette* of 8th November 1851:—

"The mode of harvesting our root crop which we have adopted for several years is this; we let the lifting—cutting off the leaves and the roots, and putting the roots into the cart—at so much per acre, according to the weight of the crop, to one man, who gets other men to join with him in the work and share in the profits; and the arrangement I require to be adopted is, that the one-horse carts, which I employ to haul the roots, shall be constantly employed, and I require from 16 to 20 loads, or tons of roots, to be filled hourly. The number of carts required is according to the distance of the field from the store; thus the distance from the middle of the field to the store being 15 chains, four carts are required; 22 chains require five carts; and 30 chains require seven carts.

"*The mode of lifting the roots.*—Five men are employed to pull up the roots; each man pulls up two rows; standing between the rows, he takes with his left hand a root from the row on his left side, and with his right hand a root from the row on his right side, and pulling both up at the same time, places them side by side, across the row where he pulled up the roots with his right hand, so as to have the tops lying in the space between the two rows he has pulled up; the next man takes the two rows at the right hand of the last two rows we have just described, and he, with each of his hands, pulls up a row, and places them on the line of the row which he has pulled up with his left hand, with the root end lying towards the root end of the first row, so that we have now four rows of roots lying close together in two rows, side by side, with their leaves on the outside of each of these rows, and the roots of each row nearly touching each other; and every four rows, when growing, are thus, when pulled, laid in two rows, root to root, occupying not more than 27 inches. Now, as the next four rows are lifted in the same way, and placed in like manner, we have a space unoccupied of three times 27 inches, or 6 feet 9 inches between each double row of roots, for the cart to go between them (viz. this double row of bulbs after they have had the leaves and roots cut off), to carry off the bulbs to the store. After the five men who are pulling the roots, there follow ten women or boys with knives, made of pieces of old scythes, who, with repeated blows, cut off the leaves and roots, without ever moving one of them with their hands; this is constant, but not hard work, and it requires ten active women or boys to keep up with the five men pulling.

Immediately on the heels of the cutters follow the carts between the two double rows of bulbs as they lie, having their leaves and roots cut off; and a man, one of the principals of the gang, and nine young active boys and girls throw up the bulbs as fast as they can into the cart, the man speaking to the horse to move forward, or stop, as they clear the ground; when one cart is full, an empty one has been brought by one of the boys who drive the carts, and placed immediately behind the full one; so that, as he moves off with the full cart, the man calls the horse with the empty cart to move forward, and they proceed to throw the roots into the cart as fast as they did into the one that has just gone off the field.

"The pulling of the roots and the filling of the carts being the principal work, one of the leaders is in each of these departments of the work; so that, by his example, he shows those with him how he wishes them to work, and thus the work proceeds with the utmost regularity and despatch; 20 cart-loads are hourly filled in the fields and delivered in the store; 180 to 182 loads of 22 cwt. and 23 cwt. each in a day of nine hours; thus a cart-load is filled every three minutes by 10 pairs of hands, which are pulled by five pairs of hands, and the leaves and roots cut off by 10 pairs of hands—in all 25 pairs of hands, men, women, and boys; this has been repeatedly done in a day.

"The stores are made of posts and rails, enclosing a space 9 feet apart and 4½ feet high, and of any length, if the space will admit, and as near to where they are to be consumed as possible. The posts are 5 feet apart, let into the ground 18 inches, and 4½ feet above, with five rails above, 4 or 5 inches wide, nailed to the inside of the posts; and each of these stores is 3 feet apart. I have 14 of them about 70 feet long each, which is sufficient to store from 1000 to 1200 tons of bulbs."

The heaps are carefully thatched, and the spaces betwixt them filled with straw to keep out frost. The expense, exclusive of the carting, Mr Morton shows to be 3s. 6d. per acre.

It is believed that in many cases crops of turnip and mangel could be more cheaply stored by means of the portable railway than by carts, and with less injury to the land. This is especially the case with clay soils, and in such seasons as the autumn of 1852 has proved. In using it, eight drills of roots are trimmed and laid in two rows, as Mr Morton describes; the rails are shifted betwixt each of these pairs of rows; the roots pitched into light trucks, which a man pushes before him to the headland, where the contents are discharged by tipping. Being there heaped up and thatched, the roots are carted to the homestead as required.

*Carrots.*—This root, though so deservedly esteemed and universally grown in gardens, has not hitherto attained to general cultivation as a field crop. This is owing chiefly to certain practical difficulties attending its culture on a larger scale. Its light feathery seeds cannot easily be sown, so as to secure their regular germination; the tardy growth of the young plants, and the difficulty of discriminating betwixt them and weeds makes the thinning a troublesome affair; the harvesting of the crop is comparatively expensive; and it is only on sandy and light loamy soils, or those of a peaty character that it can be grown successfully. The increasing precariousness in the growth of potatoes, turnips, and clover, and the consequent necessity for a greater variety of green crops entitle the carrot to increased attention as a field crop. Its intrinsic qualities are, however, very valuable, especially since the introduction of the white Belgian variety. On light soils it is alleged that larger crops of carrots than of turnips can be obtained, and with less exhaustion of their fertility, which is explained as arising from the greater depth to which the carrots descend for their nourishment. This root is eaten with avidity by all kinds of farm stock. Horses, in particular, are very fond of it, and can be kept in working condition with a considerably smaller ration of oats when 20 lb. of carrots are given to them daily. They can also be readily kept to an advanced period of spring when stored with ordinary care.

The mode of culture is very similar to that already described for mangel-wurzel. A usual practise is to prepare

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the seed for sowing, by mixing it with moist sand, and turning the mass repeatedly for several days until germination begins, when it is sown by hand at the rate of 6 lb. per acre of the dry seeds, in a seam opened by the coulters of the corn or turnip drill, according as it is wished to have it on the flat or on ridglets. Some prefer merely to rub the mixture of seeds and sand or mould betwixt the palms, until the seeds are thoroughly separated from each other, and so divested of their hairs, as when mixed with sand to run from a drilling-machine. It is of the utmost importance to secure seeds of the previous year's growth, as if older their germination cannot be depended upon. Much care is also needed in saving the seed only from selected roots, as carrots have a decided tendency to degenerate. The white Belgian variety is certainly the best for farm use, not only from the weight of crop, but from its growing more rapidly in its earliest stage than other approved sorts, and showing a broader and deeper coloured leaf which can more easily be discriminated from weeds, and thus admits of the earlier use of the hoe. When the sowing and first hoeing and thinning of the crop are got over successfully, the after culture of the crop is very simple; all that is needed being the occasional use of the horse and hand-hoe to keep down weeds. The fork must be used in lifting the crop. The greens are then cut off and given to young stock or cows, and the roots stored in long narrow heaps, exactly as mangel. Fifteen tons per acre is an average crop, although on suitable soils, with liberal manuring and skilful cultivation, double the weight is sometimes obtained. Those who intend to cultivate this crop statedly, will do well to raise their own seeds from carefully selected roots. Unless genuine and fresh seed is sown, failure and disappointments can scarcely be avoided.

*Parsnip.*—This plant bears so close a resemblance to the carrot, and its culture and uses are so similar, that they need not be repeated. It can, however, be cultivated successfully over a much wider range of soils than the carrot, and, unlike it, rather affects those in which clay predominates. It is grown extensively, and with great success, in the Channel Islands. The cows there, fed on parsnips and hay, yield butter little inferior, either in colour or flavour, to that produced from pasture. About 10 lb. of seed are required per acre. It requires, like that of the carrot, to be steeped before sowing, to hasten germination, and the same care is needed to have it fresh and genuine. It should be sown in April. The roots, when matured, are stored like carrots.

*Jerusalem Artichoke.*—This root, although decidedly inferior to the potato in flavour, is yet deserving of cultivation. It grows freely in inferior soils, is easily propagated from the tubers, and requires little attention in its cultivation. When once established in the soil, it will produce abundant crops for successive years on the same spot. It is sometimes planted in woods to yield shelter for game, for which purpose it is admirably fitted, as it grows freely under the shade of trees, and yields both food and covert. In properly fenced woods it might yield abundant and suitable food for hogs, which might there root it at their pleasure, without damage to anything. Where they had mast along with these juicy tubers, they would undoubtedly thrive apace. After they had grubbed up what they could get, enough would be left to reproduce a crop for successive seasons. Such a use of this esculent seems well deserving of careful trial.

There are several crops which, under a strict classification, should be noticed among forage crops rather than here, but which, in an agricultural point of view, are so closely analogous to drilled root-crops, that we regard this as the suitable place in which to notice them.

*Cabbage.*—On strong rich soils, large crops of very nutritious food for sheep or cattle, and of a kind very acceptable to them, are obtained from the field culture of the Drumhead cabbage. A seed-bed is prepared in a garden, orchard, or other sheltered situation, in August, either by sowing in rows, 12 inches apart, and thinning the plants about 3 inches, in the rows, or, what is better, sowing in a bed, and transplanting them into narrow rows so soon as the plants will admit of it. In April, the land to be occupied with this crop is prepared as for turnips, in drills 27 to 30 inches wide, along the flattened top of which the cabbage-plants are dibbled two feet apart, and afterwards kept clean by horse and hand-hoeing. Another plan is to plough in the dung in autumn, and in April, when the soil is dry enough, to plough it and to dibble in the plants 30 to 36 inches apart each way in rectangular lines. A long line with feathers inserted in it at the requisite spaces for the guidance of the planters, is stretched along and set at the proper width; and, by employing a sufficient force of planters, the work proceeds simultaneously with the poughing,—a row of cabbages being inserted at every three or four furrows, according to the distance betwixt plants that is fixed upon. The advantage of this mode of planting is, that when accurately performed, the horse-hoe can be used in all directions, lengthwise, across, and diagonally, thus simplifying the summer culture. We have seen a crop of cabbages treated in this way, and planted but one to each square yard, completely closed in autumn. Cabbages are much in repute with breeders of rams and prize sheep, which fatten rapidly on this food. Cabbages are usually drawn off, and given to sheep on their pastures, or to cattle in byres and yards; but they are also fed off, where they grow, by sheep, in the same way as turnips. It is an exhausting crop when wholly drawn off, and is sometimes grown with advantage on this account on spots greatly enriched by irrigation with sewage or otherwise, and where the succeeding grain crop is expected to suffer from over-luxuriance, the cabbages being grown, as the phrase goes, to "take the shine out of it." In favourable circumstances, from 30 to 40 tons per acre of this nutritious crop may be obtained. From what has been said, it is evidently not adapted for extensive field culture; but on most farms a few acres might be grown annually with great advantage. It is a peculiarly suitable food for either sheep or cattle during the autumnal transition from grass to turnips.

*Rape.*—This plant is peculiarly adapted for peaty soils, and is accordingly a favourite crop in the fen-lands of England, and on recently reclaimed mosses and moors elsewhere. Its growth is greatly stimulated by the ashes resulting from the practice of paring and burning. In these cases it is sown broad-cast; but when such soils are brought into a regular course of tillage, it is drilled, and otherwise treated in the same manner as turnips. As we have described its culture under the head of "Oil-producing plants," we shall only say further here, that its highly nutritious leaves and stems are usually consumed by folding sheep upon it where it grows, and that there is no green food upon which they fatten faster. Occasionally it is carried to the homestead, and used with other forage in carrying out the system of soiling cattle.

*Kohl-Rabi.*—This plant has been frequently recommended to the notice of farmers of late years. Like mangel, it is better adapted for strong soils, and dry and warm climates, than the turnip. It may either be sown on drills in the same manner as the turnip, or in a seed-bed, and afterwards transplanted. The latter plan is expensive, if it is desired to cultivate the crops to any extent; but is commendable for providing a supply of plants to make good deficiencies in the rows of other crops, or when a small

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quantity only is wanted. By sowing a plot of ground in March in some sheltered corner, and transplanting the crop early in May, it is more likely to prosper than in any other way. Cattle and sheep are fond of it, and it is said not to impart any unpleasant flavour to milk. We have seen a few trials of it in Scotland as a field crop; but, from whatever cause, the weight of food produced per acre was greatly less than from the mangel and Swedes growing alongside of it. For further information about this plant, the reader is referred to the *Book of the Farm*, vol. ii. p. 87; Hewit Davis' *Farming Essays*, p. 90; Lawson's *Synopsis of the Vegetable Products of Scotland*, Div. ii. p. 109. Mr Stephens calls it "turnip rooted cabbage," which is a distinct and inferior plant. Lawson says that the pulp or flesh of kohl has the same taste as the leaves of the cabbage, and hence its adaptation as food for milch cows.

## CHAPTER VIII.

### HERBAGE AND FORAGE CROPS.

Under this general heading, we propose to include what we have to say concerning the grasses, whether natural or cultivated, and those other crops which are grown expressly for the sake of the cattle food yielded by their leaves and stems. This kind of farm-produce is either consumed where it grows, by depasturing with live stock, or mown and given to them in a green state under cover, or dried and stored for after use. It thus embraces the cultivation of these crops, and their disposal, whether by grazing, soiling, or haymaking. Following this method, we shall first of all briefly describe the cultivation of those pasture and forage crops which are of best repute in British husbandry.

Tillage lands are now everywhere cropped according to some settled rotation, in which the well recognised principles of the alternate husbandry are carried out according to the actual circumstances of each locality. With rare exceptions, such lands at stated intervals bear a crop of the clovers or cultivated grasses. As these are usually sown in mixture, especially when intended for pasturage, the resulting crop is technically called "seeds." As it is of importance to have the land clean, and in good heart, when such crops are sown, they usually follow the grain crop which immediately succeeds the fallowing process. Being for the most part of a lower habit of growth than white corn crops, they can be sown and grow together without mutual injury. When the latter are harvested, the former being already established in the soil, at once occupy it, and grow apace. By this arrangement, there is therefore secured an important saving both of time and tillage. Barley being the crop amongst which the seeds of the clover and grasses are most frequently sown, and amongst which, upon the whole, they thrive best, it is customary to sow these small seeds at the same time as the barley, and to cover them in with a single stroke of the common harrows. This is erroneous practice, both as regards the time and manner of sowing these small seeds. We have already mentioned, in the proper place, that barley should be sown as early in March as possible. Now, if the clovers, &c., are sown as early as this, they are almost certain to get so forward as both to rob the barley of its due share of nourishment, and, when it is reaped, to bulk so largely in the sheaves, as to retard their drying, and aggravate the risk of their being ill harvested. It is found, moreover, that if there be but plants enough, the clovers stand the winter better, and ultimately yield a better crop, when but puny looking, than when very strong, at the reaping of the grain crop. It is better, therefore, to delay the sowing of the small seeds until April. As to the manner of covering them in, we have to remark that the smallness of these seeds, and their manner of germinating, alike requires that they receive only the very slightest covering of soil. This important fact is so well illustrated in the following table, which exhibits the results of some carefully conducted experiments, reported to the Highland Society by Mr Stirling of Glenbervie, that we shall here quote it:—

Sowing of clover and grass seeds.

"Column I. contains the scientific names.
Column II. contains the average weight of the seeds per bushel in pounds.
Column III. contains the average number of seeds in one ounce.
Column IV. shows, in inches, the depth of cover at which the greatest number of seeds brairded.
Column V. shows, in inches, the depth of cover at which only about half the number of seeds brairded.
Column VI. shows, in inches, the least depth of cover at which none of the seeds brairded.

| I. | II. | III. | IV. | V. | VI. |
|---|---|---|---|---|---|
| Agrostis stolonifera, ............ | 13 | 500,000 | 0 to $\frac{1}{4}$ | $\frac{1}{2}$ to $\frac{3}{4}$ | 1 |
| vulgaris, .................... | 12 | 425,000 | ... | ... | ... |
| Aira cæspitosa, .................. | 14 | 132,000 | 0 to $\frac{1}{2}$ | $\frac{3}{4}$ to 1 | $2\frac{1}{4}$ |
| Alopecurus pratensis, ........... | 5 | 76,000 | 0 to $\frac{1}{2}$ | 1 to $1\frac{1}{4}$ | $2\frac{1}{4}$ |
| Anthoxanthum odoratum,....... | 6 | 71,000 | 0 to $\frac{1}{2}$ | 1 to $1\frac{1}{4}$ | 2 |
| Arrhenatherum avenaceum, .... | 7 | 21,000 | $\frac{1}{2}$ to $\frac{3}{4}$ | $1\frac{1}{2}$ to $1\frac{3}{4}$ | 4 |
| Brachypodium sylvaticum,...... | 10 | 15,500 | 0 to $\frac{1}{4}$ | $\frac{1}{2}$ to $\frac{3}{4}$ | 2 |
| Cynosurus cristatus, ............ | 26 | 28,000 | ... | ... | ... |
| Dactylis glomerata,.............. | 12 | 40,000 | 0 to $\frac{1}{4}$ | $\frac{3}{4}$ to 1 | $2\frac{1}{4}$ |
| gigantea, .............. | 10 | 34,000 | ... | ... | ... |
| Elymus arenarius, ............... | 11 | 2,320 | 1 to $1\frac{1}{2}$ | 2 to $2\frac{1}{2}$ | 5 |
| geniculatus, .................. | 12 | 2,300 | ... | ... | ... |
| Festuca duriuscula, .............. | 10 | 39,000 | 0 to $\frac{1}{4}$ | $\frac{3}{4}$ to 1 | $2\frac{1}{4}$ |
| elatior, ......................... | 14 | 20,500 | 0 to $\frac{1}{4}$ | 1 to $1\frac{1}{4}$ | $2\frac{3}{4}$ |
| gigantea, ............... | 13 | 17,500 | 0 to $\frac{1}{4}$ | $1\frac{1}{4}$ to $1\frac{1}{2}$ | 3 |
| heterophylla, ................ | 12 | 33,000 | 0 to $\frac{1}{4}$ | 1 to $1\frac{1}{4}$ | $2\frac{1}{4}$ |
| gigantea, ...................... | 16 | 8,600 | ... | ... | ... |
| ovina, ......................... | 14 | 64,000 | 0 to $\frac{1}{4}$ | $\frac{3}{4}$ to 1 | 2 |
| tenuifolia, .............. | 15 | 80,000 | ... | ... | ... |
| pratensis, ...................... | 14 | 26,000 | 0 to $\frac{1}{2}$ | $\frac{3}{4}$ to 1 | $2\frac{1}{2}$ |
| loliacea, ................ | 15 | 24,700 | ... | ... | ... |
| rubra, .......................... | 10 | 39,000 | ... | ... | ... |
| Glyceria aquatica,................ | 13 | 58,000 | $\frac{1}{4}$ to $\frac{1}{2}$ | $\frac{3}{4}$ to 1 | $2\frac{1}{4}$ |
| fluitans,....................... | 15 | 33,000 | ... | ... | .. |

| I. | II. | III. | IV. | V. | VI. |
|---|---|---|---|---|---|
| Holcus lanatus, .................... | 7 | 95,000 | ¼ to ½ | ¾ to 1 | 2½ |
| mollis, .......................... | 6 | 85,000 | ... | ... | ... |
| Lolium italicum,.................... | 15 | 27,000 | 0 to ¼ | 1 to 1¼ | 3¼ |
| perenne, ...................... | 18 to 30 | 15,000 | ¼ to ½ | 1½ to 1¾ | 3½ |
| Milium effusum, .................. | 25 | 80,000 | ¼ to ½ | 1 to ¼ | 2¾ |
| Phalaris arundinacea,............ | 48 | 42,000 | ... | ... | ... |
| Phleum pratense, ................. | 44 | 74,000 | 0 to ¼ | ¾ to 1 | 2 |
| Poa nemoralis,..................... | 15 | 173,000 | ... | ... | ... |
| ,, sempervirens, ......... | 15½ | 133,000 | 0 to ¼ | ¼ to ½ | 1 |
| pratensis, ..................... | 13 | 243,000 | ... | ... | ... |
| trivialis, ....................... | 15 | 217,000 | 0 to ¼ | ½ to ¾ | 1½ |
| Psamma arundinacea,............ | 15 | 10,000 | ½ to 1 | 1½ to 1¾ | 4 |
| Trisetum flavescens, ............. | 5½ | 118,000 | 0 to ¼ | ¾ to 1 | 2 |
| | | | | | |
| Achillea Millefolium,............ | 30 | 200,000 | ¼ to ½ | ½ to ¾ | 1½ |
| Cichorium Intybus (chicory),... | 32 | 21,000 | ... | ... | ... |
| Lotus corniculatus, ............... | 62 | 28,000 | 0 to ¼ | ¼ to ½ | 1½ |
| major, ........................ | 64 | 51,000 | ... | ... | ... |
| Medicago lupulina, ............... | 63 | 16,000 | 0 to ¼ | ¾ to 1 | 1½ |
| sativa, ........................ | 60 | 12,600 | ... | ... | ... |
| Onobrychis sativa, ................ | 26 | 1,280 | ¾ to 1 | 2 to 2¼ | 4¼ |
| Petrosalinum sativum, .......... | 41 | 12,800 | ... | ... | ... |
| Plantago lanceolata, .............. | 52 | 15,600 | ¼ to ½ | 1¼ to 1½ | 2½ |
| Poterium Sanquisorba (burnet), | 25 | 3,320 | ½ to ¾ | 1½ to 1¾ | 4 |
| Trifolium filiforme, ............... | 65 | 54,000 | 0 to ¼ | ¼ to ½ | 1¼ |
| hybridum, .................... | 63 | 45,000 | 0 to ¼ | ½ to ¾ | 1¼ |
| pratense, ..................... | 64 | 16,000 | 0 to ½ | 1¼ to 1½ | 2 |
| ,, perenne,................ | 64 | 16,000 | 0 to ½ | 1¼ to 1½ | 2 |
| repens, ........................ | 65 | 32,000 | 0 to ¼ | ½ to ¾ | 1½ |

"The results in the three last columns of the preceding table were obtained by sowing the seed in finely sifted dark loam, which was kept moist throughout the process of germination, to which is attributable the circumstance of so many of the sorts vegetating best—as shown in Column IV.—without covering, and under full exposure to the light. The combination of such favourable circumstances of soil and moisture, can, however, seldom be calculated upon in field sowing, therefore a covering of mould for the seeds, however slight, is always advisable. But it will be seen, by the results in Column VI., that a great number of seeds must be inevitably lost from over-depth of covering, unless the ground be in all cases carefully prepared and pulverised before sowing either the *natural* or *artificial* grasses."[1]

From this it is evident that to scatter these tiny seeds over a cloddy surface, and then to harrow it, may more aptly be called burying than sowing them. The following is a more rational mode of proceeding. When these seeds are to be sown among winter wheat, it is expedient to begin by using the horse-hoe (supposing the wheat to have been drilled), as well to loosen the surface and produce a kindly bed for the seeds, as to destroy weeds. In the case of broad-casted wheat, a turn of the harrows secures the same end. In the case of the more recently-sown barley, all that is needed is to smooth the surface with the one-horse roller. Over the ground thus prepared, the small seeds are distributed by a broad-cast sowing machine, which covers at once a ridge of 15 or 18 feet in width. The covering in is then effected by simply rolling with the smooth roller, or by dragging over the surface Smith of Deanston's chain-web, which may either be attached to the sowing machine, or to a separate frame; or by using Crosskill's roller with a hurdle interlaced with bushes tethered to it. On clay soils the chain-web is to be preferred; but on loose soils Crosskill's roller imparts a beneficial firmness, and with its tail-piece of bushes to fill up the indentations, gives an accuracy of finish, which rivals the neatness of a newly-raked garden plot. We have long regarded this covering in of grass seeds as the most important use to which Crosskill's valuable implement is put. The only drawback to it is, that it makes a heavy demand on the horse-power of the farm at a pressing season. As it can only be worked in dry weather, it is advisable, when the land is in trim, to work it double tides by means of a relay of horses. This mode of procedure is alike applicable to the sowing of mixed clovers and grasses, and to that of the clovers alone; and is the course usually pursued in sowing for one or two years' "seeds." When it is intended to lay down arable land to grass for several years, or to restore it to permanent pasture or meadow, it is always advisable to sow the seeds without a corn crop. This doubtless involves an additional cost at the outset, but it is usually more than repaid by the enhanced value of the pasture thus obtained. To grow the grasses well, the soil should be pulverised to the depth of 3 or 4 inches only, and be full of manure near the surface. There is no better way of securing these conditions, than by first consuming a crop of turnips on the ground by sheep folding, and then to pulverise the surface by means of the grubber, harrow, and roller, *without ploughing it.* Much diversity of practice exists in regard to the kinds and quantities of seeds used in sowing down with a grain crop. In Scotland from 2 to 4 pecks of ryegrass seeds, with from 10 to 14 lb. of those of red, white, and yellow clovers, in about equal proportions, is a common allowance for an acre. A pound or two of field-parsley is occasionally added, or rather substituted, for an equal weight of clover seeds. The natural grasses are seldom sown, and only when the land is to be laid to permanent pasture. In England ryegrass is in much less repute than in Scotland, the clovers being there very generally sown unmixed, and always in larger quantities than we have just named—20 lb. per acre being a common allowance. There can be little doubt that both of these plans are faulty. When a good natural pasture is carefully examined, it is found to consist of an amazing number of dif-

Great variety of plants in natural pastures.

[1] Morton's *Cyclopædia of Agriculture*—article "Grasses," p. 999.

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ferent grasses and other plants. We once plucked *seventeen* distinct species in an old pasture, taking only those that could be reached without stirring a foot; and as it was only those that were in flower at the time, or which had escaped the browsing of the cattle that could be discriminated, we have no doubt that the list was far from complete. Not only does a natural pasture contain a great variety of herbage at any one time, but it has its plants which replace each other at different seasons; and some also which are prominent only in wet years and others in dry ones. The provision thus made for affording, at all times, such a variety of food as is at once grateful and wholesome to the animals which browse it, and for keeping the ground fully occupied under every diversity of seasons and weather, is truly admirable, and the study of it well-fitted to interest and instruct the husbandman. The importance of this subject is beginning to be appreciated by agriculturists; as one proof of which we now see our leading seedsmen regularly advertising for sale a numerous list of grasses, and other pasture plants. Most of them also, for the guidance of their customers, point out the kinds and quantities per acre, which are appropriate for diversity of soils and other circumstances. We refer, as an example of this, to the manual of Messrs Lawson of Edinburgh, who have devoted much attention to this subject.

The following tables are from another source.

" I.—For Alternate-Husbandry.

| | For 1 year's Hay. | For 1 year's Hay and 1 year's Pasture. | For 1 year's Hay and 2 years' Pasture. |
|---|---|---|---|
| | lb. | lb. | lb. |
| " Lolium italicum.......... | 9 | 9 | 9 |
| perenne........... | 18 | 18 | 18 |
| Dactylis glomerata....... | — | 2 | 2 |
| Phleum pratense.......... | 1 | 2 | 2 |
| Medicago lupulina........ | — | 1 | 1 |
| Trifolium hybridum...... | 1 | 2 | 2 |
| pratense.......... | 8 | 4 | 2 |
| pratense perenne | — | 2 | 4 |
| repens............ | 2 | 4 | 4 |
| | 39 | 44 | 44 |

" For sheep pastures, it will often be found advantageous to add from two to four lb. per acre of *parsley* seed to the above mixtures; and for pastures in certain upland districts, established practice will justify the introduction of an additional lb. or two of yellow clover (*Medicago lupulina*), together with from two to three lb. of ribgrass (*Plantago lanceolata*). And for very heavy, as well as for peaty soils, one to one-and-a-half lb. of *Phleum pratense* may be added advantageously, both for hay and pasture.

" II.—For Permanent Pasture, No. I.

| | lb. |
|---|---|
| " Alopecurus pratensis..................... | 2 |
| Dactylis glomerata......................... | 6 |
| Festuca duriuscula......................... | 2 |
| elatior............................. | 2 |
| pratensis.......................... | 2 |
| Lolium italicum.............................. | 6 |
| perenne.............................. | 8 |
| Phleum pratense............................ | 2 |
| Poa nemoralis sempervirens............ | 2 |
| trivialis................................ | 3 |
| Medicago lupulina......................... | 1 |
| Trifolium pratense......................... | 1 |
| perenne........................ | 3 |
| repens.......................... | 6 |
| | 46 |

" In certain cases, the following additions to Table II. may be made, namely one to two lb. each of *Festuca rubra* and *Poa pratensis* on dry sandy soils; one lb. of *Achillea Millefolium*, and one to two lb. of *Petrosalinum sativum* in sheep pastures; two lb. chicory (*Cichorium Intybus*) in cattle pastures, six or ten lb. of *Onobrychis sativa* and four to six lb. of *Poterium Sanguisorba* (burnet) in dry calcareous soils. When a crop of hay is taken the first year, both the rye-grasses (*Lolium*) may be increased by a third; and two lb. of *Trifolium pratense* added. Also one-half to one lb. per acre of *Anthoxanthum odoratum* when occasional crops of hay are to be taken."[1]

Having described the means to be used for obtaining good pastures, let us now consider how to use them profitably. To the uninitiated the management of grass land may seem much easier than that of arable land, although the reverse is the case. After a lengthened practice, we, at least, find it so in our own experience. Nothing, indeed, can be more simple than to turn a quantity of live stock into a pasture in spring, and leave them there to shift for themselves until autumn; but such a procedure is *simple* in more than one acceptation.

The art of grazing.

The art of grazing embraces the practical solution of two important problems, viz., 1*st*, how to obtain the greatest amount and best quality of herbage from any given pasture; and, 2*d*, how to consume this herbage by live stock so as to make the most of it. The grazier has ever to keep in view what is best for his land, and what is best for his stock; and must take his measures throughout the entire season with an eye to both these objects. As regards the first of them, experience yields the following maxims for his guidance:—

Never to stock his pastures in spring until genial weather is fairly established, and the pasturage is abundant.

Never to allow the grasses to run to seed, nor parts of a field to be eaten bare, and others to get rank and coarse.

Duly to spread about the droppings of the cattle; to remove stagnant water, and to extirpate tall weeds.

Sometime in early autumn to make a point of having the pasture eaten so close that no dead herbage or "foggage" shall be left on any part of it.

In what more immediately concerns the welfare of the live stock he is in like manner taught in stocking his pastures,—

To adapt the stock as regards breed, size, condition, and numbers, to the actual capabilities of the pasturage.

To secure to the stock at all times a full bite of clean, fresh grown, succulent herbage.

In moving stock from field to field to take care that it be a change to better fare—not to worse.

Pasturage consists either of natural herbage or of "seeds." In the lowlands of Scotland there is little good old grass: all the really fertile soils being employed in arable husbandry, with the exception of small portions around the mansions of landowners. The pasturage consists, therefore, for the most part, of the cultivated clovers and grasses. Comparatively few cattle are there fattened on grass; the object of graziers being rather to stock their pastures with young and growing animals, and to get them into forward condition for being afterwards fattened upon turnips. The grazing season is there also much shorter than in England: old grass seldom affording a full bite for a well-conditioned bullock before the middle of May, or later than the middle of September. It is quite otherwise in England, various parts of which abound with old grass lands of the very richest description, on which oxen of the largest class can be fattened rapidly. These in many cases admit of being stocked towards the end of April, and under judicious

Rich old pastures of England.

[1] Morton's *Cyclopædia of Agriculture*—article "Grasses," p. 1000.

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management, continue to yield excellent pasturage for half the year. When stocked with cattle in fresh condition, two sets or "runs" are not unfrequently fattened, in such pastures, in the same season. These grass-fed cattle begin to come to market early in July, and for four or five months thereafter constitute the chief supplies of beef in our markets.

Cattle grazing.

Cattle, already well-fleshed, are alone suitable for turning into these rich old pastures. When this is attended to, and care taken not to stock the pastures until they yield a full bite, the progress of the oxen will usually be very rapid. It is now customary to hasten this progress by giving about four lb. of oil-cake to each beast daily. The dust and crumbs being sifted out, the bits of cake are strewn upon the clean sward, from whence they are quickly and carefully gleaned by the cattle. This is usually a profitable practice. It brings the beasts forward rapidly, improves their appearance and handling, and, besides enriching the land, admits of about *twelve* per cent. more numbers being fed upon a given acreage. These choice old pastures are usually occupied in combination with others of inferior quality. The most forward lot of cattle having been fattened and sold off from the former, they are ready to receive a fresh stock. If it is contemplated to get them also fattened before the expiry of the season, they are not put on the best land instantly on the first lot being sold; but a crowd of sheep or store-beasts being turned upon it for a few days, the existing herbage is cleared off, and the pasture (*Anglice*) "laid in" or (*Scottice*) "hained," until a fresh, clean growth fits it for receiving a suitable number of the best cattle from the other pastures. It is inexpedient to graze sheep promiscuously with cattle on these best lands, as they pick out the sweetest of the herbage, and so retard the fattening of the oxen. Neither do we approve of having horses among such cattle; not so much from their interfering with their pasturage, as from the disturbance which they usually cause by galloping about. This does not apply to the draught-horses of a farm, which are usually too tired and hungry when turned out from the yoke to mind anything but food and rest; but it is better thrift to soil them; and frolicsome, mischievous colts are unsuitable companions for sedate, portly oxen. In favourable seasons, the grass often grows more rapidly than an ordinary stocking of cattle can consume it, in which case they select the best places and allow the herbage on some parts to get rank and coarse. If these rank places are neglected until the herbage gets dry and withered, the finer plants die out, the coarser-growing grasses usurp the ground, and the pasturage is injured for future years. To check this evil in time, these neglected places should be mown, and the grass either brought to the homestead for soiling, or left to dry where it grew; in which state the cattle will eat up most of it, and be the better for it, especially if their bowels are unduly relaxed by the succulence of the growing herbage. The remarks now made apply equally to all old pastures employed for the fattening of cattle, although not of the first quality. All that is required is, to observe a due proportion betwixt the capabilities of the pasturage and the breed and size of the cattle. A pasture that will fatten a fifty-stone ox may be quite inadequate for one of seventy, and the hardy Galloway or West Highlander will thrive apace where the heavier and daintier short-horn could barely subsist.

Sheep grazing.

With the exception of the best class of rich old pastures, grass is usually consumed to greater profit by a mixed stock of sheep and store cattle, than by one kind of animals only. This holds true both as regards the natural herbage of pastures, and water meadows, and cultivated grasses, clovers, and sainfoin. When old pastures and mixed "seeds" are grazed chiefly by sheep, the same rules apply that have already been noticed in connection with cattle. The herbage should if possible be fully established in a growing state, and so far advanced as to afford a full bite, before the pasture is stocked in spring. If the sheep are turned into it prematurely, their close nibbling hinders the plants from ever getting into a state of rapid growth and productiveness, and the necessity imposed upon the stock of roaming over the whole field, and keeping long afoot before they can glean enough to appease their appetite, is prejudicial alike to them and to their pasture. The prudent grazier endeavours to avoid these evils by having his stores of Swedes or mangels to last until the full time at which he may reckon on having good pasturage. In distributing the flocks to different fields, the best pasturage is allotted to those that are in most forward condition. It is advantageous to have the pastures so subdivided that one portion may be double stocked while another is rested. By frequently removing the stock from the one portion to the other the herbage of each by turns gets time to grow and freshen, and is more relished by the sheep, than when the whole is tainted by their uninterrupted occupation of it. In the case of clover, trefoil, sainfoin, and water-meadows, this principle is yet more fully carried out by folding the flock and giving them a fresh piece daily. The crop is thus eaten close off at once in daily portions and the plants being immediately thereafter left undisturbed, and receiving over the whole area their due share of the excrements of the flock, grow again more rapidly than when subjected to constant browsing under a system of promiscuous grazing. This plan of folding sheep upon such crops has the same advantages to recommend it as soiling, only that it is cheaper to shift the fold daily than to mow and cart home the forage and carry back the manure. In the case of water-meadows it is the practice to irrigate them afresh as each crop of grass is fed off. This is attended with considerable risk of the sheep getting tainted with rot, which must be guarded against as much as possible. In the first place it is well to give them a daily allowance of bran, beans, or cake, and salt; and besides this to put on this land only such sheep as are nearly ready for the butcher. They will thus fatten very rapidly, and be slaughtered before there is time for harm to ensue.

The modes of grazing which we have now described are appropriate for sheep in forward condition. The poorer pastures are usually stocked with nursing ewes and lean sheep bought in from higher grazings. Lambs, both before and after weaning, require clean pastures, and of course frequent changes. If kept on tainted pastures they are certain to become subject to diarrhœa, to be stinted in their growth, and to have their constitution so weakened that many of them will die when afterwards put upon turnips. To avoid these evils they must be frequently moved from field to field. A sufficient number of store cattle must be grazed along with them to eat up the tall herbage and rank places avoided by the sheep. After the lambs are weaned, the ewes require to fare rather poorly for a time, and can thus be made use of to eat up the worst pasturage, and the leavings of the young and fattening sheep. When the latter, with the approach of autumn, are put upon aftermath, clover-stubbles, rape, cabbages, or turnips, their previous pastures should in succession be thickly stocked by the ewes and other store stock so as to be eaten bare and then get leave to freshen and get ready for the ewes by rutting time, when they require better food. In depasturing sheep on poor soils it is usually highly advantageous to give them a daily allowance of grain or cake in troughs which must be shifted daily so as to distribute the manure regularly over the land. By means of this auxiliary food, sheep can be fattened on land, the herbage of which would not alone suffice to do this. It admits also of a larger number of sheep being kept per acre,

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and of the pasturage being fed off more closely than could otherwise be done. The produce of poor siliceous soils, both in grass and after crops, is much increased by the additional manuring and treading which the consumption of such extraneous food upon them occasions.

It is always advantageous to have pastures provided with a shed under which the stock can find shelture from sudden storms, or from the attacks of insects, and the scorching rays of the summer's sun. When such sheds are regularly strewed with dried peat or burnt clay, much valuable compost for top-dressing the pasture can be obtained. The dung of the cattle thus secured and applied benefits the pastures more than that which is dropped upon it by the animals. Such clots require to be spread about from time to time.

To carry out successfully the various details now referred to, which constitute the art of grazing, there is required much foresight, accurate observation, sound judgment, and constant superintendence. Without all this it is impossible to make the most of any given amount of live stock and pasturage, and hence the extraordinary disparity in the results obtained by different graziers from similar materials.

Soiling *versus* grazing.

The temperate climate of Britain is so peculiarly favourable to the growth of the grasses and other pasture plants, and to the keeping of live stock with safety in the open fields for a large part of the year, that the practice of consuming these crops by depasturing, as already described, has hitherto been decidedly preferred to soiling. One consequence of this is, that forage crops have been comparatively neglected. There is now, however, a growing conviction among agriculturalists that it is more convenient to keep neat-cattle and horses, during summer, in yards or loose boxes, and to feed them with succulent forage, mown and brought to them daily as it is needed, than to turn them adrift to browse in the fields. The pasturing plan is preferred by many because it involves the least labour, and is alleged to be more healthful to the animals. In behalf of the soiling plan, it is urged that a given space of ground under green crop keeps nearly twice as much stock, when its produce is mown and consumed elsewhere, than when it is constantly nibbled and trodden upon; that housed cattle being exempted from the vicissitudes of the weather, the attacks of insects, mutual disturbance, and the labour of gathering their food, eat less and yet fatten more rapidly than they do at pasture; that more good is gotten of their excrements when mixed with litter, and trodden down under cover, than when dropped about in the open fields; and that land from which a green crop has been mown, when ploughed up, is freer of weeds and (other things being equal) bears a better corn crop than that which has been pastured. It is a further recommendation to the soiling plan that it admits of oil-cake or meal being administered along with green food with a precision and economy that is unattainable in the pasture fields. There being so many, and such cogent reasons in favour of the practice of soiling, we may warrantably anticipate that it will in future be much more generally adopted. It is proper, however, to notice that the success of this system is absolutely dependent on the following conditions. The green food must be mown and brought home at least *twice* a-day, owing to the rapidity with which it ferments when put together; it must be given to the stock not less than *four* times daily, and only in such quantity at each feed as they can eat clean up in the interval betwixt meals; they must have constant and ample supplies of pure water and of fresh litter; and, in particular, matters must be so arranged that there shall be an unfailing supply of green forage of the best quality, through the entire season. This is accomplished either by successive cuttings of one kind of crop from the same ground—as of irrigated meadow, or Italian ryegrass—or by a combination of such crops as naturally come to maturity in succession, or are made to do so by a sequence of sowings. From what has been said, it is obvious that soiling can only be carried out successfully with a moderately good soil and climate, a liberal use of manure, and skill and foresight on the part of the farmer. With these, however, its results will usually be highly satisfactory. It is peculiarly adapted for clay soils, on which the culture of root crops is attended with much difficulty, and where there is, therefore, abundance of litter for use in summer, and much need for the soiling system to get it converted into good manure.

In proceeding to notice the crops most usually cultivated in Britain for green forage, we shall begin with Natural Meadow Grass. In the south-western parts of England abundant crops of grass are obtained by irrigation with simple water. Our remarks shall here, however, be restricted to those situations where sewage from towns or villages is available. Wherever a few scores of human families are congregated together, and have their dwellings properly drained and supplied with water, there is an opportunity for manuring a considerable extent of meadow with the sewage-water accruing from them throughout the year. The celebrated meadows in the environs of Edinburgh are interesting illustrations of the value of such water for irrigating purposes, and of the astonishing bulk of rich herbage which can be obtained in the course of a year from an acre of land thus treated. From the thickness of the crop in these meadows, and the rank luxuriance of its growth, the grass must be cut before it exceeds *ten* inches in height, as otherwise the bottom gets blanched, and the grass rots out. The mowing begins usually in April, and continues till November, so that by fitly proportioning the head of stock to the extent of meadow, and having the latter arranged in plots to be mown in regular succession, soiling can be practised throughout the season by means of the produce of the meadow alone. This practice is necessarily limited to situations where sewage water is available. The following excerpt from the *Minutes of Information to the General Board of Health, collected in the practical application of Sewer Water and Town Manures to Agricultural Production*, p. 65, will explain the system here referred to, and exhibit its results:—

"Craigentinney Meadows, situate about one mile and a half south-east of Edinburgh, have been put under irrigation at various times, the most recent addition being nearly 50 acres laid out in the course of last year (1850) and the year previous, which lying above the level of the rest are irrigated by means of a steam-engine. The meadows first laid out are watered by contour channels following the inequalities of the ground, after the fashion commonly adopted in Devonshire; but in the more recent parts the ground is disposed in 'panes' of half an acre, served by their respective feeders, a plan which, though somewhat more expensive at the outset, is found preferable in practice. The whole 260 acres take about fourteeen days to irrigate; the men charged with the duty of shifting the water from one pane to another, give to each plot about two hours' irrigation at a time; and the engine serves its 50 acres in ten days, working day and night, and employing one man at the engine and another to shift the water. The produce of the meadows is sold by auction on the ground, 'rouped,' as it is termed, to the cowfeeders of Edinburgh, the purchaser cutting and carrying off all he can during the course of the letting, which extends from about the middle of April to October, when the meadows are shut up, but the irrigation is continued through the winter. The lettings average somewhat over L.20 the acre; the highest last year having brought L.31, and the lowest L.9; these last were of very limited extent, on land recently denuded in laying out the ground, and consequently much below its natural level of productiveness. There are four cuttings in the year, and the collective weight of grass cut in parts was stated at the extraordinary amount of eighty tons the imperial acre.

The only cost of maintaining these meadows, except those to which the water is pumped by the engine, consists in the employment of two hands to turn in and off the water, and in the expense of clearing out the channels, which was contracted for last year at L.29, and the value of the refuse obtained was considered fully equal to that sum, being applied in manuring parts of the land for a crop of turnips, which, with only this dressing in addition to irrigation with the sewage-water, presented the most luxuriant appearance. The crop from present indications, was estimated at from thirty to forty tons the acre, and was expected to realise 15s. the ton, sold on the land. From calculations made on the spot, we estimated the produce of the meadows during the eight months of cutting, at the keep of ten cows per acre, exclusive of the distillery refuse they consume in addition, at a cost of 1s. to 1s. 6d. per head per week. The sea-meadows present a particularly striking example of the effects of the irrigation; these, comprising between 20 and 30 acres skirting the shore between Leith and Musselburgh, were laid down in 1826 at a cost of about L.700; the land consisted formerly of a bare sandy tract, yielding almost absolutely nothing; it is now covered with luxuriant vegetation, extending close down to high-water mark, and lets at an average of L.20 per acre at least. From the above statement it will be seen how enormously profitable has been the application in this case of town refuse in the liquid form; and I have no hesitation in stating, that, great as its advantages have been, they might be extended four or five fold by greater dilution of the fluid."

*Italian Ryegrass* can, however, be cultivated over as wide a range of soils and climate as any forage crop which we possess, and its value for soiling is every day getting to be more generally appreciated. When first introduced, and indeed until very recently, it was chiefly sown in mixture with other grasses and clovers for pasturage, a purpose to which it is well adapted from its early and rapid growth in spring. Its true function, however, is to produce green food for soiling, for which purpose it is probably unrivalled. It is in connection with the system of irrigation with liquid manure, as practised at Myremill and elsewhere, that its astonishing powers have been most fully developed. When grown for this purpose it is sown in April, on land that has borne a grain crop after turnips or summer fallow. If sown *with* a grain crop and as thickly as is requisite, it gets nearly as tall as the grain, and both are injured. A liberal dressing of farm-yard dung is spread upon the stubble in Autumn, and immediately ploughed in. In the end of March or beginning of April the land is prepared for the seed by being stirred with the grubber and then well harrowed. The seed, at the rate of four bushels per acre, is then sown in the way already described for clover and grass seeds. When the liquid manure system is practised, the crop is watered as soon as the young plants are about an inch high, and so rapid is its growth in favourable circumstances that a cutting of ten tons per acre has in some cases been obtained six weeks after sowing. When there is no provision for supplying liquid manure, a top-dressing of guano, nitrate of soda, soot, or the first two articles mixed, is applied by hand-sowing, taking care to give this dressing when rain seems at hand, or has just fallen. A similar top-dressing is repeated after each cutting, by which means three cuttings are ordinarily obtained from the same space in one season. A very great quantity of stock can thus be supported from a very limited extent of ground. This grass is also found to be very grateful to the palates of horses, cattle, and sheep, which all thrive upon it. Though so very succulent, it does not produce purging in the animals fed upon it. It is peculiarly suitable feeding for milch cows, as appears from the published account at Canning park. Such results as those obtained by Mr Kennedy and others, are not to be expected unless under similar conditions; but on good loams, clean and in good heart, and under such treatment as is described at the beginning of this section, as large crops of this grass with at least equal feeding powers to red clover may be reckoned on, and with a degree of certainty which the farmer cannot now entertain in regard to the latter crop. If regularly mown when the ear begins to shew, taking care never to allow the seed to form, it is fully ascertained that this grass will grow abundantly for a second year, with the advantage of being ready for use very much earlier than in its first season. It is sometimes sown in Autumn, but those who have had the fullest experience in its cultivation give a decided preference to spring sowing, either after a grain crop which has followed a green crop or fallow, or at once after turnips. It is of great importance to get fresh and genuine seed. That directly imported from Italy yields the best crop when otherwise good. As a proof of the fondness of sheep for this grass, it has been observed that when it had been sown in mixture with red clover and cut for hay, sheep, on being turned into the aftermath, eat down the Italian ryegrass in preference to the clover.

*Crimson Clover*, though not hardy enough to withstand the climate of Scotland in ordinary winters, is a most valuable forage crop in England. It is sown as quickly as possible after the removal of a grain crop at the rate of 18 lb. to 20 lb. per acre. It is found to succeed better when only the surface of the soil is stirred by the scarifier and harrow, than when a ploughing is given. It grows rapidly in spring, and yields an abundant crop of green food, peculiarly palatable to live stock. It is also suitable for making into hay. It may be sown in mixture with Italian ryegrass with great propriety.

*Red Clover.*—This plant, either sown alone or in mixture with ryegrass, has for a long time formed the staple crop for soiling, and so long as it grew freely, its power of shooting up again after repeated mowings, the bulk of crop thus obtained, its palatableness to stock, and feeding qualities, the great range of soils and climate in which it grows, and its fitness either for pasturage or soiling, well entitled it to this preference. Except on certain rich calcareous clay soils, it has now, however, become an exceedingly precarious crop. The seed, when genuine, which unfortunately is very often not the case, germinates as freely as ever; and no greater difficulty than heretofore is experienced in having a full plant during autumn and the greater part of winter; but over most part of the country, the farmer, after having his hopes raised by seeing a thick cover of vigorous-looking clover plants over his field, by March or April finds, to his dismay, that they have either entirely disappeared, or are found only in capricious patches here and there over the field. No satisfactory explanation of this clover failure has yet been given, nor any certain remedy, of a kind to be applied to the soil, discovered. One important fact is, however, now well established, viz., that, when the cropping of the land is so managed as that clover does not recur at shorter intervals than eight years, it grows with much of its pristine vigour. The knowledge of this fact now determines many farmers in varying their rotation so as to secure this important end. At one time there was a somewhat prevalent belief that the introduction of beans into the rotation had a specific influence of a beneficial kind on the clover when it came next to be sown; but the true explanation seems to be, that the beans operate favourably only by the incidental circumstance of almost necessarily lengthening the interval betwixt the recurrences of clover. When the four-course rotation is followed, no better plan of managing this process has been yet suggested than to sow beans, pease, potatoes, or tares, instead of clover, for one round, making the rotation one of eight years instead of four. The mechanical condition of the soil seems to have something to do with the success or failure of the clover crop. We have often noticed that head lands,

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or the converging line of wheel tracks near a gateway at which the preceding root crop had been carted from a field, have had a good take of clover when on the field generally it had failed. In the same way a field that has been much poached by sheep while consuming turnips upon it, and which has afterwards been ploughed up in an unkindly state, will have the clover prosper upon it, when it fails in other cases where the soil appears in far better condition. If red clover can be again made a safe crop, it will be a boon indeed to agriculture. Its seeds are usually sown along with a grain crop any time from 1st February to May, at the rate of 12 lb. to 20 lb. per acre when not combined with other clovers or grasses.

Italian ryegrass and red clover are now frequently sown in mixture for soiling, and succeed admirably. It is, however, a wiser course to sow them separately, as by substituting the Italian ryegrass for clover, for a single rotation, the farmer not only gets a crop of forage as valuable in all respects, but is enabled, if he choose, to prolong the intervals betwixt the sowings of clover to twelve years, by sowing, as already recommended, pulse the first round, Italian ryegrass the second, and clover the third.

These two crops, then, are those on which the arable-land farmer mainly relies for green forage. To have them good, he must be prepared to make a liberal application of manure. Good farm-yard dung may be applied with advantage either in autumn or spring, taking care to cart it upon the land only when it is dry enough to admit of this being done without injury. It must also be spread very evenly so soon as emptied from the carts. But it is usually more expedient to use either guano, nitrate of soda, or soot for this purpose, at the rates respectively of 2 cwt., 1 cwt., and 20 bushels. If two or more of these substances are used, the quantities of each will be altered in proportion. They are best also to be applied in two or three portions, at intervals of fourteen to twenty days, beginning towards the end of March, and only when rain seems imminent or has just fallen.

When manure is broad-cast over a young clover field, and presently after washed in by rain, the effect is identical with that of first dissolving it in water, and then distributing the dilution over the surface, with this difference, namely, that the first plan costs only the price of the guano, &c., and is available at any time and to every one, whereas the latter implies the construction of tanks and costly machinery.

*Vetches* are another very valuable forage crop. Being indigenous to Britain, and not fastidious in regard to soil, they can be cultivated successfully under a great diversity of circumstances, and are well adapted for poor soils. By combining the winter and spring varieties, and making several sowings of each in their season, at intervals of two or three weeks, it is practicable to have them fit for use from May till October, and thus to carry out a system of soiling by means of vetches alone. But it is usually more expedient to use them in combination with grass and clover, beginning with the first cutting of the latter in May, taking the winter vetches in June, recurring to the Italian ryegrass or clover, as the second cutting is ready, and afterwards bringing the spring vetches into play. Each crop can thus be used when in its best state for cattle food, and so as gratefully to vary their dietary.

*Winter Vetches.*—There is no botanical difference betwixt winter and spring vetches, and the seeds being identical in appearance, caution is required in purchasing seed to get it of the right sort. Seed grown in England is found the most suitable for sowing in Scotland, as it vegetates more quickly, and produces a more vigorous plant than that which is home-grown. As the great inducement to cultivate this crop, is the obtaining of a supply of nutritious green food, which shall be ready for use about the 1st May, and so as to fill up the gap which is apt to occur betwixt the root crops of the previous autumn, and the ordinary summer food, whether for grazing or soiling, it is of the utmost importance to treat it in such a way, that it may be ready for use by the time mentioned. To secure this, winter tares should be sown in August if possible, but always as soon as the land can be cleared of the preceding crop. They may yield a good crop though sown in October, but, in this case, will probably be very little in advance of early sown spring vetches, and possess little, if any, advantage over them in any respect. The land on which they are sown should be dry and well sheltered, clean, and in good heart, and be farther enriched by ploughing into it from 12 to 15 loads of farm-yard manure. Not less than 3½ bushels of seed per acre should be sown, to which some think it beneficial to add half a bushel of wheat. Rye is frequently used for this purpose, but it gets reedy in the stems, and is rejected by the stock. Winter beans would probably succeed better than either. The land having been ploughed rather deeply and well harrowed, it is found advantageous to deposit the seed in rows, either by a drilling-machine, or by ribbing. The latter is the best practice, and the ribs should be at least a foot apart and rather deep, that the roots may be well developed before top-growth takes place. As soon in spring as the state of the land and weather admits of it, the crop should be hoed betwixt the drills, a top-dressing at the rate of 40 bushels of soot, or 2 cwt. of guano per acre applied by sowing broad-cast; and the roller then used for the double purpose of smoothing the surface, so as to admit of the free use of the scythe, and of pressing down the plants which may have been loosened by frost. It is thus by early sowing, thick seeding, and liberal manuring, that this crop is to be forced to an early and abundant maturity. May and June are the months in which winter vetches are used to advantage. A second growth will be produced from the roots if the crop is allowed to stand; but it is much better practice to plough up the land, as the crop is cleared, and to sow turnips upon it. After a full crop of vetches, land is usually in a good state for a succeeding crop. When the whole process has been well managed, the gross amount of cattle food yielded by a crop of winter vetches, and the turnip crop by which it is followed in the same summer will be found considerably to exceed what could be obtained from the fullest crop of turnips alone, grown on similar soil, and with the same quantity of manure.

*Spring Vetches*, if sown about the first of March, will be ready for use by 1st July, when the winter vetches are just cleared off. To obtain the full benefit of this crop, the land on which it is sown must be clean, and to keep it so, a much fuller allowance of seed is required than is usually given in Scotland. When the crop is as thick set as it should be, the tendrils intertwine, and the ground is covered by a solid mass of herbage, under which no weed can live. To secure this, not less than four bushels of seed per acre should be used, if sown broad-cast, or three bushels if in drills. The latter plan, if followed by hoeing, is certainly the best; for if the weeds are kept in check until the crop is fairly established, they have no chance of getting up afterwards. With a thin crop of vetches, on the other hand, the land is so certain to get foul, that they should at once be ploughed down, and something else put in their place. As vetches are in the best state for use when the seeds begin to form in the pods, repeated sowings are made at intervals of three weeks, beginning by the end of February, or as early in March as the season admits, and continuing till May. With *two* sowings in autumn, and *four* in spring, a supply of this valuable food can be had in good condition from May till October, so that by means of vetches alone, if well managed, the interval betwixt the old and new crops of roots can be filled

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up. There are, as we have seen, other forage crops, well worthy the attention of the farmer, but the vetch is less fastidious in regard to soil and climate than any of them, and can be grown successfully on very poor soils. The usual practice in Scotland has been to sow vetches on part of the oat break, once ploughed from lea. Sometimes this does very well, but a far better plan is to omit sowing clover and grass seeds on part of the land occupied by wheat or barley after turnips, and having ploughed that portion in autumn to occupy it with vetches, putting them *instead of* "*seeds*" for one revolution of the course.

Folding sheep upon vetches.

When vetches are grown on poor soils, the most profitable way of using them is by folding sheep upon them. A different course, must, however, be adopted than when turnips are disposed of in this way. When sheep are turned in upon a piece of tares, a large portion of the food is trodden down and wasted. Cutting the vetches and putting them into racks does not much mend the matter, as much is still pulled out and wasted, and the manure unequally distributed over the land. To avoid those evils, hurdles with vertical spars, betwixt which the sheep can reach with head and neck, are now used. These are set close up to the growing crop along a considerable stretch, and shifted forward as the sheep eat up what is within their reach. This requires the constant attention of the shepherd, but the labour is repaid by the saving of the food, which, being always fresh and clean, does the sheep more good. A modification of this plan is to use the same kind of hurdles, but, instead of shifting them as just described, to mow a swathe parallel to them, and fork this forward within reach of the sheep as required, repeating this as often during the day as is found necessary, and at night moving them close up to the growing crop, so that the sheep may lie for the next twenty-four hours on the space which has yielded food for the past day. During the night they have such pickings as have been left on the recently-mown space, and so much of the growing crop as they can get at through the spars. There is less labour by this last mode than the other, and in practice it has been found to do well.

As spring-sown vetches are in perfection at the season when pastures usually get dry and scanty, a common practice is to cart them on to grass land and spread them out in wisps, to be eaten by the sheep or cattle. It is, however, much better either to have them eaten by sheep where they grow, or to cart them to the homestead.

By means of the crops now enumerated, the practice of soiling can be carried out in all cases where it is practicable.

There are other valuable crops of this kind, several of which we shall now describe; but their culture is either limited by their requirements in regard to soil and climate, or attended with too great expense to admit of their competing with those already described.

*Sainfoin.*—This very important forage plant would be well entitled to a more prominent place in our list, but for the circumstance that it is only on dry calcareous soils that its excellences are fully developed; and to these accordingly its culture may be said to be confined. In all the chalk districts of England, sainfoin occupies an important place in the rotation of crops. Referring to the chalky downs round Ilsley in Berks, Mr Caird says:—"About a tenth part of the land is kept under sainfoin, in which it remains for four years, being each year cut for hay, of which it gives an excellent crop. A farmer having forty acres of sainfoin, sows out ten acres and breaks up ten acres annually. This goes regularly over the whole farm, the sainfoin not returning on the same field for considerable intervals, and when its turn comes round the field receives a rest of four years from the routine of cultivation. It is then ploughed up in spring, and sown with oats on one furrow, the crop of which is generally excellent, as much as eighty bushels an acre not being uncommon." The seed, at the rate of four bushels per acre, is drilled in immediately after barley or oats has been sown, working the drill at right angles to its course when it deposited the grain. It is frequently pastured for one or more years before being mown either for green forage or for hay. It is sometimes allowed to stand for eight or ten years, but the plan described in the above quotation is the more approved one. A variety called giant-sainfoin has been introduced by Mr Hart of Ashwell, Herts. As compared with the common sort it is more rapid in its growth in spring, and still more so after the first and second cuttings. Three cuttings for hay, and one of these ripening the seed, have been yielded by it in one year, and a good eddish after all. The yield from it in the first year, after sowing, is large in comparison with the common sainfoin, from its attaining maturity much sooner; but for the same reason it is thought judicious to break it up after three years, while still in vigour.

*Lucerne* is much cultivated as a forage crop in France and other parts of the continent of Europe, but has never come into general use in Britain. It is, however, frequently met with in small patches in districts where the soil is very light, with *a dry subsoil.* Its thick tap-roots penetrate very deeply into the soil; and if a good cover is once obtained, the plants will continue to yield abundant cuttings of herbage for eight or ten years, provided they are statedly top-dressed, and kept free from perennial weeds. In cultivating lucerne, the ground must first be thoroughly cleaned, and put into good heart by consuming a turnip crop upon it with sheep. In March or April, the surface-soil having first been brought to a fine tilth, the seed, at the rate of 10 lb. per acre, is sown in rows at 15 to 18 inches apart. So soon as the plants appear, they must be freed from weeds by careful hoeing and hand-weeding, repeated as occasion requires. Little produce is obtained from them the first season, and not a very heavy cutting the second; but by the third year it will yield two or more abundant crops of herbage, peculiarly suitable for horse-feed. It is the slow growth of the plants at first, and the difficulty of keeping them free from weeds on those dry soils which alone are adapted for growing lucerne, that have deterred farmers from growing it more extensively than has hitherto been done. We have grown it successfully in Berwickshire on a muiry soil, resting on sandstone rock, in an exposed situation, at an elevation of 400 feet. The time to cut it is, as with clover and sainfoin, when it is in full flower.

*Chicory*, *Burnet*, *Cow-Parsnip*, and *Prickly Comfrey*, all known to be palatable to cattle, and yielding a large bulk of produce, have probably been less carefully experimented with than their merits deserve. Although they have long figured in such notices as the present, or in occasional paragraphs in agricultural periodicals, they have never yet, that we are aware of, been subjected to such a trial as either conclusively to establish their claim to more extended culture, or to justify the neglect which they have hitherto experienced.

*Gorse* or *Whin.*—Notwithstanding its formidable spines, the young shoots of this hardy evergreen yield a palatable and nutritious winter forage for horses and cattle. To fit it for this purpose, it must be chopped and bruised to destroy the spines. This is sometimes done in a primitive and laborious way by laying the gorse upon a block of wood, and beating it with a mallet, flat at one end, and armed with crossed knife-edges at the other, by the alternate use of which it is bruised and chopped. There are now a variety of machines by which this is done rapidly and efficiently. and which are in use where this kind of forage is used to any extent. The agricultural value of this plant has often been over-rated by theoretical writers. In the case of very poor, dry soils, it does however yield much valuable food at a season when green forage is not otherwise to be had. It is, on this account, of importance to dairymen; and to them it has this further recommendation, that cows fed upon it give much rich milk, which is free from any unpleasant flavour. To turn it to good account, it must be sown in drills, kept clean by hoeing, and treated as a regular green crop. If sown in March, on land fitly prepared, and afterwards duly cared for, it is ready for use in the autumn of the following year. Only alternate rows should then be cut, and the others left for another year's growth. In this way a succession of cuttings of proper age are obtained for several years from the same field. It is cut by a short stout scythe, and must be brought from the field daily; for when put in a heap, after being chopped and bruised, it heats rapidly. It is given to horses and cows, in combination with chopped hay or straw. An acre will produce about 2000 faggots of green two-year-old gorse, weighing 20 lb. each.

This plant is invaluable in mountain sheep walks. The rounded form of the furze bushes that are met with in such situations, shows how diligently the annual growth, as far as it is accessible, is nibbled by the sheep. The food and shelter afforded to them in snow-storms by clusters of such bushes is of such importance, that the wonder is our sheep farmers do not bestow more pains to have it in adequate quantity. Young plants of whin are so kept down by the sheep, that they can seldom attain to a profitable size unless protected by a fence for a few years.

*Tussac Grass.*—The tussac grass of the Falkland Islands has, of late years, attracted considerable attention as a forage plant. From its gigantic growth, even in those ungenial regions, and the extraordinary relish manifested for it by horses and cattle, sanguine hopes were entertained that it was to prove a truly valuable addition to our present list of forage plants. The attempts hitherto made to introduce it in Britain have not been of a very encouraging kind. The only successful cases have been in the Orkneys and in Lewis. Messrs Lawson of Edinburgh, who have given much attention to it, say, "Our own experience leads to the conclusion, that localities within influence of the sea spray, the soil being of a peaty nature, are, without doubt, the best adapted for the growth of the tussac; and in such places it is likely to be of great service, as few other nutritive grasses will exist there. In our own experimental grounds it does not thrive well; which may, perhaps, be accounted for by the nature of the soil, which is light and dry. Regarding its value as a forage plant, we have before us an analysis made, at our request, by Professor Johnston, the results of which show that 'the tussac grass ought to be very nutritive.' Propagation, in the absence of seed, is easily effected, under favourable circumstances, by subdivision of the roots."

We have thus noticed all the more important of our forage crops of ascertained value. Additions will probably be made to them from time to time, especially from the increased attention now bestowed on green crops of all kinds. It has lately been suggested that maize, although unfit for our climate as a grain crop, might with advantage be tried as a forage plant.

*Haymaking.*—Having spoken of the cultivation and use in a green state of herbage and forage crops, it remains to describe the process by which they are preserved for use in a dry state, or *made into hay*. On every farm a supply of good hay, adequate to the wants of its own live stock is, or at least ought to be, statedly provided. This is, no doubt, an expensive kind of food, but on the other hand it is highly nutritious, and conduces much to the healthfulness of the animals fed upon it. Many a valuable farm horse is annually sacrificed to a false economy in feeding him solely on innutritious straw or ill-gotten hay. The owners of such stock would do well to consider that the price of an annual dead horse, and the impaired health and condition of the whole stud, more than counterbalance any saving that can be effected by using bad fodder instead of good. But the great consumpt of hay is by the numerous horses constantly required in this country for other purposes than farm labour. In the vicinity of towns hay is therefore a staple agricultural product, and haymaking an important branch of rural economy. It is one in the practice of which English farmers generally excel their brethren north of the Tweed. In the counties near the metropolis, in particular, this process is conducted with admirable skill.

In converting the grasses and forage plants into hay the object is to get quit of the water which they contain, amounting to nearly *two-thirds* of their weight, with the least possible loss of their nutritive qualities. In order to this the crops must be mown at that stage of their growth when the greatest weight of produce with the maximum of nutritive value can be obtained; and then so to conduct the drying process that the inspissated juices shall not be washed out and lost by external wetting. A simple and sufficiently accurate rule for determining the first point, is to mow when the plants are in full flower. If this stage is exceeded both the quality of the hay and amount of the foggage or aftermath are seriously impaired. It follows from this, that mowing should be commenced somewhat earlier than the stage indicated, otherwise before the whole can be cut, the last portion will have exceeded the proper degree of ripeness. By cutting a part too soon a slight loss of weight is incurred, which, however, is compensated for by a better aftermath, whereas if part is allowed to mature the seeds, there is a loss both of weight, quality, and aftermath. Haymaking, to be done well, must be done quickly, and, in order to this a full supply of labourers is indispensable. As a good mower can cut, on the average, an acre in a day, as many must be engaged as can overtake the extent of crop while it is in the best state for cutting. It is of great importance, too, to have the grass cut close by the ground. A loss of from five to ten per cent. on the gross produce is frequently incurred by unskilful or careless mowers leaving the sward too high. To admit of accurate and expeditious mowing, care must be taken, at the proper season, to remove all stones and other obstructions, and to make the surface smooth by rolling. Confining our attention, in the first place, to natural meadow grass, let us glance at the process as conducted by those who are most proficient in it. The mowers having commenced their work at sunrise, the haymakers, in the proportion of two men and three women to each mower, so soon as the dew is off, shake out the swaths evenly over the whole ground, until they have overtaken as much as they can get into cocks the same day. This quantity they now turn and toss about as frequently as possible, getting it, before evening, either into a compact windrow, or forming it into very small cocks. Next day these cocks are again opened out, and as much more of the grass in swath as can be overtaken, all of which is anew subjected to the same repeated turnings, and again, as evening approaches, secured from dew and rain by windrowing and cocking; that which is driest being put into larger cocks than on the previous day. If the weather is hot and parching, that which was first cut is by the fourth day ready for the stack, and is immediately carried. A large rick-cloth is drawn over the incipient stack until more hay is in condition to be added to it, and then, if weather favour, the whole process, from mowing to stacking, for a time goes on simultaneously, and is speedily completed. As the building of the stack proceeds, its sides are, by pulling, freed from loose hay and straightened; and, when completed, it is thatched with the least possible delay. If the weather proves showery, the grass is left untouched in the swath until it be-

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gins to get yellow on the under side, in which case it is usually turned over without opening out until weather again favour. To produce fine hay, care must be taken to secure it from dew or rain by cocking, before nightfall, all that has been spread out during the day,—never to touch it until dew or wet is off,—to shake all out so thoroughly as that the whole may be dried alike,—and never to suffer it, after being tedded out, to lie so long as to get scorched on one side. When these operations are conducted successfully, the hay is of a fine, light-green colour, delightfully fragrant, and retains its nutritious matter unimpaired. To accomplish this in our variable climate, much skill and energy, and an ample command of labour, are necessary. The cost and labour of this process are now, indeed, much reduced by the use of machinery, consisting of haymakers and horse-rakes, by means of which a lad and horse can, in a day, break out from the swath, turn, and draw together into rows, as much grass as could be overtaken in the same time by fifteen people. The hay-tedder, moreover, shakes out the grass more thoroughly than it can be done by hand. After the hay is gathered into rows, horse labour is also sometimes employed to thrust it into heaps by means of a sweep, that is, a piece of plank with a rope attached to each end of it, by which a horse draws it along *on edge*, while two lads hold it down, and the hay is thus pushed forward in successive portions, which are then, by hand labour, made into orderly cocks. The yield of meadow hay ranges from one to two tons per acre, and the cost of making it about 10s. per ton. In London, hay is brought to market in trusses, each weighing 56 lb. and 36 of which are called a load. In cutting up a stack these trusses are removed from it in compact squares, which are then neatly secured by bands of twisted hay.

Haymaking machinery.

In converting the cultivated forage crops, such as clover (either pure or mixed with ryegrass), sainfoin, lucerne, or vetches, into hay, the procedure varies considerably from that pursued with the natural grasses. A considerable part of these plants consists of broad, tender leaves, which, when scorched by the sun, become so dry and brittle that, on the least rough handling, they fly into dust, and are totally lost. These crops, therefore, do not admit of being shaken asunder, and tossed about like the natural grasses, a circumstance which unfortunately forbids the use of machinery and horse labour in getting them. The swaths are accordingly left untouched until they have got slightly withered on the upper side, after which they are turned several times, with as little breaking up as possible; made up first into small cocks—opened out again—gently turned, and made into larger cocks, which, as speedily as possible, are carried and stacked. These crops can be stacked with safety in a very green state by mixing with them frequent layers of clean dry straw, by which the redundant juices are absorbed, and injurious heating prevented. The straw thus impregnated acquires a flavour which renders it palatable to cattle; but it is advisable, when this practice is adopted, to cut the whole into chaff before using it as fodder.

The following system of making clover and ryegrass into hay is practised in several districts:—

"So soon as the surface is dry, a portion, about a yard in length, of the swath is taken, and the surface folded inwards, and the whole rolled into a kind of cone. A piece of ryegrass is pulled out of the top, and tied round the head of the 'ruckle,' as it is called, and set in rows to admit of being easily carted. Thus, while the sun and air thoroughly dry the whole mass, the rain, should it come, descends over the inclined surface of the cone, and as the large mass of leaves the clover possesses renders it peculiarly liable to injury from the wet, this process is most valuable, and in few places is it secured in better condition. In a dry time it is carted directly from the 'ruckles' to the stack; in a damp one, they are sometimes to pull down before they are carted off, and made into 'pikes,' or small heaps, of from two to three cart-loads each; here the clover is allowed to ferment, and in a week or two, put into the stack."[1]

Saving the seeds of ryegrass.

When it is desired to save the seeds of Italian or common ryegrass, the crop after being sown is allowed to lie for a day or two in swath, and is then neatly gathered into sheaves, bound and stooked precisely like a crop of oats. When sufficiently dried, the seed is either thrashed out in the field, the straw stacked like other hay, and the seed spread thinly over a granary floor, and turned several times daily until it is dry enough to keep in a bin or in sacks; or the sheaves are built into small round stacks, which stand until the seed is wanted, when it is thrashed out by machinery like grain.

Defects in Scottish haymaking.

Much has been said and written about the wastefulness of the system of haymaking annually practised in Scotland. To a considerable extent these animadversions are merited, although those who make them usually overlook the causes which account for, and to some extent palliate, the faults complained of. The facts of the case are simply these. In many parts of England, hay is both an important marketable commodity and the principal winter food of the live stock of the farm. In Scotland it is neither, its place being there more than supplied by the turnip crop, to which accordingly the farmer devotes his chief attention. Not only so, but from the nature of the climate, these two crops demand instant attention at precisely the same time; the hay needing to be made just when the turnips are urgently in want of thinning. The more important crop of course gets the preference, and the other is comparatively neglected. Add to this that it is but seldom that the Scottish farmer can command extraneous labour to help him in this dilemma, and it will be seen that it is not from mere ignorance or slovenliness that his hay crop is usually so sadly mismanaged. This lack both of leisure and labour might be somewhat remedied by the use of haymaking machinery; but as it is almost exclusively "seeds" that are mown in Scotland, this resource is scarcely available. Still it might be cheaper to lose some weight of hay by the rough handling of the machinery than, as at present, by over-ripeness and exposure to the weather. Perhaps, also, some aid may by and by arise by the application of horse labour to the preliminary thinning of turnips, and thus enable the hands to be spared for the haymaking. While we think it due to truth to make these statements, we are far from thinking that they justify the present state of matters. It would be better to have no hay at all, than to ruin both crop and land, as is often done, by delaying to mow until the crop is little else than ripened seeds and woody fibre, and then to bleach it, and leave it afield in pikes, for weeks or even months before stacking. Such barbarity as this is of frequent occurrence, and is utterly inexcusable. We are but too well aware of the difficulty of doing anything like justice to a hay crop with a turnip one competing with it for attention; but yet, with favouring weather, their rival claims can be so far adjusted, as we find it practicable in our own case, to have good green hay in about *four* years out of *five*.

## CHAPTER IX.

### CROPS OF LIMITED CULTIVATION.

Crops of limited cultivation.

Under this head we shall notice a variety of crops which, however valuable in themselves, and important to the far-

[1] *Royal Agricultural Society's Journal*, vol. ix. p. 507.

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mers of particular localities, are, from one cause or other, not adapted for general cultivation.

Flax.

*Flax* is probably the most important of them. Indeed, from the rapid growth of our linen trade, the growing demand for linseed and its products, and the fitness of the soil and climate for the successful growth of flax, it is not without cause that its more extended cultivation has been so strenuously urged upon our farmers, and that influential societies have been organised for the express purpose of promoting this object. Viewed merely as an agricultural crop, the cultivation of flax is exceedingly simple, and could be practised as readily and extensively as that of the cereal crops. The difficulty is, that before it can be disposed of to any advantage, it must undergo a process of partial manufacture; thus there is required not only an abundant supply of cheap labour, but such an amount of skill and personal superintendence on the part of the farmer, as is incompatible with due attention to corn and cattle husbandry. If a ready and remunerative market were available for the fibre in its simple form of flax straw, this, in combination with the value of the seed for cattle feeding, would at once hold out sufficient motive to our farmers to grow it statedly, and to any required extent. Until this is the case its culture cannot extend in the corn-growing districts of Great Britain. In Ireland, and parts of the Highlands of Scotland, where there is a redundant population much in want of such employment as the flax crop furnishes, and where the climate is suited for its growth, it is highly desirable that its culture should extend, and probable that it will do so.

Hindrances to its general cultivation.

Soils adapted for its growth.

Flax prospers most when grown upon land of firm texture resting upon a moist subsoil. It does well to succeed oats or potatoes, as it requires the soil to be in fresh condition without being too rich. Lands newly broken up from pasture suit it well, as these are generally freer from weeds than those that have been long under tillage. It is usually inexpedient to apply manure directly to the flax crop, as the tendency of this is to produce over-luxuriance, and thereby to mar the quality of the fibre, on which its value chiefly depends. For the same reason it must be thickly seeded, the effect of this being to produce tall slender stems, free from branches. The land having been ploughed in autumn, is prepared for sowing, by working it with the grubber, harrow, and roller, until a fine tilth is obtained.

Sowing of flax.

On the smooth surface the seed is sown broad-cast by hand or machine, at the rate of three bushels per acre, and covered in the same manner as clover seeds. It is advisable immediately to hand-rake it with common hay-rakes, and thus to remove all stones and clods, and to secure a uniform close cover of plants. When these are about three inches long the crop must be carefully hand-weeded. This is a tedious and expensive process, and hence the importance of sowing the crop on land as free as possible from weeds of all kinds. To obtain flax of the very finest quality the crop must be pulled so soon as the flowers fall, but in the improved modes of steeping, whether by Schenck's or Watt's patent, the value of the fibre is not diminished by allowing the seeds to mature. It must not, however, be allowed to become dead ripe, but should be pulled whenever the seeds appear, on opening the capsule, to be slightly brown coloured.

Pulling of flax.

The pulling requires to be managed with much care. It is performed by men or women, who seize a small quantity with both hands, and pull it by a slight jerking effort. The important point to be attended to, is to keep the butts even, as successive quantities are seized and twitched from the ground. When a convenient handful has been pulled it is laid on the ground, and the next parallel to it at a foot or so apart. The next handfuls are laid across these, and so on until a small pile is made, after which another is begun. After lying in this position for a few days, the seed-vessels or bolls are separated from the flax by lifting each handful separately and pulling the top through a ripple or iron comb, fixed upon a piece of plank. As many of these handfuls as will make a small sheaf are then laid very evenly together, and bound near both ends with bands formed of a few stems of flax. These sheaves are set up in stooks, and when dry enough to keep without heating, are stacked and thatched until an opportunity occurs of disposing of the flax straw. Sometimes the flax is bound into sheaves and stooked as it is pulled, and treated exactly like a grain crop. In this case the seed is separated from the straw by passing the head of each sheaf betwixt iron rollers. The only objection to this plan is that the bolls of separate sheaves get so entangled in each other, as to render it exceedingly difficult to handle them in carrying the crop, building, and taking down the stacks, without disarranging the sheaves and wasting much straw and seed.

Retting.

It would be tedious to enter here into a minute detail of the ordinary method of separating the flax fibre from the woody part of the stem. Suffice it to say that in the ordinary practice the sheaves or beets of flax straw are immersed in a pit or pool filled with clear soft water. The sheaves are kept under water by laying boards upon them loaded with stones to keep them down. Here the flax undergoes a process of fermentation by which the parts are separated. About nine or ten days are usually required for this purpose, but this is much influenced by the temperature. A good deal of skill and close watching is required to know exactly when it has been watered enough. The flax is now taken from the pit and evenly spread upon a smooth, clean, recently-mown meadow, where it lies for about ten days more, receiving several turnings the while. When the *retting*, as it is called, is perfected, the flax is carefully gathered up when perfectly dry, and again tied into sheaves, in which state it is stored under cover until the breaking and scutching can be overtaken.

Schenck's retting process.

All this necessarily requires much skilful watching and nice manipulation,—more, as we have already said, than is compatible with the other avocations of an extensive farmer. There are, however, improved modes of accomplishing this preliminary manufacture of flax, which, wherever established, pave the way for the growth of flax as an ordinary field crop. The first of these is known as Schenck's process, which is thus described in a report by "The Royal Society for the Promotion and Improvement of the growth of Flax in Ireland:"—

"The tenements containing the vats and drying-shelves, are simple wooden sheds, of cheap construction. In one end of the building are four vats, set parallel to each other, the length of the house. They are made of inch deal, in the form of a parallelogram, fifty feet long, six broad, and four deep. There are false bottoms, perforated with holes. Underneath these are introduced the steam-pipes, crossing the vats, and having stop-cocks at their entrance, by which the steam can be let on from the main pipe, as required. The steam is generated in a small boiler, which also serves to turn two hydro-extractors, —a patent apparatus used to drive off a portion of the water with which the flax is saturated, on being taken from the vats. The flax is packed into the empty vats, on the butt ends, in a half sloping position, precisely as in the case of a steep-pool, only one layer being the depth. The water is then let in, and a frame fastened over the top of the flax, answering the end of stones and straw, or sods, in the steep-pools—the prevention of the rising of the flax in the course of fermentation.

"The steam is then let into the pipes by turning the stop-cocks, and the water is some eighteen or twenty hours in becoming heated to the required point—85° to 90°. The fermentation then commences, and no further steam is required, the action going on until the flax is thoroughly retted, which is in forty hours afterwards, being sixty from the time of the admission of the water. It is worthy of remark, that, if the

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water be heated before the flax is put into the vats, or if the heat be raised above 90°; the process is not in the least hastened, but, on the contrary, the fermentation is rather retarded. The footsteps of nature must be followed, and the heat gradually communicated to the water; otherwise the uniformity of watering, and the preservation of quality and colour, cannot be fully realised. At the end of the sixty hours, the flax is taken out, the water allowed to run off, and the vat permitted to cool. The same process is then repeated, with fresh water and fresh flax. When taken from the water, the flax is packed into the hydro-extractor, which is a round vessel of iron, made to revolve by steam-power with great velocity, the water being driven out of the flax on the principle of centrifugal force. Thirty beets or small handfuls are placed on this machine at a time, and about twenty pounds of water are extracted in three to five minutes. A few hours suffice for the contents of a vat, each vat containing two tons of flax straw. The hydro-extractor only separates a portion of the water; the flax now remains to be thoroughly dried. In summer, or, indeed, for six months in the year, this can be accomplished, as usual, by spreading on grass land in the open air. During winter, however, it is necessary to find other means of drying. A shed has therefore been erected communicating by doors with the vat house, filled with ranges of shelves, composed simply of railings of lathwood, in five or six tiers. The flax is spread lightly along these shelves by women, and the house is heated by steam-pipes. This house is capable of drying the full of one vat *per diem*. The flax, when dried, is made up in small beets or handfuls, of a size suited for feeding into the breaking-rollers of the mill.

"About ten vats per week can be steeped in this establishment—say twenty tons weight of straw, and producing, say two-and-a-half to three tons of fibre. Thus, in one year, such an establishment would be capable of turning out 120 to 150 tons of flax for market, being the produce of 400 to 500 statute acres. The fuel used for the boilers is principally 'shoves,' with a small quantity of turf. Mr Bernard estimates the cost of steeping, drying, heating, aud scutching the flax, at L.10 to L.11 per ton, which is L.3 per statute acre. Subtracting say 10d. per stone, or 6s. per cwt. for scutching, the cost of steeping and drying would thus appear to be about 24s. per acre—a sum certainly less than the usual estimates of these operations, as commonly performed by farm labour."[1]

Watt's process of retting.

More recently what is believed to be an improvement on this plan has been introduced by Mr Watt. It is thus described in the Annual Report of the Royal Society for the Promotion and Improvement of the growth of Flax in Ireland :—

"The flax straw is delivered at the works by the grower, in a dry state, with the seed on. The seed is separated by metal rollers, and afterwards cleaned by fanners. The straw is then placed in close chambers, with the exception of two doors, which serve the purpose of putting in and discharging the straw; the top, which is of cast-iron, serves the double purpose of a top and condenser. The straw is then laid on a perforated false bottom of iron, and the doors being closed and made tight by means of screws, steam is driven in by a pipe round the chamber and between the bottoms, and, penetrating the mass, at first removes certain volatile oils contained in the plant, and then is condensed on the bottom of the iron tank, descending in a continuous shower of condensed water, saturating the straw, and forming, in fact, a decoction of the extractive matters which attach the fibrous and non-fibrous portions of the plant. This liquid is drawn off from time to time, and the more concentrated portions are used for feeding; the process is shortened by using a pump, or such arrangements as will repeatedly wash the mass with the water allowed to accumulate. In about eight to twelve hours, varying with the nature of the straw, it is removed from the chambers, and having been robbed of its extractive matter without decomposition, it is then passed through the rollers for the purpose of removing the epidermis or outer skin of the plant, of discharging the greater part of the water contained in the saturated straw, and while in the wet and swollen state, splitting it up longitudinally. The straw being free of all products of decomposition, is then easily dried, and is in a few hours ready for scutching."[2]

The growth of flax has greatly increased in Ireland of late years. In the Irish Agricultural Return for 1852, it is stated that the extent of the flax crop in 1850 was 91,040 acres, which in 1851 had increased to 140,536 acres.

*Hemp*, although at one time very generally cultivated in Great Britain, is now so rarely met with, that it is unnecessary to enter into details of its management.

*Hops.*—The hop is, however, an important crop in several of the southern counties of England. We glean from Morton's *Cyclopædia*, and from the *Journal of the Royal Agricultural Society*, the following information regarding it. Although an indigenous plant, it was originally brought into England for cultivation from Flanders in 1525. It is cultivated to a considerable extent in Belgium, Bavaria, in the United States of America, and more recently in Australia. The duty now paid on home-grown hops is 17s. 7½d. per cwt.; that on those imported, is L.2, 5s. per cwt. Before the alteration of the tariff in 1846 it was L.4, 5s., and some years previous to that L.8, 8s., which in practice was a prohibitory duty. Hops, as is well known, are chiefly used for preserving and imparting a peculiar flavour to beer. Probably the only parts of the hop flower which enter into the composition of the beer, are the seeds, and the yellow glutinous matter which surrounds the outer integuments of the seed, and lies at the bottom of the petals. This yellow matter (technically termed the *condition* of the hop) has an intensely bitter taste, and emits a peculiar and very agreeable aroma, which, however, is extremely volatile; and hence the necessity for close packing as soon as possible after the hops are dried. When kept over a year, much of this aroma flies off, and hence *new* hops are indispensable in brewing the first kinds of beer. Several varieties of the hop are cultivated in England. Of these the Farnham and Canterbury whitebines, and goldings are esteemed the finest. These are tall varieties, requiring poles of from fourteen to twenty feet. The grapes, so called from growing in clusters, and of which there are several varieties of various quality, requires poles from ten to fourteen feet long. Jones's, adapted for lighter and inferior land, requires these but eight to ten feet. The colegates are a hardy and late ripening variety which grow best on stiff soils,—and the Flemish redbine only cultivated from its less liability than the other to be attacked by the aphis or black blight.

The hop is a very exhausting crop for the land, requiring to be planted only on the most fertile soils, and to have them sustained by frequent and large dressings of manure rich in nitrogen. Hops are principally cultivated in the counties of Kent, Sussex, Surrey, Hants, Worcester, and Hereford, and to a more limited extent in Essex, Suffolk and Nottingham. The best quality of hops are grown at Farnham in Kent, upon the outcrop of the upper greensand formation, from whence the phosphoric nodules or coprolites, now so well known in the manure market, are obtained. The greatest extent of land under this crop in any one year during the present century was in 1837, when it amounted to 56,323 acres. Owing to lower prices, and consequent less profitable returns, the extent in 1849 was reduced to 42,798 acres.

In forming a new plantation, the ground soon after Michaelmas is trenched to the depth of eighteen inches, if it has previously been in meadow or old pasture, taking care

[1] Morton's *Cyclopædia of Agriculture*, article "Flax."

[2] *North British Agriculturist*, 10th November 1852.

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not to bury the surface-soil above half that depth. Subsoil-ploughing will suffice with land that is in tillage. If the land is wet, drains are made from four to five feet deep, laid with pipes, and a foot of broken stones over them, to prevent the roots of the hops from obstructing the pipes. The frequency of the drain is determined by the necessities of each case. Perfect draining is essential to the success of the crop; and the hops are planted in squares or triangles at equal distances, varying from six to seven feet, according to the fertility of the soil, and the greater or less luxuriant habit of growth of the variety selected. The plants are raised by cutting off the layers or shoots of the preceding year, which are bedded out during the month of March, in ground previously prepared, and in the succeeding autumn become what are called nursery plants or bedded sets. Early in November these are planted; one, two, or three being used for a hill, according to the strength of the plants. Care must be taken to introduce a sufficient number of *male* plants, six hills to the acre being deemed sufficient. The presence of these is found to induce earlier maturity, and to improve both the quality and weight of the crops. The ground must at all times be kept free from weeds, and have a good depth of pulverised soil. From the first, a stick six feet high or so, is placed to each hill, to which *all* the young bines, as they shoot out during summer, must be tied. A liberal dressing of superphosphate of lime and guano is in June hoed in around each hill, which is repeated in July, under which treatment, two or three cwt. of hops is obtained the first year, besides growing a crop of mangel, turnips, or potatoes, in the intervals betwixt the hills. On newly broken up ground, lime is applied the following spring. When a plantation has been established, the annual routine of culture begins in autumn, as soon as the crop has been gathered, when the haulm is stripped from the poles, and stored away as a substitute for straw. The poles are stacked or piled in quantities of 400 or 500, at regular distances on the ground. During winter they are sorted, and repointed when required, and new ones substituted for those that are broken or decayed; this work and the carrying on of manure being accomplished in frosty weather. The ground is dug over by the fork at this season. In March the earth is removed from the plants by a beck or pronged hoe till the crown is exposed, that the plant may be pruned. Immediately after this the poles are set, the length and number of these for each hill depending upon the kind of hops and amount of growth anticipated. They are fixed into holes made for them by a hop-bar. As the season advances, the ground is hoed and again dug or stirred by a nidget or scarifier drawn by a horse. Early in May, the bines or young shoots, as soon as long enough, are, by women, tied to the poles with rushes or bast. This tying is repeated several times as the bines get higher, and has even to be done by step-ladders. In June, the hops are earthed up or *hilled*, at which time weak plants get a dressing of guano. Throughout the summer weeds are destroyed as they appear, and the soil kept loose by the nidget or the hand-hoe. If poles are blown over by high winds, they are constantly replaced.

The picking of the hops usually begins about the second week in September, and furnishes ample employment for several weeks to the entire population of the districts, and to a large influx of strangers, men, women, and children, all engaging in it. In favourable years, a labourer with his wife and several children can earn from L.6 to L.8 during the hop-picking season. The hop-pickers are arranged into companies, and are supplied with baskets or bins, holding seven or eight bushels each, and which are gauged with black lines inside to save the trouble of measuring. Each company is under the superintendence of a hop bailiff, who keeps an account of the earnings, &c. Under him are several men called pole-pullers, whose duty it is to supply the pickers with poles of hops, and to assist in carrying the picked hops to the carts. They use an iron lever called a hop-dog, in pulling up the poles. The hops are picked, one by one, into the bins, care being taken that no bunches nor leaves, nor mouldy hops are included. The price paid for picking ranges from 1½d. to 3d. per bushel, although in blighted seasons it may be as high as 6d. The hops are dried in kilns or oast-houses, on floors of haircloth. Great improvements have been made of late years in the construction of these oasts. Much nice discrimination is required in managing the drying, so as to produce the best quality of hops. As soon as they are removed from the kiln they are packed into pockets, which, during the process, are suspended from a hole in the floor, and the hops trodden into them by a man. This is now done more accurately by machines, in which a piston presses the hops into the pockets. Hop-growing is a hazardous speculative business, the return at times being very great, and at other times not covering expenses. This arises from the liability of the hop to the attacks of insects, but more especially to blight and mould. The blight is caused by innumerable hordes of the *aphis humuli*, which sometimes destroy the plants altogether. The mould is a parasitical fungus. It is believed that a means has at last been discovered of checking the ravages of these assailants, by enveloping each plant separately in a light covering, and subjecting it to the fumes of tobacco in the case of blight, and to a cloud of powdered brimstone in the case of mildew. The charges attendant upon the cultivation of an acre of hop-ground are estimated, including rent, tithes, interest on capital and duty, at from L.50 to L.60; and as 10 cwt. is considered an average crop, and L.5 per cwt. a frequent price, it is evident that the business is a very precarious one. In blight years it usually happens, that some grounds altogether escape, in which case the returns from them are enormous, owing to the enhanced price.

*Sugar-Beet.*—"During the wars of the French revolution, the high price which colonial sugar obtained on the continent induced the manufacture of sugar in large quantities from beet-root. This has become so large in France that since the restoration of peace the French government have felt compelled to protect the beet-root sugar makers by the imposition of prohibitory duties on colonial sugars.

"Some years since, the manufacture of sugar from beet-root began to be attempted, and not without success, in England. The absence of any excise duties, and an existing considerable import duty on colonial sugars seemed to offer a kind of premium to the English makers. The government naturally took the alarm; a revenue on imported sugars, which in 1850 yielded about L.4,130,000, could not be allowed to be endangered. Parliament therefore interfered; and by the 1st Vict. c. 57 (1837), a duty of 24s. per cwt. was imposed on all sugar made from beet-roots in the United Kingdom. The manufacture was placed under the management of the Commissioners of Excise, and the entire process must now be carried on under the regular survey of their officers. Four hours' notice must be given before any maker can begin to rasp, or grind, or mash any beet-root, for the purpose of sugar-making, and other restrictions are directed. In 1840, by the 3d and 4th Vict. c. 57, the same duty was imposed upon sugar made from potatoes, rice, and other materials, in the United Kingdom. In 1845, however, by the 8th Vict. c. 13, the amount of this duty was reduced to 14s."[1]

[1] *Farmer's Magazine*, vol. i. p. 481.—(June 1852).

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The matter has again been taken up in good earnest, and a company formed, by whom the process of manufacturing beet-sugar is in actual operation at Mount Meillick, in Queen's County, Ireland. By this operation the fact has already been established, that the climate and soil of Ireland are exceedingly favourable to the sugar-beet, and that the quality of the roots is equal, if not superior, to those of France or Belgium. By recent improvements in the manner of conducting the manufacture, it is said that the sugar obtained from beet amounts to 8 per cent. of the gross weight of the roots, instead of 5 per cent., as at first. "That this is a question of national importance is beyond all doubt; and to shut our eyes to the undisputed advantages which home-made sugar promises, is to reject a benefit which our continental neighbours have long turned to good account. At the earliest period of this manufacture in France, great mechanical and chemical difficulties had to be overcome. The English manufacturer goes to his task with all the experience at his command which the continent has acquired. In France, for these reasons, the progress was slow at the commencement, but once having taken root was never given up.

"We subjoin an historical sketch of the gradual progress of this branch of industry in France from 1820 to 1840:—

| Year. | Production of Inland Sugar. | Foreign Sugar entered for Consumption. | Total Consumption of Sugar. |
|---|---|---|---|
| | Kilogrammes. | Kilogrammes. | Kilogrammes. |
| 1820 | 50,000 | 44,416,795 | 44,416,795 |
| 1821 | 100,000 | 41,502,749 | 41,502,649 |
| 1822 | 300,000 | 49,328,057 | 49,328,057 |
| 1823 | 500,000 | 37,590,270 | 38,590,270 |
| 1824 | 800,000 | 56,048,430 | 56,048,439 |
| 1825 | 1,000,000 | 48,546,683 | 49,546,683 |
| 1826 | 1,600,000 | 64,407,342 | 65,407,342 |
| 1827 | 2,000,000 | 50,797,139 | 52,797,139 |
| 1828 | 2,700,000 | 61,987,771 | 64,987,771 |
| 1829 | 4,400,000 | 62,160,175 | 66,160,175 |
| 1830 | 5,500,000 | 54,647,941 | 60,647,941 |
| 1831 | 7,000,000 | 67,750,207 | 74,750,207 |
| 1832 | 9,000,000 | 62,642,643 | 71,642,643 |
| 1833 | 12,000,000 | 57,874,877 | 69,874,876 |
| 1834 | 20,000,000 | 65,643,511 | 85,643,511 |
| 1835 | 30,000,000 | 64,095,647 | 94,095,647 |
| 1836 | 40,000,000 | 56,276,475 | 96,276,475 |
| 1837 | 45,000,000 | 64,167,840 | 109,167,840 |
| 1838 | 50,000,000 | 63,251,965 | 113,251,965 |
| 1839 | 55,000,000 | 62,731,995 | 117,731,095 |

Within the last ten years the augmentation has been less rapid. In 1851, the production was 60,000 tons, or 60,000,000 of kilogrammes, notwithstanding the repeated prophecies that the beet-sugar would not compete with the cheap sugar of Brazil, Java, and Manilla.

In Germany, the manufacture of sugar is of more recent date than in France. Its progress of late has been,—

| Beet-root Sugar made in the Zollverein. | | Foreign Sugar imported. | |
|---|---|---|---|
| 1848 | 26,000 tons. | 1848 | 60,500 tons. |
| 1849 | 34,000 „ | 1849 | 54,000 „ |
| 1850 | 40,000 „ | 1850 | 48,000 „ |
| 1851 | 43,000 „ | 1851 | 45,000 „ |

In the Austrian empire 8000 tons were made in 1848, and in 1851, 15,000 tons. Russia is said to have contributed 25,000 tons in the year 1851.

It does not at all follow that sugar made in England is to drive our colonial sugar out of the market. There is more foreign sugar imported than we could hope to see replaced in many years. In 1851, it exceeded 45,000 tons, of which but a small portion was re-exported. To this figure we may therefore push our efforts; and most gratifying it is to be able to reflect, that while slave-labour must inevitably grow dearer, every mechanical and scientific improvement can but enhance the powers of the European producers, and ensure their ultimate victory over the slave-owner. Samples have been shewn in the city of beet-sugar from the Rhine, quite equal to "white Havanna, and refined sugar made from the same that could not be distinguished from West Indian."[1]

It has also been ascertained that excellent beer can be made from the juice of the beet. The refuse from the sugar manufacture is said to be available for feeding cattle and pigs, and as a manure.

The cultivation of the Silesian white-beet, which is the variety of this plant most in repute for yielding sugar, differs in no respect from that of mangel-wurzel, which we have already described.

*Chicory for its roots.*—The very extensive and constantly increasing consumption of the roots of chicory, as a substitute for coffee, renders it now an agricultural crop of some importance. The soils best adapted for its growth are deep friable loams. The process of cultivation is very similar to that required for the carrot, excepting only that it is not sown earlier than the first week of May, lest the plants should run to seed. When this happens, such plants must be thrown aside when the crop is dug, else the quality of the whole will be injured. About four pounds of seed is the quantity to sow per acre, either broad-cast or in rows. The latter is undoubtedly the best mode, as it admits of the land being kept clean, and yields roots of greater weight. The crop is ready for lifting in November. A long stout fork is the best implement for this purpose. In using it, care must be taken to get out the roots entire, not only for the sake of the roots, but to lessen an inconvenience attendant on the culture of this plant, namely, that the fragments left in the soil grow amongst the after crops, and are as troublesome as weeds. The roots, when dry, are carefully washed, cut into thin slices, and kiln-dried, when they are fit for the coffee-grinder. From 1 to $1\frac{1}{4}$ tons per acre of the dried root is an average produce. A few years ago, from L.20 to L.30 per ton was a current price for good samples, but like other crops of limited consumption, it has been grown too extensively—the market has been glutted, and the price reduced to L.6.

*Oil-yielding Plants.*—Various plants are occasionally cultivated in Britain for the sake of the oil which is expressed from their ripened seeds. We have already noticed the value of flax-seed for this purpose, although the fibre is the product which is chiefly had in view in cultivating it. The plants most commonly sown expressly as oil-yielding crops are, rape (*Brassica napus*), colsa (*Brassica campestris*), gold of pleasure (*Camelina sativa*), and the poppy (*Papaver somniferum*). Rape is the plant most frequently and extensively grown for the production of oil. The colsa or *B. campestris* is said to yield better crops of seed than the other species. This plant is much cultivated in Flanders for this purpose. In Great Britain it seems rather on the decline. It is chiefly on rich alluvial soils that this crop is grown. For a seed crop rape is sown in June or July pre-

[1] *Farmer's Magazine*, pp. 558, 559.

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cisely in the manner already described for turnips. The young plants are thinned out to a width of six or eight inches apart, and afterwards kept clean by hoeing. The foliage may be eaten down by sheep early in autumn, without injuring it for the production of a crop of seed. In spring the horse and hand hoe must be used, and the previous application of one or two cwt. of guano will add to the productiveness of the crop. It suits well to lay down land to clover or grass after a crop of rape or turnip seed, and for this purpose the seeds are sown at the time of giving this spring culture. The crop must be reaped as soon as the seeds are observed to acquire a light-brown colour. The reaping is managed precisely as we have described in the case of beans. As the crop after being reaped and deposited in separate handfuls on the ground very soon gets dry enough for thrashing, and as the seed is very easily shed after this is the case, this process must be performed as rapidly as possible. Sometimes it is conveyed to the thrashing-mill on harvest-carts, on which a cloth is stretched to save the seeds knocked out in the loading and unloading, but more usually the flail is used on temporary thrashing-floors, provided in the field by spreading down large cloths. The crop is gently lifted from the ground and placed heads innermost, on a blanket which two persons grasp by the corners, and carry to the thrashing-floors. A great number of people are required to push this process through rapidly, for unless the crop is quickly handled, a great loss of seed ensues. The seed is immediately spread thinly upon a granary floor, and frequently turned until dry enough to keep in sacks, when it is cleaned and disposed of. On good soil, and in favourable seasons the yield sometimes reaches to forty bushels per acre. The haulm and husks are either used for litter, or burned. and the ashes spread upon the land. It makes good fuel for clay burning.

*Seeds of Agricultural Crops.*—In the case of seed-corn it is customary for farmers either to select from the best of their own growth, to exchange with or purchase from neighbours, or, if they wish a change from a different county, to employ a commission-agent to buy for them. In all districts there are careful farmers, who, by occupying land that produces grain of good appearance, and being at pains to have good and pure sorts, are stated sellers of seed-corn, and manage in this way to get a few shillings more per quarter for a part of their produce. It is therefore only in the case of new and rare varieties that professional seedsmen ordinarily deal in seed-corn. There are, however, other field crops, such as clovers, grasses, turnip, mangel, carrots, winter vetches, &c., the seeds of which, to a large extent, pass through the hands of seedsmen, and the growing of which is restricted to particular districts, and is in the hands of a limited number of farmers. In general, a good soil and climate, and a considerable amount of skill and minute personal attention on the part of the farmer are indispensable, in order to produce these seeds of good quality. These seed crops are sometimes very remunerative to the grower; but are hazardous ones for farmers to attempt at their own risk. The only safe course is to grow them at a stipulated price, to the order of some thoroughly respectable seedsman, and to hold to the production of the particular kind or kinds which he requires. This applies, in a less degree, to the clovers, and to the more commonly cultivated grasses than to the other seeds just referred to. Such an arrangement is beneficial to all concerned. The grower having a fixed price, and certain market, knows exactly what he is doing, the seedsman purchasing only from selected growers, to whom he usually supplies a choice stock of the article to be raised by them, can vouch for the genuineness and freshness of his seeds; and his customers knowing the guarantee against disappointment and loss which this mode of conducting his business affords to them, give him a full price, and find it true economy to do so.

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We have already described the mode of saving the seeds of Italian or common ryegrass; and as other grasses are managed in the same way. it is unnecessary to say more regarding them.

Clover seed.

It is only in the southern parts of England that clover is grown for the sake of its seeds. When it is meant to take a crop of seed, the clover is fed off with sheep, or mown early in the season, and then allowed to produce its flowers, and ripen its seeds. This preliminary eating or cutting over causes the plants to throw up a greater number of seed-stems, and to yield a fuller and more equally ripening crop. The crop is mown when the seeds are seen to be matured. In the case of white clover the cutting takes place while the dew is upon the crop, as working amongst it when dry would cause a loss of seed. After mowing and turning the crop, the ground is raked with close-toothed iron rakes, to catch up loose heads. The thrashing is a twofold process; first the separation of the heads or cobs from the stem, called "cobbing," and then of the seeds from the husks, called "drawing." This was formerly accomplished by a laborious and tedious process of thrashing with flails, but it is now done by machinery. In favourable seasons. the yield is about five or six bushels (of 70 lb. each) per acre.

Turnip seed.

*Turnip Seed* is the next most important crop of this kind. From the strong tendency in the best varieties of turnips and Swedes to degenerate, and the readiness with which they hybridise with each other, or with any member of the family *Brassica*, no small skill and pains are needed to raise seed that can be depended upon to yield roots of the best quality. Turnip seed is saved either from selected and transplanted roots, or from such as have been sown for the express purpose, and allowed to stand as they grow. The first plan, if the selection is made by a competent judge, is undoubtedly that by which seed of the purest quality is obtained. But it is an expensive way, not only from the labour required in carrying it out, but from the yield of seed being generally much less than from plants that have not been disturbed. Professional seed-growers usually resort to a compromise, by which the benefit of both plans is secured, viz. by selecting with great care, and transplanting a limited number of bulbs, and saving the seed obtained from them to raise the plants which are to stand for their main seed crop. The latter are carefully examined when they come into bloom, and all plants destroyed the colour of whose flowers varies from the proper shade. Turnips that are to bear seed are purposely sown much later in the season than when intended to produce cattle food, as it is found that bulbs about 1 lb. weight are less liable to be injured by frost, or to rot before the seed is matured, than those of larger size. The management of a turnip-seed crop, both as regards culture and harvesting, is identical with that of rape for its seeds, which has already been described.

*Mustard.*—Both the white and brown mustard is cultivated to some extent in various parts of England. The former is to be found in every garden as a salad plant; but it has of late been coming into increasing favour as a forage crop for sheep, and as a green manure, for which purpose it is ploughed down when about to come into flower. The brown mustard is grown solely for its seeds, which yield the well-known condiment. When white mustard is cultivated for its herbage, it is sown usually in July or August, after some early crop has been removed. The land being brought into a fine tilth, the seed, at the rate of 12 lb. per acre, is sown broad-cast, and covered in in the way recommended for clover seeds. In about six weeks it is ready, either for feeding off by sheep, or for ploughing down, as a preparative for wheat or barley. White mustard is not fastidious

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in regard to soil. When grown for a seed crop, it is treated in the way about to be described for the other variety. For this purpose either kind requires a fertile soil, as it is an exhausting crop. The seed is sown in April, is once hoed in May, and requires no further culture. As soon as the pods have assumed a brown colour the crop is reaped and laid down in handfuls, which lie until dry enough for thrashing or stacking. In removing it from the ground, it must be handled with great care and carried to the thrashing-floor or stack on cloths, to avoid the loss of seed. The price depends much on its being saved in dry weather, as the quality suffers much from wet. The yield varies from twenty to thirty bushels per acre, and the price from 10s. to 20s. per bushel. It is chiefly grown on rich alluvial soils in the south-eastern counties of England. This great evil attends its growth, that the seeds which are unavoidably shed in harvesting the crop remain in the soil, and stock it permanently with what proves a pestilent weed amongst future crops.

*Canary Seed* (*Phalaris canariensis*) is cultivated to some extent in Essex and adjoining counties, for the sake of its grain, which is used exclusively for feeding cage-birds. In an agricultural point of view, it is exceedingly similar to our staple corn crops, and in practice is sown instead of wheat or barley. It is drilled in February, at the rate of two gallons per acre, on land that has been ploughed the previous autumn, and stirred by the grubber immediately before sowing. It requires hoeing, to protect it from weeds during the first stages of its growth. It is late in ripening, and requires to be thoroughly dried before being stacked. It is recommended to stack it on frames, to guard it from the attacks of mice, which manifest a peculiar fondness for it. Its yield and weight per bushel are similar to those of wheat. Its price fluctuates exceedingly, but averages from 50s. to 60s. per quarter.

*Coriander and Caraway* are noticed together, not only because they are used for similar purposes, but because they are frequently grown in mixture. Both are cultivated for the sake of their seeds, which are used by confectioners, and for medicinal and other purposes. The coriander being an annual and the caraway a biennial, the former yields a crop the first year, and then leaves the latter in possession of the ground. At one time a third crop, viz. the teazel, was also sown with them, but owing to improvements on the machinery for dressing cloth it has become obsolete. The coriander being also less grown than formerly, the caraway is frequently drilled amongst wheat. After the latter is harvested, the stubble and weeds are cleared away by horse and hand hoeing. Beans or dwarf pease are also sometimes grown betwixt the rows of caraway during the first and unfruitful year of its growth. The mode of harvesting both of these crops is the same. They are reaped and deposited in handfuls until dry enough for thrashing, and are then carried with great care on cloth-covered sledges to a temporary thrashing-floor where the seeds are beaten out by flails. About ten cwt. of coriander and five of caraway per acre, is an average yield. The price of the former ranges from 10s. to 20s. per cwt., that of the latter from 35s. to 45s. per cwt. The cultivation of these crops for sale is nearly confined to the county of Essex; but plots of caraway are to be met with in farm and cottage gardens in all parts of Great Britain.

Garden seeds.

In Essex and Kent no inconsiderable extent of land is annually occupied in growing the seeds of the staple crops of our kitchen and flower gardens. Wholesale seedsmen contract with farmers to grow these seeds for them at a stipulated price.

Fruits and vegetables.

The growth of fruits and of culinary vegetables is in various parts of Great Britain an important department of farming—for the scale on which it is conducted allies it quite as much to agriculture as to horticulture. We learn from Mr Cuthill,[1] that in the counties contiguous to London above 12,000 acres are occupied in growing vegetables, and about 5000 more in producing fruit. About 35,000 people find employment in these market gardens. The system of cultivation pursued in them is admirable. The soil is trenched two spits deep for nearly every crop; it is heavily manured and kept scrupulously clean by incessant hoeing. Whenever a crop is removed, some other suited to the season is instantly put in its place, and not an inch of ground is suffered to be unproductive. A young farmer bent on knowing his business thoroughly, could not well occupy a few months to better purpose than by placing himself under one of these clever market gardeners.

Kent has long been peculiarly celebrated for its orchards. The best of them are on the borders of the greensand formation, or ragstone as it is provincially called. Apples, pears, plums, cherries, and nuts are produced in immense quantities. The filbert plantations alone are said to occupy 5000 acres. An abundant and cheap supply of fruit and vegetables for the inhabitants of our towns is undoubtedly an important object, and is likely to occupy increased attention wherever a suitable soil and exposure with facility of carriage by railway are combined.

## CHAPTER X.

### LIVE STOCK.

The breeding and rearing of domesticated animals has ever been a favourite pursuit in Great Britain, and has been carried to greater perfection than any other department of rural affairs. In no other country of similar extent can so many distinct breeds of each class of these animals be found; most of them excellent of their kind, and admirably adapted to the particular use for which they are designed. Observing the usual order, we notice first—

Saddle horses.

*Horses.*—In doing so we shall confine our attention to those breeds which are cultivated expressly for the labours of the farm; for although the breeding of saddle-horses is chiefly carried on by farmers, and forms in some districts an important part of their business, it does not seem advisable to treat of it here. It is a department of husbandry requiring such a combination of fitness in the soil, climate, and enclosures of the farm, of access to first-class stallions, and of taste and judgment on the part of the farmer, that few indeed of the many who try it are really successful. The *morale* too of the society into which the breeding of this class of horses almost necessarily brings a man, is so unwholesome, that none can mingle in it freely without experiencing to their cost that "evil communications corrupt good manners." We have noted it as a fact of peculiar significance, in this connection, that of the few men who really make money by this business, scarcely one desires to see it prosecuted by his sons.

London dray horses.

*Breeds.*—The immense size and portly presence of the English black horse, entitle him to priority of notice. This breed is widely diffused throughout England, though found chiefly in the Midland Counties. It is in the fens and rich pastures of these counties, that the celebrated London dray horses are bred and reared. "These ponderous animals are frequently seventeen hands high, and their sleek and glossy appearance as they move majestically through the streets of the metropolis, presents one of the most striking sights to the eye of the foreigner." These horses are too slow and heavy

[1] See *Market Gardening round London*, by James Cuthill, Camberwell, 1851.

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for ordinary farm-work, and would not be bred but for the high prices obtained for them from the great London brewers, who pride themselves on the great size, majestic bearing, and fine condition of their team horses. It is alleged indeed, that it is only such massive animals that can cope with the heavy loads of coals, timber, and merchandise of all kinds, requiring to be conveyed over jolting pavements from wharves and similar places. But in reality these heavy horses are destroyed by their own weight, few of them being free from ring-bone and other diseases of the feet and pasterns. Smaller but more muscular and energetic horses,—especially if yoked singly in carts, instead of by teams in great waggons,—would perform more work at less expense, and with less fatigue to themselves. The breeders of these horses employ brood mares and young colts exclusively for their farm-work. The colts are highly fed, and worked very gently until four years old, when they are sold to the London brewers, often at very great prices. The same breed is largely used in England for ordinary farm labour, although not found of such gigantic proportions as in those districts where they are bred for the special destination just referred to. Although very docile, their short step, sluggish gait, large consumption of food, and liability to foot lameness, render them less profitable for ordinary farm-work than the breeds about to be mentioned.

*The Suffolk Punch* is a well-marked breed which has long been cultivated in the county from which it takes its name. These horses are, for the most part, of a sorrel, bay, or chestnut colour, and are probably of Scandinavian origin. They are compact, as their name imports, hardy, very active, and exceedingly honest pullers. These horses at one time were very coarse in their form, and rather slow; but they have now been so much improved in form and action, that we find them the chief prize-takers at the recent exhibitions of the Royal Agricultural Society.

*The Cleveland Bays* are properly carriage-horses; but still, in their native district, they are largely employed for field work. Mr Milburn says, " The Cleveland, as a pure breed, is losing something of its distinctiveness. It is running into a proverb, that ' a Cleveland horse is too stiff for a hunter, and too light for a coacher;' but there are still remnants of the breed, though less carefully kept distinctive than may be wished by advocates of purity. Still the contour of the farm-horses of Cleveland has the lightness, and hardiness, and steadiness of the breed in outline; and it is singular that while the lighter soils have horses more calculated for drays, the strong-land farmer has the compact and smaller, but comparatively more powerful animal."

In the north-eastern counties of England, and the adjacent Scottish borders, compact, clean-legged, active horses, of medium size, with a remote dash of blood in them, are generally preferred to those of a heavier and slower kind. One needs only to see how such horses get along at turnip-sowing, or with a heavy load in a one-horse cart, to be convinced of their fitness for the general work of a farm.

*The Clydesdale Horses* are not excelled by any cart breed in the kingdom for general usefulness. They belong to the larger class of cart-horses, 16 hands being an average height. Brown and bay are now the prevailing colours. In the district whose name they bear, the breeding of them for sale is extensively prosecuted, and is conducted with much care and success. Liberal premiums are offered by the local agricultural societies for good stallions. Many admirable specimens of this breed of horses were brought forward at the Highland Society meeting at Glasgow in 1850; not the least interesting of which were those which competed for the premiums offered for the best cart-horses statedly employed on the streets of that city, attended by their usual drivers and mounted with their usual harness. Horses of this breed are peculiarly distinguished for the free step with which they move along, when exerting their strength in cart or plough. Their merits are now so generally appreciated, that they are getting rapidly diffused over the country. Many small farmers in Clydesdale make a business of raising entire colts, which they either sell for stallions, or send into distant counties to serve for hire in that capacity.

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Highland and Welsh ponies.

In the Highlands of Scotland, a breed of hardy and very serviceable ponies, or "Garrons," as the natives call them, are found in great numbers. In their native glens they are employed in tillage, and although unable for stated farm-work in the low country, are even there often used in light carts for work requiring despatch, rather than great power. Similar ponies abound in Wales.

*Breeding.*—In breeding cart-horses, regard must be had to the purpose for which they are designed. If the farmer contemplates the raising of colts for sale, he must aim at larger frame than if he simply wishes to keep up his own stock of working cattle. These considerations will so far guide him as to the size of the mares and stallions which he selects to breed from; but vigorous constitutions, perfect freedom from organic disease, symmetrical form, and good temper, are qualities always indispensable. Nothing is more common than to see mares used for breeding, merely because, from lameness or age, they have ceased to be valuable for labour. Lameness from external injury is, of course, no disqualification; but it is mere folly to expect valuable progeny from unsound, misshapen, ill-tempered, or delicate dams, or even from really good ones, when their vigour has declined from age. A farmer may grudge to lose the labour of a first-rate mare for two or three months at his busiest season; but if he cannot make arrangements for doing this, he had better let breeding alone altogether; for it is only by producing horses of the best quality that it can be worth his while to breed them at all. In the case of horses it is always desirable that both sire and dam should have arrived at maturity before being put to breed.

The head of the cart-horse should not be large, at least not heavy in the bones of the face and jaws, nor loaded with flesh. Full development of brain is, indeed, of great importance, and hence a horse somewhat wide betwixt the ears is to be preferred. Prick ears and narrow forehead have by some been reckoned excellences, but we have so invariably noticed such horses to be easily startled, given to shying, and wanting in courage and intelligence, that we regard such a form of head as a defect to be avoided. The eye should be bright, full, and somewhat prominent, the neck inclining to thickness, of medium length, and slightly arched, and the shoulders oblique. Upright shoulders have been commended as an advantage in a horse for draught, it being alleged that such a form enables him to throw his weight better into his collar. It should be remembered, however, that the horses which display the greatest power in drawing heavy loads, are characterised by muscular vigour and nervous energy, rather than mere weight of carcase; and these qualities are more usually found in connection with the oblique shoulder than the upright one—not to mention that this form is indispensable to that free and full step so necessary in a really useful farm-horse.

" The back should be straight and broad, the ribs well arched, and the false ribs of due length, so as to give the abdomen capacity and roundness. The tail should be well set out, not too drooping, and the quarters should be full and muscular. The horse should girth well, and have his height in his body rather than in his legs, so as to look less than measurement proves him to be. The forelegs should be strong, and flat below the knee, and by no means round and gummy either before or behind, neither should they have white hair about them, nor much hair of any colour. The hocks should be broad in front,

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and neither too straight nor too crooked, nor yet cat-hammed. All diseases of this joint, whether curbs, spavins, or thoroughpins, are sufficient grounds for rejecting a horse. The feet are a matter of very much importance. The tendency of many heavy horses is to have thin horn and flat feet. A stallion possessing such feet is exceedingly objectionable. Plenty of horn is a recommendation, and the feet had better be too large than too small. The brood mare should possess as many of the points now enumerated as possible. If the mare is small, but symmetrical, we may very properly select a large stallion, provided he has good action. If, on the other hand, the mare is large, and has a tendency to coarseness, we should select a middle-sized horse of symmetrical appearance."[1]

Sixteen hands is a good height for a farm-horse. Except for very heavy land, we have always had more satisfaction from horses slightly below this standard than above it.

We have repeatedly put a well-bred saddle mare to a cart-horse, and have invariably found the produce to prove excellent farm-horses. The opposite cross, betwixt a cart-mare and blood stallion, is nearly as certain to prove ungainly, vicious, and worthless. These horses are generally much stronger than their appearance indicates, have great powers of endurance, and can be kept in prime working condition at much less cost than bulkier animals. We have often noticed that village carters, who perform cartage for hire, invariably purchase small horses, and yet carry loads with them which farmers would consider too much for their best cattle. It is on muscular power, and nervous energy, that the strength of animals depends, and this, therefore, should be sought after in the farm-horse, rather than mere bulk.

Time when mares should foal.

Cart-mares should not foal earlier than May. So that they are not unduly pushed nor put to draw heavy loads, they may be kept at work almost up to their time of foaling, and are thus available for the pressing labours of spring. It is of importance, too, that the pasture should be fresh, and the weather mild, ere their nursing duties begin. Mares seldom require assistance in bringing forth their young, and although it is well to keep an eye upon them, when this event is expected, they should be kept as quiet as possible, as they are impatient of intrusion, and easily disturbed in such circumstances. The new-born foal not unfrequently has some difficulty in getting suck, and also in voiding the first fæces.

Treatment of foals.

Both these matters must be attended to, and assistance given if necessary. If it is observed to strain without voiding the tough excrement which is in its bowels at birth, greasing the passage, by pushing in a tallow candle, will usually afford it instant relief. A sheltered paddock with good grass, and where there are no other horses, is the most suitable quarters for a newly foaled mare. There must be no ditch or pond in it, as young foals have a peculiar fatality for getting drowned in such places. A mare, in ordinary condition, receives the stallion on the ninth or tenth day after foaling, and with a greater certainty of conceiving than when it is delayed until she is again in heat. If the mare's labour can at all be dispensed with, it is desirable to have her with her foal for two months at least. She may then be put to easy work with perfect safety, so that she is not kept away from the foal longer than two or three hours at a time. When the foal has got strong enough, it may even be allowed to follow its dam at her work, and to get suck as often as it desires it. Towards the end of September, foals are usually weaned, and are then put under cover at night, and receive a little corn, along with succulent food. If the dam has been put to work before weaning, she will have been allowed a feed of oats, in which case the foal will already have got a liking for this food by tasting a little along with her. This is a great advantage, as when put on its own resources, it takes at once to the generous fare which it ought always to be allowed at this stage. Good hay, bran, carrots, or Swedes, and a few oats, must be given regularly during the first winter, with a warm shed to lie in, and an open court for exercise. At weaning it is highly expedient to put a cavasin on colts, and lead them about for a few times. A few lessons at this early age, when they are easily controlled, saves a world of trouble afterwards. Before being turned to grass in spring, they should, on the same principle, be tied up in stalls for a week or so. It is customary to castrate colts at a year old. Some, indeed, advise its being done a few weeks after birth, when, of course, the pain to the animal, and risk of death, are less. It must, however, be borne in mind that this early emasculation will probably ensure a skranky neck, whereas a natural tendency to this defect can in good measure be remedied by deferring the operation. We have seen a puny colt much improved in figure by being left entire until he was two years old. By giving good pasture in summer, and a liberal allowance of hay, roots, and oats in winter, colts may, with safety, and even benefit, be put to moderate work in their third spring. Some time before this is done, they should be put through a short course of training, to use them to the bit, and make them quiet and handy. Many good cart-horses are ruined for want of a little timeous attention in this way. When they have got familiar with the harness, they should be yoked to a log of wood, and made to draw that up and down the furrows of a fallow field, until they become accustomed to the restraint and exertion, after which they may with safety be put to plough alongside a steady and good-tempered horse, and what is of equal conquence, under the charge of a steady good-tempered ploughman. As they should not have more than five hours' work a day for the first summer, it is always an advantage to have a pair of them to yoke at the same time, in which case they take half-day about, and do a full horse's work betwixt them. With such moderate work and generous feeding their growth will be promoted. By midsummer, the throng of field labour being over, it is advisable to turn the striplings adrift, and let them enjoy themselves in a good pasture until after harvest, when they can again be put to plough. Horses should not be required to draw heavy loaded carts until they are five years old. When put into the shafts earlier than this they frequently get strained and stiffened in their joints. On every farm requiring four or five pairs of horses, it is highly expedient to have a pair of young ones coming in annually. This enables the farmer to be provided against contingencies, and to have his stable occupied at all times with horses in their full vigour; which go through their work with spirit, and never falter for a little extra pushing in emergencies.

Importance of early training.

*Feeding and General Management.*—As there is true economy in employing only the best quality of horses, and these in their prime, so also is there in feeding them uniformly well, and looking to their comfort in all respects. The following quotation from the report of a discussion on the feeding of farm-horses, at a monthly meeting of the Highland and Agricultural Society of Scotland, published in the *Transactions* for October 1850, describes the practice of some of our most experienced farmers in this particular.

"The system of feeding I adopt is as follows:—From the middle of October till the end of May, my horses get one feed of steamed food, and two feeds of oats daily, with the best oat or wheat straw for fodder. I never give bean straw, unless it has been secured in fine condition, having often seen the bad

[1] Morton's *Cyclopædia of Agriculture*—article "Horse."

effects of it, partly owing, I think, to its long exposure to the weather. In our variable climate, and from the quantity of sand which adheres to it, I use it generally for litter. The steamed food used is well washed Swedish turnips and potatoes in equal proportions, mixed with sifted wheat-chaff. In those years when we had a total loss of potatoes, Swedish turnip alone was used, but not with the same good effects as when mixed with potatoes. This year having plenty of diseased potatoes in a firm state, I give a larger proportion of potatoes than turnip, and never upon any occasion give oat husks, commonly called meal-seeds, having often seen their injurious effects. At five o'clock in the morning each horse gets 6 lb. weight of bruised oats, at noon the same quantity of oats, and at half-past seven P.M., 47 lb. weight of steamed food. I find that it takes 62 lb. weight of unsteamed potatoes and turnip to produce 47 lb. steamed; to each feed of steamed food, 4 oz. of common salt are added, and mixed up with one-fourth part of a bushel of wheat-chaff, weighing about $1\frac{1}{2}$ lb., a greater quantity of wheat-chaff than this having generally too laxative an effect. Each horse eats from 14 lb. to 18 lb. of fodder during the twenty-four hours, besides what is required for litter. In spring I sometimes give a mixture of bruised beans and oats, instead of oats alone; from June to the middle of October, those horses that are required for the working of the green crop, driving manure, and harvest-work, are fed with cut grass and tares in the house; and about 7 lb. of oats each day, given at twice, increasing or decreasing the quantity according to the work they have to do; and I turn out to pasture only those horses that are not required until the busy season. I disapprove of horses that are regularly worked being turned out to grass, and exposed to all the changes of our variable climate, as I believe it to be the origin of many diseases. The expense of this mode of feeding, at present prices in this district, for each horse per annum, is as follows:—

| | L. | s. | d. |
|---|---|---|---|
| 12 lb. of oats per day, for 30 weeks, is $7\frac{1}{2}$ qrs. of 42 lb. per bushel. | | | |
| 7 lb. of do. do. 22 do. $3\frac{1}{8}$ do. do. | | | |
| $10\frac{5}{8}$ qrs. at 17s. | L.9 | 0 | 7 |
| 145 stones straw consumed, at 4d. per stone of 22 lb. | 2 | 8 | 4 |
| Each horse consumes 5 tons 16 cwt. of turnips and potatoes in 30 weeks. | | | |
| 58 cwt. potatoes, at 1s. 6d. .............................. | 4 | 7 | 0 |
| 58 cwt. turnips, at 9d. .............................. | 2 | 3 | 6 |
| 53 lb. salt, 1s. 8d., 52 bushels wheat-chaff, 4s. 4d. ... | 0 | 6 | 0 |
| 22 weeks on cut grass and tares, at 9d. per day ...... | 5 | 15 | 6 |
| | L.24 | 0 | 11 |

For the thirty weeks, the keep of each horse per day is 7d. for oats, $7\frac{1}{2}$d. for steamed food, and $2\frac{1}{2}$d. for fodder, or 1s. 5d. per day; for the twenty-two weeks, the keep is, grass 9d., oats 4d., or 1s. 1d. per day. The expense of preparing the steamed food, including coals, is 1s. 2d. per day for each horse. 260 stones of straw will be required for litter for each horse during the year; for this no charge is made, as it is left in manure. By this mode of feeding, the horses are always in fine sleek condition, and able for their work. I have acted upon this system for the last fifteen years; have always had from sixteen to twenty horses, and during that period I have only lost seven horses, three of them from accidental causes; and I attribute this, in a great measure, to the mode of feeding, and in particular, to the steamed food."

Berwickshire system of feeding.

The general treatment of horses in Berwickshire differs somewhat from that now detailed. They are usually turned to pasture so soon as the mildness of the weather and the forwardness of the pasture admit of it. While employed in carrying the crop, their fodder consists largely of tares, from whence until Martinmas they are fed on hay. From this date until 1st March, oat and bean straw are substituted, when, with the recurrence of harder labour, hay is again given until the return of the grazing season. During three-fourths of the year, they receive about 16 lb. of oats per diem, in three separate feeds. From the close of turnip-sowing until harvest, oats are either withheld or given only when a harder day's work occurs. The practice of bruising the whole of the oats given to horses, and also of chopping their hay, is now very prevalent. By giving a few pounds of chopped hay with each feed of bruised oats, and oat-straw in the racks, during the whole of the winter half-year, horses are kept in better condition, and at no more expense, than by giving them straw alone for half the period, and hay alone the other half. We are persuaded, also, that unless horses are stripped of their shoes and turned adrift altogether for a summer's run, that soiling in boxes, or sheds with an open yard, is preferable to grazing. The supper of cooked roots and chaff described in the Mid-Lothian practice, is probably preferable to the use of raw Swedes or potatoes, frequently given in other parts of Scotland. Hay and oats ought undoubtedly to constitute the staple fare of farm-horses. Without a liberal allowance of suitable and nourishing food, it is impossible that they can perform the full amount of work of which they are capable, or be sustained for any length of time in robust health. When *alleged* very cheap plans of feeding horses are inquired into, it is usually found that the amount and quality of the work performed by them is in fitting proportion. In this, as in so many other things, cheapness and economy are not convertible terms. The true way to economise the horse-labour of a farm is to have only good and well-fed cattle, and to get the greatest possible amount of work out of them.

### CATTLE.

As our limits do not admit of even a brief notice of all those breeds of cattle for which Great Britain is so famous, we shall restrict our remarks to some of the most important of them. Without entering upon curious speculations as to the origin of these breeds, we proceed to notice them in that order which is suggested by their relative importance in practical agriculture. The large lowland cattle thus claim our first attention, and amongst them we cannot hesitate in assigning the first place to the

Short-horn breed.

*Short-horns.*—It appears that from an early date the valley of the Tees possessed a breed of cattle which, in appearance and general qualities, were probably not unlike those *quasi* short-horns which abound in various parts of the country at the present day. By the time that the Messrs Colling came upon the field, it is evident that there were many herds around them in which considerable improvement had already been effected, and that they commenced their memorable efforts in cattle-breeding with exceedingly hopeful materials to work upon. But in their masterly hands these materials seemed at once to acquire an unwonted plasticity; for in an incredibly short time their cattle exhibited, in a degree that has not yet been excelled, that combination of rapid and large growth with aptness to fatten, of which their symmetry, good temper, mellow handling, and gay colours, are such pleasing indices and accompaniments, and for which they have now acquired a world-wide celebrity. It was by judicious selection in the first instance, and then by coupling animals of near affinity in blood, that they so developed and stereotyped these qualities in their cattle, as to entitle them at once to take rank as the progenitors of a new and well-marked breed. These *Durham*, *Teeswater*, or *Short-horn* cattle, as they were variously called, were soon eagerly sought after, and spread over the whole country with amazing rapidity. For a time their merits were disputed by the eager advocates of other and older breeds, some of which (such as the long-horns, once the most numerous breed in the kingdom) they have utterly supplanted, while others, such as the Herefords, Devons, and Scotch polled cattle, have each their zealous admirers, who still maintain their superiority to the younger race. But this controversy is meanwhile getting practically decided in favour of the short-horns, which constantly encroach upon

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their rivals even in their headquarters, and seldom lose ground which they once gain. Paradoxical as the statement appears, it is yet true that the very excellence of the short-horns has in many cases led to their discredit. For many persons desiring to possess these valuable cattle, and yet grudging the cost of pure-bred bulls, or being ignorant of the principles of breeding, have used worthless cross-bred males, and so have filled the country with an inferior race of cattle, bearing, indeed, a general resemblance in colour, and partaking in some measure of the good qualities of short-horns, but utterly wanting in their peculiar excellencies. By ignorant or prejudiced persons the genuine race is nevertheless held answerable for the defects of the mongrels which usurp their name, and for the damaging comparisons which are made betwixt them, and choice specimens of other breeds. That the short-horn breed should spread as it does, in spite of this hindrance, is no small proof of its inherent excellence, and warrants the inference that whenever justice is done to it, it will take its place as the one appropriate breed of the fertile and sheltered parts of Great Britain. This desirable consummation has hitherto been retarded by the scarcity and high price of pure-bred bulls. We are quite aware that bull-breeding, as hitherto conducted, is a hazardous and unremunerative business, notwithstanding the great prices sometimes obtained for first-class animals. We are of opinion, however, that it might be conducted in such a way as to be safer and more profitable to the breeder, and more beneficial to the country at large than it has hitherto been. There is at present a large and growing demand for good yearling short-horn bulls, at prices ranging from L.20 to L.30. With a better supply, both as to quality and numbers, this demand would steadily increase, for we have long observed that there is no want of customers for really good animals at such prices as we have named. When higher prices than these are demanded, farmers who breed only for the production of beef feel that they are beyond their reach, and are fain to content themselves with lower-priced and inferior animals. What we desire is, to see this business taken up by parties who, avoiding all needless expense, diminishing the risk of abortion and barrenness in their cows by never overfeeding them, and bestowing more pains to have their cows good milkers, would look for their profit from the sale of large numbers at moderate prices, rather than of few at exorbitant ones. The portraits of short-horn cattle appended to this treatise afford a good illustration of the prominent features of the breed.

Bull-breeding.

Herefords.

As already hinted, the *Hereford* is the breed which, in England, contests most closely with the short-horns for the palm of excellence. They are admirable grazier's cattle, and when of mature age and fully fattened, present exceedingly level, compact, and massive carcases of excellent beef. But the cows are poor milkers, and the oxen require to be at least two years old before being put up to fatten, defects which, in our view, are fatal to the claims which are put forward on their behalf. To the grazier who purchases them when their growth is somewhat matured they usually yield a good profit, and will generally excel short-horns of the same age. But the distinguishing characteristic of the latter is that, when properly treated, they get sufficiently fat, and attain to remunerative weights at, or even under, two years old. If they are kept lean until they have reached that age their peculiar excellence is lost. From the largeness of their frame they then cost more money, consume more food, and yet do not fatten more rapidly than bullocks of slower growing and more compactly formed breeds. It is thus that the grazier frequently gives his verdict in favour of Herefords as compared with short-horns. Even under this mode of management short-horns will usually yield at least as good a return as their rivals *to the breeder and grazier conjointly.* But if fully fed from their birth so as to bring into play their peculiar property of growing and fattening simultaneously, we feel warranted in saying that they will yield a quicker and better return for the food consumed by them than cattle of any other breed. Unless, therefore, similar qualities are developed in the Herefords, we may expect to see them more and more giving place to the short-horns. These remarks apply equally to another breed closely allied to the Herefords, viz. the

Devons.

*North Devons*, so much admired for their pleasing colour, elegant form, sprightly gait, and gentle temper, qualities which fit them beyond all other cattle for the labour of the field, in which they are still partially employed in various parts of England. If it could be proved that ox-power is really more economical than horse-power for any stated part of the work of the farm, then the Devons, which form such admirable draught oxen, would be deserving of general cultivation. We see, however, that duly as agriculture reaches a certain stage of progress, ox-labour has been found inadequate to the more rapid and varied operations that are called for, and has been superseded by that of horses. But supposing the ox-team to be everywhere laid aside, is this beautiful breed of cattle not worthy of being cherished for the purposes of the dairyman or the grazier? Now, although the milk of the Devon cows is very rich, it is too scanty, and they go too soon dry to admit of their being selected for strictly dairy purposes, or by the breeder who desires to rear several calves by the milk of each cow; and, although the oxen of this breed, *when their growth is matured*, can be fattened more quickly and on less food than short-horns of the same age, they do not yield so good a return as the latter for the whole food consumed by them respectively from birth to maturity. We consequently infer that they will, like other cherished breeds, either be superseded by the short-horns or amalgamated with them.

Ox-power *versus* horse-power.

Long-horns.

Until a comparatively recent period the *Long-horns* were the prevailing breed of our midland counties, as they still are of many parts of Ireland. Bakewell applied himself with his characteristic skill and success to the improvement of this breed; but at best they were so decidedly inferior to short-horns that they have now everywhere given place to them. Even in Lancashire, where they lingered longest, they have, within these few past years, nearly disappeared.

Scotch polled breeds.

Scotland possesses several indigenous breeds of heavy cattle, which, for the most part, are black and hornless, such as those of Aberdeen, Angus, and Galloway. These are all valuable breeds, being characterised by good milking and grazing qualities, and by a hardiness which peculiarly adapts them for a bleak climate. Cattle of these breeds, when they have attained to three years old, fatten very rapidly, attain to great size and weight of carcase, and yield beef which is not surpassed in quality by that of any cattle in the kingdom. The cows of these breeds, when coupled with a short-horn bull, produce an admirable cross-breed, which combines largely the good qualities of both parents. The great saving of time and food which is effected by the earlier maturity of the cross-breed has induced a very extensive adoption of this practice in all the north-eastern counties of Scotland. Such a system is necessarily inimical to the improvement of the pure native breeds: but when cows of the cross-breed are continuously coupled with pure short-horn bulls, the progeny in a few generations become assimilated to the male parent, and are characterised by a peculiar vigour of constitution, and excellent milking power in the cows. With such native breeds to work upon, and this aptitude to blend thoroughly with the short-horn breed, it is much more profitable to introduce the latter in this gradual way of continuous crossing than at once to substitute the one pure breed for the other. The cost of the former plan is much less, as there needs but

Cross-breeds.

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the purchase from time to time of a good bull; and the risk is incomparably less, as the stock is acclimated from the first, and there is no danger from a wrong selection. The greatest risk of miscarriage in this mode of changing the breed is from the temptation to which the breeder is exposed, on a false view of economy, of rearing a cross-bred bull himself, or purchasing a merely nominal short-horn bull from others.

From this hurried review of our heavy breeds of cattle it will be seen that we regard the short-horn as incomparably the best of them all, and that we anticipate its ultimate recognition as the breed which most fully meets the requirements of all those parts of the country where grain and green crops are successfully cultivated.

Dairy breeds.

The *dairy breeds* of cattle next claim our attention, for although cattle of all breeds are used for this purpose, there are several which are cultivated chiefly, if not exclusively, because of their fitness for it. Dairy husbandry is prosecuted under two very different and well-defined classes of circumstances. In or near towns, and in populous mining and manufacturing districts, it is carried on for the purpose of supplying families with new milk. In the western half of Great Britain, and in many upland districts, where the soil and climate are more favourable to the production of grass and other green crops than of corn, butter and cheese constitute the staple products of the husbandman. The town dairyman looks to quantity rather than quality of milk, and seeks for cows which are large milkers, which are long in going dry, and which can be readily fattened when their daily yield of milk falls below the remunerative measure. Large cows, such as short-horns and their crosses, are accordingly his favourites. In the rural dairy, again, the merits of a cow are estimated by the weight and quality of the cheese or butter which she yields, rather than by the mere quantity of her milk. The breeds that are cultivated expressly for this purpose are accordingly characterised by a less fleshy and robust build than is requisite in graziers' cattle. Of these we select for special notice the Ayrshire, the Jersey, and the Suffolk-dun breeds.

Ayrshire breed.

The Ayrshires, by common consent, now occupy the very first rank as profitable dairy cattle. From the pains which have been taken to develop their milk-yielding power it is now of the highest order. Persons who have been conversant only with grazing cattle cannot but be surprised at the strange contrast betwixt an Ayrshire cow in full milk, and the forms of cattle which they have been used to regard as most perfect. Her wide pelvis, deep flank, and enormous udder, with its small wide-set teats, seem out of all proportion to her fine bone and slender forequarters. As might be expected, the breed possesses little merit for grazing purposes. Very useful animals are however obtained by crossing these cows with a short-horn bull, and this practice is now rather extensively pursued in the west of Scotland by farmers who combine dairy-husbandry with the fattening of cattle. The function of the Ayrshire cattle is however the dairy. For this they are unsurpassed, either as respects the amount of produce yielded by them in proportion to the food which they consume, or the faculty which they possess of converting the herbage of poor exposed soils, such as abound in their native district, into butter and cheese of the best quality.

Suffolk Duns.

The county of Suffolk has for centuries been celebrated for its dairy produce, which is chiefly obtained from a polled breed of cattle, the prevailing colour of which is dun or pale red, from whence they are known as the *Suffolk Duns.* They have a strong general resemblance to the Scotch polled cattle, but nevertheless seem to be indigenous to Suffolk. They are ungainly in their form, and of little repute with the grazier, but possess an undoubted capacity of yielding a large quantity of milk in proportion to the food which they consume. They are now encroached upon, and will probably give place to the short-horns, by which they are decidedly excelled for the combined purposes of the dairy and the fattening stall.

Jersey breed.

The breeds already referred to are those to which professional dairymen give the preference, but the cattle of the Channel Islands, of which the *Jersey* may be regarded as the type, are so remarkable for the choice quality of the cream and butter obtained from their rather scanty yield of milk, that they are eagerly sought after for private dairies, in which quality of produce is more regarded than quantity. The rearing of heifers for the English market is of such importance to these islands, that very stringent regulations have been adopted for insuring the purity of their peculiar breed. These cattle in general are exceedingly ungainly in their form, and utterly worthless for the purposes of the grazier. The choicer specimens of the Jerseys have a certain deer-like form which gives them a pleasing aspect. The race, as a whole, bears a striking resemblance to the Ayrshires, which are alleged to owe their peculiar excellencies to an early admixture of Jersey blood.

Mountain breeds.

The mountainous parts of Great Britain are not less favoured than the lowlands in possessing breeds of cattle peculiarly adapted to the exigencies of the climate.

Kyloes.

The *Kyloes* or *West Highland cattle* are the most prominent of this group. They are widely diffused over the Highlands of Scotland, but are found in the greatest perfection in the larger Hebrides. Well-bred oxen of this breed, when of mature growth, and in good condition, exhibit a symmetry of form and noble bearing which is unequalled by any cattle in the kingdom. Although somewhat slow in arriving at maturity, they are contented with the coarsest fare, and ultimately get fat, where the daintier short-horns could barely exist. Their hardy constitution, thick mellow hide, and shaggy coat peculiarly adapt them for a cold humid climate and coarse pasturage. Fewer of these cattle are now reared in the Highlands than formerly, owing to the lessened number of cottars and small tenants, and the extension of sheep husbandry. Large herds of cows are however kept on such portions of farms as are unsuited for sheep walk. The milk of these cows is very rich, but as they yield it in small quantity, and go soon dry, they are unsuited for the dairy, and are kept almost solely for the purpose of suckling each her own calf. The calves are generally housed during their first winter, but after that they shift for themselves out of doors all the year round. Vast droves of these cattle are annually transferred to the lowlands, where they are in request for their serviceableness in consuming profitably the produce of coarse pastures and the leavings of daintier stock. Those of a dun or tawny colour are often selected for grazing in the parks of the aristocracy, where they look quite as picturesque as the deer with which they are associated. Indeed, they strikingly resemble the so-called wild cattle that are carefully preserved in the parks of several of our nobility, and like them are probably the descendants of the cattle of the ancient Britons. This view is confirmed by the strong family likeness borne to them by the

*Welsh cattle*, which is quite what might be expected from the many features, physical and historical, which the two provinces have in common. Although the cattle of Wales, as a whole, are obviously of common origin, they are yet ranged into several groups, which owe their distinctive features either to peculiarities of soil and climate, or to intermixture with other breeds. The *Pembrokes* may be taken as the type of the mountain groups. These are hardy cattle, which thrive on scanty pasturage and in a humid climate. They excel the west highlanders in this respect, that they make good dairy cattle, the cows being peculiarly adapted

Pembrokes

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for cottagers' purposes. When fattened they yield beef of excellent quality. Their prevailing and most esteemed colour is black, with deep orange on the naked parts. The *Anglesea* cattle are larger and coarser than the Pembrokes, and those of Merioneth and the higher districts are smaller and inferior to them in every respect. The county of Glamorgan possesses a peculiar breed, bearing its name, which has long been in estimation for combined grazing and dairy purposes. It has latterly been so much encroached upon by Herefords and short-horns that there seems some likelihood of its becoming extinct, which will be cause for regret unless pains are taken to occupy their place with cattle not inferior to them in dairy qualities. We conclude this rapid review of our native breeds by noticing the most singular of them all, viz.

The *Shetland cattle*, which are the most diminutive in the world. The carcase of a Shetland cow when fully fattened scarcely exceeds in weight that of a long-woolled wedder. These little creatures are however excellent milkers in proportion to their size, they are very hardy, are contented with the scantiest pasturage, they come early to maturity, are easily fattened, and their beef surpasses that of all other breeds for tenderness and delicacy of flavour. These miniature cows are not unfrequently coupled with short-horn bulls, and the progeny from such apparently preposterous unions not only possess admirable fattening qualities, but approximate in bulk to their gigantic sires. These curious and handsome little creatures, apparently of Scandinavian origin, are so peculiarly fitted to the circumstances of their bleak and stormy habitat, that the utmost pains ought to be taken to preserve the breed in purity, and to improve it by judicious treatment.

We cannot leave this part of our subject without reminding the reader of the singular richness of our country in cattle, not merely as regards numbers, but variety of breeds, endowed collectively with qualities which adapt one or other of them to every diversity in its soil and climate. So great is this diversity, and so complete that adaptation, that the requirements of each district are met, and the country as a whole enriched with every benefit that the domestic ox is capable of rendering to mankind.

Farm management of cattle.

We shall now endeavour to describe the farm management of this valuable animal, under the several heads of *breeding*, *rearing*, and *fattening*. What is peculiar to dairy management will be found treated of in a separate article. The breeding and rearing of cattle—subject to the exception just intimated—is prosecuted almost exclusively for the production of beef. The proceedings of those engaged in it are however largely determined by the character of the soil and climate of particular districts and farms. The occupiers of all comparatively fertile soils carry forward to maturity such animals as they breed, and dispose of them directly to the butcher. Those who are less fortunately circumstanced in this respect, advance their young cattle to such a stage as the capabilities of their farms admit of, and then transfer them to others by whom the fattening process is conducted. The ultimate object of both these parties being essentially the same, their practice, as far as it goes, ought undoubtedly to be also similar. In practice, this, we regret to say, is very far from being the case. The principles upon which this branch of husbandry should be conducted are indeed little affected by diversity of situation. This may and ought to determine the particular breed of cattle to be selected, but it is everywhere alike important to have a breeding stock of the best quality, to keep their produce uniformly in good condition, and to dispose of them whenever they cease to improve on such food as the farm affords. It cannot be too strongly impressed upon those who engage in this business that it never can be profitable to breed inferior cattle; or (however good their quality) to suffer their growth to be arrested by cold or hunger; or to sell them in a lean state.

Breeding of cattle.

In selecting a breeding stock of cattle, the qualities to be aimed at are, a sound constitution and a symmetrical form, aptitude to fatten, quiet temper, and large milk-yielding power in the cows. As all these qualities are hereditary, cattle are valuable for breeding purposes not merely in proportion as they are developed in the individuals, but according to the measure in which they are known to have been possessed by their progenitors. A really good pedigree adds therefore greatly to the value of breeding-stock. It is doubtless important to have both parents good; but in the case of ruminants, the predominating influence of the male in determining the qualities of the progeny is so well ascertained, that the selection of the bull is a matter of prime importance. We are able to state, from ample personal experience, that by using a bull that is at once good himself, and of good descent, a level and valuable lot of calves can be obtained from very indifferent cows. In Berwickshire it is the practice to employ chiefly married labourers who reside upon the farm, and one part of whose wages is the keep of a cow. These labourers usually give the preference to small cows, and—so that they are healthy, and yield milk plentifully—care little about their breed or other qualities. A good judge of grazier's cattle could not easily imagine a more unpromising breeding-stock than is furnished by these cottager's cows; and yet when they are coupled with a really good short-horn bull, it is truly surprising to see what admirable cattle are obtained from them. It is indeed miserable economy to grudge the price of a good bull.

Wastefulness of breeding inferior cattle.

Coarse, mis-shapen, unthrifty cattle cost just as much for rearing and fattening as those of the best quality, and yet may not be worth so much by L.3 or L.4 a-head, when they come ultimately to market. The loss which is annually sustained from breeding inferior cattle is far greater than those concerned seem to be aware of. It is impossible to estimate this loss accurately, but from careful observation and inquiry, we feel confident that it amounts to not less than 50s. a-head, on one half of the fat cattle annually slaughtered in Great Britain. If this be so, it follows that without expending a farthing more than is done at present on food, housing, and attendance, the profit which would accrue from using only the best class of bulls would be equivalent to an advance of 1s. per stone in the price of beef as regards half of the fat bullocks brought to market. This profit could moreover be secured by a very moderate outlay; for if properly gone about, the best class of bulls might be employed without adding more than 3s. or 4s. a-head to the price of each calf reared. We may surely anticipate that such a palpable source of profit will not continue to be neglected by the breeders of cattle. There are many instances in which landlords would find it much for their interest to aid their tenantry in at once procuring really good bulls. Cattle-shows and prizes are useful in their way as a means of improving the cattle of a district, but the introduction of an adequate number of bulls from herds already highly improved is the way to accomplish the desired end cheaply, certainly, and speedily. We must here protest against a practice by which short-horn bulls are very often prematurely unfitted for breeding. Their tendency to obesity is so remarkable that unless they are kept on short commons they become unwieldy and unserviceable by their third or fourth year. Instead, however, of counteracting this tendency, the best animals are usually "made up" as it is called, for exhibition at cattle-shows, or for ostentatious display to visitors at home, and the consequence is that they are ruined for breeding purposes. We rejoice to see that the directors of our national agricultural societies are resolutely setting their faces against this pernicious practice. It is needful certainly that all young ani-

Live Stock. mals, although intended for breeding stock, should be well fed, for without this they cannot attain to their full size and development of form. But when this is secured, care should be taken in the case of all *breeding* animals never to exceed that degree of flesh which is indispensable to perfect health and vigour. The frequent occurrence of abortion or barrenness in high-pedigreed herds seems chiefly attributable to overfeeding. The farmer who engages in cattle-breeding with the view of turning out a profitable lot of fat beasts annually, will take pains first of all to provide a useful lot of cows, such as will produce good calves, and if well fed while *giving milk* will yield enough of it to keep two or three calves a-piece. That he may be able to obtain a sufficient supply of good calves, he will keep a really good bull, and allow the cottagers residing on the farm or in its neighbourhood to send their cows to him free of charge, stipulating only that when they have a calf for sale he shall have the first offer of it. When cows are kept solely for the purpose of rearing calves, it becomes a matter of prime importance to have an adequate and seasonable supply of them from some source that can be relied upon both as regards their quality and numbers. We have long observed that calves produced in the early and late months of the year thrive better than those that are born about midsummer. Cottagers and others who keep cows in rural districts usually find it most suitable to have them to calve in spring, that they may be in full milk when pasturage is at its best. On the other hand, dairymen who provide milk for the supply of large towns, usually try to have a set of cows to calve in autumn, as it is in the winter months that their produce is most valuable. When a farmer has access to both these sources of supply, he can, by having his own cows to calve chiefly in spring, avail himself of both, and thus rear four or five calves annually, by the milk of each cow which he keeps, and, at the same time, allow her to go dry for two or three months before again calving. Cows are an expensive stock to keep, and it is therefore of importance to turn their milk to the best account. It is poor economy, however, to attempt to rear a greater number of calves than can be done justice to. Seeing that they are to be reared for the production of beef, the only profitable course is to feed them well from birth to maturity. During the first weeks of calf-hood the only suitable diet is unadulterated milk, warm from the cow, given three times a-day, and not less than two quarts of it at each meal. By three weeks old they may be taught to eat good hay, linseed cake, and sliced Swedes. As the latter items of diet are relished and freely eaten, the allowance of milk is gradually diminished until about the twelfth week, when it may be finally withdrawn. The linseed cake is then given more freely, and water put within their reach. For the first six weeks calves should be kept each in a separate crib; but after this they are the better of having room to frisk about. Their quarters, however, should be well sheltered, as a comfortable degree of warmth greatly promotes their growth. During their first summer, they do best to be soiled on vetches, clover, or Italian ryegrass, with from 1 lb. to 2 lb. of cake to each calf daily. When the green forage fails, white or yellow turnips are substituted for it. A full allowance of these, with abundance of oat straw, and not less than 2 lb. of cake daily, is the appropriate fare for them during their first winter. Swedes will be substituted for turnips during the months of spring, and these again will give place in due time to green forage, or the best pasturage. The daily ration of cake should never be withdrawn. It greatly promotes growth, fattening, and general good health, and in particular is a specific against the disease called blackleg, which often proves so fatal to young cattle. Young cattle that have been skilfully managed upon the system which we have now sketched, are at 18 months old already

Treatment of young calves.

of great size, with open horns, mellow hide, and all those other features which indicate to the experienced grazier that they will grow and fatten rapidly. This style of management is not only the best for those who fatten as well as rear; but is also the most profitable for those who rear only. We cannot better illustrate this statement, than by referring to a set of contemporaneous sales of young cattle which recently came under our personal observation. In June 1851 we happened to purchase in Kelso market at L.6, 18s. a head, a lot of fifty two-year-old short-horn steers from a dealer who had just brought them from Yorkshire. A fortnight before this a lot of *yearlings* (steers and heifers), bred and reared in the heart of the Lammermuirs, were sold in a neighbouring market at L.8, 8s. each. About the same time a friend of ours in Roxburghshire who annually rears a large lot of cattle, having noticed one of his calves affected with giddiness, forwarded him to Newcastle market, where he was sold to a butcher for L.8, being then not quite eight months old, and not a better animal than many of his lot. Now, these cases are the more valuable, because none of them were extreme ones; but just fair average examples of the fruits of the systems to which they respectively belong. They show conclusively that of a number of persons engaged contemporaneously in the business of cattle-rearing, and bringing their stock to the same markets, those who adopted the generous system of feeding, realised handsome profits, while those who, for thrift, starved their cattle must have done so at a loss to themselves. Nor are the evils of the starving system limited to the breeder. The grazier who purchases cattle that have been hunger-bitten in their youth, finds to his cost that he can only fatten them by an extra expenditure of time and food, and that after all they are worth less—weight for weight—than such as have never been lean.

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Bad effects of starving cattle.

We have already stated that, in Scotland, comparatively few cattle are fattened on pasturage. An increasing number of fat beasts are now prepared for market during the summer months by soiling on green forage; but it is by means of the turnip crop, and during the winter months, that this branch of husbandry is all but exclusively conducted in the northern half of Great Britain. But a few years ago, the fattening of cattle on Tweedside, and in the Lothians, was conducted almost exclusively in open courts, with sheds on one or more sides, in which from two to twenty animals were confined together, and fed on turnips and straw alone. Important changes have now been introduced, both as regards housing and feeding, by means of which a great saving of food has been effected. Under the former practice, the cattle received as many turnips as they could eat; which, for an average-sized two-year-old bullock, was not less than 220 lb. daily. The consequence of this enormous consumption of watery food was, that for the first month or two after being thus fed, the animals were kept in a state of habitual diarrhœa. Dry fodder was, indeed, always placed within their reach; but as long as they had the opportunity of taking their fill of turnips, the dry straw was all but neglected. By stinting them to about 100 lb. of turnips daily, they can be compelled to eat a large quantity of straw, and on this diet they thrive faster than on turnips at will. A better plan, however, is to render the fodder so palatable as to induce them to eat it of choice. For this purpose the straw is mixed with a third part of hay, and cut up into $\frac{3}{4}$-inch lengths, by a chaffing machine. A large wooden trough or bin with a lid to it being provided, the chaff, at the rate of three pecks for each beast, is put into it in layers, over each of which meal is sifted at the rate of 2 lb. to 4 lb. a head, and intermingled by stirring with a fork. Over the whole as much boiling water, with a little salt dissolved in it, is poured as will moisten the entire mass.

The fattening of cattle.

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The lid is then closed for a short time, and the mess thereafter served out to the cattle. The meal may be that of barley, oats, beans, or, in short, whatever is cheapest at the time, including all the inferior grain of the farm, with the addition of ½ lb. of ground linseed for each animal. An appropriate mode of administering the food is to give 50 lb. of sliced turnips early in the morning, the cooked mess about noon, and as much more turnips in the afternoon. A little oat straw is also given to them daily. For a few weeks before the completion of the fattening process, it is usually remunerative to give 4 or 5 lb. of linseed cake, and 6 lb. of good hay to each beast daily; the cake in combination with the cooked mess, and the hay in lieu of the oat-straw. From the peculiar structure of the digestive organs of the ox—which are adapted for disposing of bulky and but moderately nutritious food—this plan of inducing him to eat a considerable quantity of straw promotes his health and comfort, and economises the more costly food. The Rev. Mr Huxtable has pointed out a still cheaper way of accomplishing the same end. He shreds his turnips by a machine, analogous to a bark-mill, and then mixes them with cut straw, so that the cattle must eat both together. His opinion is, that he not only gains the element of bulk in this way, but that, from the straw and turnips being swallowed together, the hurtful chilling effect of the latter is avoided. He finds that 70 lb. of turnips thus administered is a sufficient daily ration for a fattening bullock.[1]

Best mode of housing cattle.

A better appreciation of the effects of temperature on the animal economy has of late years exerted a beneficial influence upon the treatment of fattening cattle. Observant farmers have long been aware that their cattle, when kept dry and moderately warm, eat less and thrive faster than under opposite conditions. They accounted for this in a vague way by attributing it to their greater comfort in such circumstances. Scientific men have now, however, shewed us that a considerable portion of the food consumed by warm-blooded animals is expended in maintaining the natural heat of their bodies, and that the portion of food thus disposed of is dissipated by a process so closely analogous to combustion, that it may fitly be regarded as so much fuel. The fat which, in favourable circumstances is accumulated in their bodies, may in like manner be regarded as a store of this fuel laid up for future emergencies. The knowledge of this fact enables us to understand how largely the profit, to be derived from the fattening of cattle, is dependent upon the manner in which they are housed, and necessarily forms an important element in determining the question whether *yards*, *stalls*, or *boxes*, are best adapted for this purpose. A really good system of housing must combine the following conditions:—

1*st*, Facilities for supplying food and litter, and for removing dung with the utmost economy of time and labour.

2*d*, Complete freedom from disturbance.

3*d*, A moderate and equal degree of warmth.

4*th*, A constant supply of pure air.

5*th*, Opportunity for the cattle having a slight degree of exercise; and

6*th*, The production of manure of the best quality.

We have no hesitation in expressing our opinion that the whole of these conditions are attained most fully by means of well-arranged boxes. Stalls are to be preferred where the saving of litter is an object; and yards for the rearing of young cattle, which require more exercise than is suitable for fattening stock.

But however excellent the system of housing and feeding which is adopted, a successful result will, in every instance, be much dependent upon the viligant superintendence of the owner, and his skill in so managing the commissariat, as to secure throughout the year a sufficiency of suitable food for the stock on hand. Unless this is attended to, he may find himself necessitated to sell his cattle before they are fat, and when markets are glutted. Whenever they have attained to what is technically called *ripe* fatness, and prices are at their average rate, it is generally more profitable forthwith to dispose of them, than to speculate upon a rise in the markets.

### SHEEP.

When Fitzherbert so long ago said, "Sheep is the most profitablest cattle that a man can have," he expressed an opinion in which agriculturists of the present day fully concur. But if this was true of the flocks of his time, how much more of the many admirable breeds which now adorn the rich pastures, the grassy downs, and heath-clad mountains of our native country. Their flesh is in high estimation with all classes of the community, and constitutes at least one-half of all the butcher meat consumed by them. Their fleeces supply the raw material for one of our most flourishing manufactures. They furnish to the farmer an important source of revenue, and the readiest means of maintaining the fertility of his fields. The distinct breeds, and subvarities of sheep found in Great Britain are very numerous. We have no intention of noticing them in detail, but shall rather confine our observations to those which, by common consent, are the most valuable for their respective and appropriate habitats. They may be fitly classed under these three heads, viz. the heavy breeds of the low country, those found on our downs and similar localities, and the mountain breeds.

Leicester breed.

Of the first class, the improved *Leicesters* are still the most important to the country. They are more widely diffused in the kingdom than any of their congeners. Although, from the altered taste of the community, their mutton is less esteemed than formerly, they still constitute the staple breed of the midland counties of England. Leicester rams are also more in demand than ever, for crossing with other breeds. It is now about a century since this breed was produced by the genius and perseverance of Bakewell, in whose hands they attained a degree of excellence that has probably not yet been exceeded by the many who have cultivated them since his day. The characteristics of this breed are extreme docility, extraordinary aptitude to fatten, and the early age at which they come to maturity. The most marked feature in their structure is the smallness of their heads, and of their bones generally, as contrasted with their weight of carcase. They are clean in the jaws, with a full eye, thin ears, and placid countenance. Their backs are straight, broad, and flat, the ribs arched, the belly carried very light, so that they present nearly as straight a line below as above, the chest is wide, the skin very mellow, and covered with a beautiful fleece of long, soft wool, which weighs on the average from 6 to 7 lb. On good soils, and under careful treatment these sheep are currently brought to weigh from 18 to 20 lb. per quarter at 14 months old, at which age they are now usually slaughtered. At this age their flesh is tender and juicy; but when carried on until they are older and heavier, fat accumulates so unduly in proportion to the lean meat, as to detract from its palatableness and market value.

Lincoln breed.

*Lincolns.*—These were at one time very large, ungainly animals, with an immense fleece of very long wool. By crossing them with the Leicesters the character of the breed has been entirely changed, and very greatly for the better. It is now, in fact, a subvariety of the Leicester, with larger frame and heavier fleece than the pure breed. Sheep of

[1] See "Present Prices" by Rev. A. Huxtable. Ridgway. London, 1850.

Live Stock. this kind are reared in immense numbers on the wolds and heaths of Lincolnshire, and are sold in the wool, and in very forward condition, when about a year old, to the graziers of the fens and marshes, who ultimately bring them to very great weights.

*Cotswolds.*—These also are large and long-woolled sheep, with good figure and portly gait, but somewhat coarse in in the bone, and in the quality of their flesh. They are found in the district whose name they bear. A variety of the Cotswold, obtained, we presume, by crossing with the Leicester, has acquired considerable reputation of late years, under the name of *New Oxfords*. These are large, heavy, rapid-growing sheep, very docile, with a fleece analogous to the Leicester, which breed, in fact, they resemble in their leading characteristics, save that they want their symmetry and fine flesh. They are bred in Oxfordshire and neighbouring districts. Both of these last-named breeds suit admirably for crossing with short-woolled sheep, and are likely to be in increasing demand for this purpose.

New Oxfords.

*Teeswaters.*—This breed, found formerly in the vale of the Tees, used to have the reputation of being one of the largest and heaviest of our native breeds. They had lighter fleeces than the old Lincolns, but greater aptitude to fatten. Like them, however, they have been so blended with Leicester blood, as to have lost their former characteristics. As now met with, they constitute simply a subvariety of the latter breed.

The *Kents*, or *Romney Marsh Sheep*, are another distinct long-woolled breed, which have much in common with the old Lincolns, although they never equalled them either in the weight or quality of their fleece. They, too, have been much modified by a large infusion of Leicester blood; but as their distinctive qualities fit them well for a bleak and humid habitat, there is now an aversion to risk these by further crossing. As they now exist they are a great improvement upon the old breed of the Kentish marshes; and this, in the first instance at least, was the result of crossing rather than selection.

The breeds peculiar to our chalky downs, and other pastures of medium elevation, next claim our notice.

*South Downs.*—Not long after Robert Bakewell had begun with admirable skill and perseverance to bring to perfection his celebrated Leicesters, which, as we have seen, have either superseded, or totally altered the character of, all the heavy breeds of the country; another breeder, Mr John Ellman of Glynde, in Sussex, equal to Bakewell in judgment, perseverance, and zeal, and wholly devoid of his illiberal prejudice and narrow selfishness, addressed himself to the task of improving the native sheep of the downs, and succeeded in bringing them to as great perfection, with respect to early maturity and fattening power, as they are perhaps susceptible of. Like Bakewell, he early began the practice of letting out rams for hire. These were soon eagerly sought after, and the qualities of this improved flock being rapidly communicated to others, the whole race of down sheep has more or less become assimilated to their standard. These improved south downs have, in fact, been to all the old *forest*, and other fine-woolled breeds, what the Leicesters have been to their congeners. Many of them have entirely disappeared, and others only survive in those modifications of the improved south-down type, which are to be found in particular localities. These down sheep possess certain well-marked features, which distinguish them from all other breeds. They have a close-set fleece of fine wool, weighing, when the animals are well-fed, about four pounds; their faces and legs are of a dusky brown colour, their neck slightly arched, their limbs short, their carcase broad and compact, their offal light, and their buttocks very thick and square behind. They are less impatient of folding, and suffer less from a pasture being thickly stocked with them than any other breed. It is in connection with this breed that the practice of folding as a means of manuring the soil is so largely carried out in the chalk districts of England. It is well ascertained that the injury done to a flock by this practice exceeds the benefit conferred on the crops. Now that portable manures are so abundant, it is to be hoped that this pernicious practice of using sheep as mere muck machines will be everywhere abandoned.

Improved by Mr Ellman.

Live Stock.

Evils of folding.

These sheep are now usually classed as Sussex downs and Hampshire downs, the former being the most refined type of the class, both as regards wool and carcase, and the latter, as compared with them, having a heavier fleece, stronger bone, and somewhat coarser and larger frame. These breeds are peculiarly adapted for all those parts of England where low grassy hills occur, interspersed with, or in proximity to, arable land. In such situations they are prolific, hardy, and easily fattened at an early age. It is to their peculiar adaptation for crossing with the long-woolled breeds, that they are indebted for their recent and rapid extension to other districts.

*Dorsets.*—This breed has, from time immemorial, been naturalised in the county of Dorset, and adjacent parts. They are a whitefaced, horned breed, with fine wool, weighing about four pounds per fleece. They are a hardy and docile race of sheep, of good size, and fair quality of mutton. But the property which distinguishes them from every other breed in Great Britain is the fecundity of the ewes, and their readiness to receive the male at an early season. They have even been known to yean twice in the same year. Being, in addition to this, excellent nurses, they have long been in use for rearing house-lamb for the London market. For this purpose the rams are put to them early in June, so that the lambs are brought forth in October, and are ready for market by Christmas. But for this peculiarity, they would ere now have shared the fate of so many other native breeds, which have given place either to the Leicesters or south downs, according to the nature of the pastures. So long, however, as the rearing of early house-lamb is found profitable, there is a sufficient inducement to preserve the Dorset breed in its purity, as they are unique in their property of early yeaning.

*Cheviots.*—As we approach and cross the Scottish border we find a range of hills covered with coarser herbage than the chalky downs of the south, and with a climate considerably more rigorous. Here the south-down sheep have been tried with but indifferent success. This, however, is not to be regretted, seeing that the native Cheviot breed rivals them in most of their good qualities, and possesses, in addition, a hardihood equal to the necessities of the climate. This breed, besides occupying the grassy hills of the border counties, is now found in great force in the north and west Highlands of Scotland. In the counties of Sutherland and Caithness, where they were introduced by the late Sir John Sinclair, they have thriven amazingly, and in the hands of some spirited breeders have attained to as great perfection as in their native district. During the last thirty years, this breed has undergone very great improvement in size, figure, weight of fleece, and aptitude to fatten. In proof of this, it is enough to mention that Cheviot wedder lambs are now in the border counties brought to market when weaned, and are transferred to the low country graziers, by whom they are sent fat to the butcher at sixteen months old, weighing then from 16 to 18 lb. per quarter. This is particularly the case in Cumberland, where Cheviot lambs are preferred by the low country farmers to all other breeds, and by whom they are managed with great skill and success. It is not at all unusual with them to realise an increase of from 20s. to 25s. per head on the purchase price of these lambs, after a twelvemonth's keep. This fact is peculiarly interesting from the proof which it affords of a hitherto unsuspected capacity in Cheviots, and probably in other upland breeds, to attain to a profitable degree of fatness and weight of carcase, at almost as early an age as the lowland breeds, when the same attention and liberal feeding is bestowed upon them. Such a system is moreover greatly more profitable both for breeder and grazier than the old one. It is every way better for the farmer to occupy his pastures with breeding stock only, and to get quit of his lambs as soon as they are fit for weaning. It is better for the grazier to get hold of them when full of their lamb flesh, as by transferring them at once to good keep, he can carry them forward without a check to the earliest stage, at which he can realise with a profit. Very great pains are now bestowed on the improvement of this breed; in proof of which it may be mentioned, that at the autumn fairs, such as Hawick, Moffat, &c., where great numbers of rams are presented for sale, L.10 a head is not unfrequently paid to the more noted breeders for their choicest animals. In August 1851 Mr Brydon of Moodlaw, whose flock of Cheviots has long enjoyed the reputation of being one of the very best in the country, sold 148 rams by public auction, at an average price of L.7, 9s. per head. The competition for these choice specimens of Cheviot sheep was so keen that one was sold for L.37, and several more from L.20 to L.30. There is no breed equally well adapted for elevated pastures, consisting of the coarser grasses, with a mixture of heath; but whenever, from the nature of the soil or greater elevation, the heaths unmistakeably predominate, a still hardier race is to be preferred, viz.

The *Blackfaced* or *Heath Breed.*—They are accordingly found on the mountainous parts of Yorkshire, Lancashire, Cumberland, and Westmoreland; over the whole of the Lammermuir range; the upper part of Lanarkshire; and generally over the Highlands of Scotland. Both male and female of this breed have horns, which, in the former, are very large and spirally twisted. The face and legs are black, with an occasional tendency to this colour on the fleece; but there is nothing of the brown or russet colour which distinguishes the older fine-woolled races. The choicest flocks of these sheep are found in Lanarkshire and in the Lammermuirs, where considerable pains are now bestowed on their improvement. Their chief defects are coarseness of fleece, and slowness of fattening until their growth is matured. In most flocks the wool, besides being open, and coarse in the staple, is mixed with *kemps* or hairs which detract from its value. Rams with this defect are now carefully avoided by the best breeders, who prefer those with black faces, a mealy mouth, a slight tuft of fine wool on the forehead, horns flat, not very large, and growing well out from the head; with a thickset fleece of long, wavy, white wool. Greater attention is now also being paid to their improvement in regard to fattening tendency; in which respect we do not despair of seeing them brought nearer to a par with other improved breeds. Whenever this is accomplished we shall possess in the breeds now enumerated, and their crosses, the means of converting the produce of our fertile plains, grassy downs, rough upland pastures, and heathclad mountains, into wool and mutton of the best quality, and with the utmost economy of which the circumstances admit.

A branch of this family of the heath breeds called Herdwicks, having its headquarters in Cumberland, although found also in Westmoreland and Lancashire, is frequently much extolled. We are of opinion, that in all their good qualities they are excelled by the best style of pure blackfaced sheep as met with in Tweeddale and the Lammermuirs.

*Cross-breeds.*—We have thus enumerated the most important of our pure breeds of sheep, but our list would be defective, were we to omit those cross-breeds which are acquiring increased importance every day. With the extended cultivation of turnips and other green crops there has arisen an increased demand for sheep to consume them. Flock-masters in upland districts, stimulated by this demand, happily bethought them of putting rams of the improved low-country breeds to their smaller ewes, when it was discovered that the lambs produced from this cross, if taken to the low-country as soon as weaned, could be fattened nearly as quickly, and brought to nearly as good weights, as the pure low-country breeds. The comparatively low prime cost of these cross-bred lambs is a farther recommendation to the grazier, who finds also that their mutton, partaking at once of the fatness of the one parent, and of the juiciness, high flavour, and larger proportion of lean flesh of the other, is more generally acceptable to consumers than any other kind, and can always be sold at the best price of the day. The wool, moreover, of these crosses being at once long and fine in the staple, is peculiarly adapted for the manufacture of a class of fabrics now much in demand, and brings in consequence the best price of any British-grown wool. The individual fleeces, from being close set in the pile, weigh nearly as much as those of the pure Leicesters. On all these accounts, therefore, these sheep of mixed blood are rapidly rising in public estimation, and are produced in ever increasing numbers. This is acccomplished in several ways. The occupiers of uplying grazings in some cases keep part of their ewe flock pure, and breed crosses from another part. They sell the whole of their cross-bred lambs, and get as many females from the other portion as keeps up the number of their breeding flock. This system of crossing cannot be pursued on the highest class of farms, as ewes bearing these heavier crossed lambs require better fare than when coupled with rams of their own race. The surplus ewe lambs from such highlying grazings are an available source of supply to those of a lower range, and are eagerly sought after for this purpose. Others, however, take a bolder course. Selecting a few of the choicest hill-country ewes which they can find, and puting these to a first-rate Leicester ram, they thus obtain a supply of rams of the first cross, and putting these to ewes, also of the first cross, manage in this way to have their entire flock *half-bred* and to go on continuously with their own stock without advancing beyond a first cross. They, however, never keep rams from such crossed parentage, but always select them from the issue of parents each genuine of their respective races. We know several large farms on which flocks of crosses betwixt the Cheviot ewe and Leicester ram have been maintained in this way for many years with entire successs; and one at least in which a similar cross with south down ewes has equally prospered. Many, however, prefer buying in females of this first cross, and coupling them again with pure Leicester rams. In one or other of these ways cross-bred flocks are increasing on every side. So much has the system spread in Berwickshire, that whereas, in our memory, pure Leicesters were the prevailing breed of the county, they are now all but confined to a few ram-breeding flocks.

### GENERAL MANAGEMENT.

As the management of sheep is influenced mainly by the nature of the lands upon which they are kept, we shall first describe the practice of Lowland flock-masters, and afterwards that pursued on Highland sheep-walks.

On arable farms, where turnips are grown, and a breeding stock of sheep regularly kept, it is usual to wean the lambs about the middle of July. When this has been done, the aged and faulty ewes are drafted out, and put upon good aftermath, or other succulent food, that they may be got ready for market as soon as possible. In many districts it is the practice to take but three crops of lambs from each

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ewe. A third part of the breeding flock, viz. the four-year old ewes, is thus drafted off every autumn, and their places supplied by the introduction of a corresponding number of the best of the ewe-lambs of the preceding year's crop. These cast or draft ewes are then sold to the occupiers of richer soils in populous districts, who keep them for another season to feed fat lambs. Such parties buy in a fresh stock of ewes every autumn, and, as they phrase it, "feed lamb and dam." In other cases the ewes are kept as long as their teeth continue sound, and after that they are fattened and sold to the butcher directly from the farm on which they have been reared. When the ewes that are retained for breeding-stock have been thus overhauled, they are put to the worst pasture on the farm, and run rather thickly upon it. Attention is necessary, for some days after weaning, to see that none of them suffer from gorging of the udder. When it appears very turgid in any of them, they are caught and partially milked by hand; but usually the change to poorer pasturage, aided by their restlessness and bleating for want of their lambs, at once arrests the flow of milk.

Rutting season.

The time of admitting the ram is regulated by the purpose for which the flock is kept, and by the date at which fresh green food can be reckoned upon in spring. When the produce is to be disposed of as fat lambs, it is of course an object to have them early; but for a holding stock, to be reared and fattened at fourteen to sixteen months old, from 20th Sept. to 20th Oct., according to the climate of the particular locality, is a usual time for admitting rams to ewes. A fortnight before this takes place the ewes are removed from bare pasture, and put on the freshest that the farm affords, or better still, on rape, failing which one good feed of white turnips per diem is carted and spread on their pastures, or the ewes are folded for part of the day on growing turnips. The rams are turned in amongst them, just when this better fare has begun to tell in their improving appearance, as it is found that in such circumstances they come in heat more rapidly, and with a greatly increased likelihood of conceiving twins. On level ground, and with moderate sized inclosures, one ram suffices for sixty ewes. Sometimes a large lot of ewes are kept in one flock, and several rams, at the above proportion, turned among them promiscuously. It is better, however, when they can be placed in separate lots. The breasts of the rams are rubbed with ruddle, that the shepherd may know what they are about. Those who themselves breed rams, or others who hire in what they use at high prices, have recourse to a different plan, for the purpose of getting more service from each male, and of knowing exactly when each ewe may be expected to lamb; and also of putting each ewe to the ram most suitable to her in point of size, figure, and quality of flesh and fleece. The rams in this case are kept in pens in a small inclosure. What is technically called a *teaser* is turned among the general flock of ewes, which, on being seen to be in heat, are brought up and put to the ram that is selected for them. They are then numbered, and a note kept of the date, or otherwise a common mark, varied for each successive week, is put on all as they come up. The more usual practice is to mark the breast of the ram with ruddle, as already described, for the first seventeen days that they are among the ewes—that being the time of the periodic recurrence of the heat—and then to use soot instead. When lambing-time draws near, the red-rumped ewes, or those that conceived from the first copulation, are brought into the fold, and the remainder after the lapse of the proper interval. If all goes on well, six weeks is long enough for the rams to remain with the flock. The ewes are then put to more moderate fare, taking care, however, not to pinch them, but to preserve the due medium betwixt fatness and poverty. Under the first-mentioned extreme, there is great risk of losing both ewe and lamb at the time of parturition; and under the second, of the ewe shedding her wool, and being unable to nourish her lamb properly either before its birth or after. When there is a considerable breadth of grass-land, the *grit* or inlamb ewes are run thinly upon it, so long as the weather continues moderate. As the pasturage fails, or winter weather sets in, they receive a daily feed of turnips or hay, or part of both. In districts where the four-course rotation is pursued, and wheat sown after seeds, there is a necessity for keeping the ewes wholly on turnips and chopped hay or straw. In this case they are made to follow the fattening sheep, and to eat up their scraps, an arrangement which is suitable for both lots.

Lambing season.

The period of gestation in the ewe is twenty-one weeks. No lambs that are born more than twelve days short of this period survive. Before any lambs are expected to arrive, a comfortable fold is provided, into which either the entire flock of ewes, or those that by their markings are known to lamb first, are brought every night. This fold, which may either be a permanent erection, or fitted up annually for the occasion, is provided all round with separate pens, or cribs, of size enough to accommodate a single ewe, with her lamb or pair. The pasture or turnip fold to which the flock is turned by day is also furnished with several temporary but well-sheltered cribs, for the reception of such ewes as lamb during the day. It is of especial consequence that ewes producing twins be at once consigned to a separate apartment, as, if left in the crowd, they frequently lose sight of one lamb, and may refuse to own it, when restored to them, even after a very short separation. Some ewes will make a favourite of one lamb, and wholly repudiate the other, even when due care has been taken to keep them together from the first. In this case the favourite must either be separated from her, or be muzzled with a piece of network, to prevent it from getting more than its share of the milk in the shepherd's absence. Indeed the maternal affection seems much dependent on the flow of milk, as ewes with a well-filled udder seldom trouble the shepherd by such capricious partialities. So soon as the lambs have got fairly afoot, their dams are turned with them into the most forward piece of seeds, or to rape, rye, winter-oats, or water-meadow, the great point being to have abundance of succulent green food for the ewes as soon as they lamb. Without this they cannot yield milk abundantly; and without plenty of milk it is impossible to have good lambs. It is sometimes necessary to aid a lamb that has a poor nurse with cow's milk. This is at best a poor alternative; but if it must be resorted to, it is only the milk of a farrow cow, or at least of one that has been calved six months, that is at all fit for this purpose. To give the milk of a recently calved cow to a young lamb is usually equivalent to knocking it on the head. Ewe milk is poor in butter, but very rich in curd, which is also known to be, in a measure, the character of that of cows that have been long calved, and are not again pregnant. We have found the Aberdeen yellow bullock turnip the best for pregnant and nursing ewes. Mangel-wurzel is much approved of by the flock-masters of the southern counties for the same purpose. It is of importance, at this season, to remove at once from the fold and pens all dead lambs, and filth of every kind, the presence of putrefying matter being most hurtful to the flock. Should a case of puerperal fever occur, the shepherd must scrupulously avoid touching the ewe so affected; or if he has done so, some one should take his accoucheur duties for a few days, as this deadly malady is highly contagious, and is often unconsciously communicated to numbers of the flock by the shepherd's hands. Unnecessary interference with ewes during parturition is much to be deprecated. When the presentation is all right, it is best to leave them as much as possible to their natural ef-

Live Stock. forts. When a false presentation does occur, the shepherd must endeavour to rectify it by gently introducing his hand after first lubricating it with fresh lard or olive-oil. The less dogging or disturbance of any kind that ewes receive during pregnancy, the less risk is there of unnatural presentations. As soon as lambs are brought forth, the shepherd must give them suck. When they have once got a bellyful, and are protected from wet or excessive cold for two or three days, there is no fear of their taking harm from ordinary weather, provided only that the ewes have plenty of suitable food. Lambs are castrated, docked, and ear-marked, with least risk when about ten days old. Ewes with lambs must have good and clean pasturage throughout the summer. For this purpose they must either be run thinly among cattle, or have two or more inclosures, one of which may always be getting clean and fresh for their reception, as the other gets bare and soiled. We have not found any advantage in allowing lambs yeaned in March to run with their dams beyond 20th July. A clover edish, or other perfectly clean pasture, is the most suitable for newly weaned lambs. Such as abound in *tath*, as it is called in Scotland, that is, rank herbage growing above the droppings of sheep, or other animals, are peculiarly noxious to them. Folding upon rape or vetches suits them admirably, so that fresh supplies are given regularly as required. All sheep are liable to be infested with certain vermin, especially by "fags," or "kaids," and by lice. To rid them of these parasites, various means are resorted to. Some farmers use mercurial ointment, which is applied by parting the wool, and then with the finger rubbing the ointment on the skin, in three or four longitudinal seams on each side, and a few shorter ones on the neck, belly, legs, &c. Those who use this salve dress their lambs with it immediately after shearing their ewes, and again just before putting them on turnips. More frequently the sheep are immersed, all but their heads, in a bath, in which arsenic and other ingredients are dissolved. On being lifted out of the bath, the animal is laid on spars, over a shallow vessel, so placed that the superfluous liquor, as it is wrung out of the fleece, flows back into the bath. If this is done when the ewes are newly shorn, the liquor goes farther than when the process is deferred until the lambs are larger and their wool longer. It is good practice to souse the newly shorn ewes, and indeed the whole flock at the same time, in a similar bath, so as to rid them all of vermin.

Salving or bathing.

The object being to bring these young animals to early and profitable maturity, every pains must be taken not only to preserve their health, but to insure their rapid and uninterrupted progress. For this end it is necessary to provide ample supplies of food suitable for the particular season. As turnips constitute their staple winter fare, it is necessary to have a portion of these sown in time to be fit for use in September. Young sheep always show a reluctance to take to this very succulent food, and should therefore be put upon it so early in autumn that they may get thoroughly reconciled to it while the weather is yet temperate. Rape or cabbages suit admirably as transitionary food from grass to turnips. When this transference from summer to winter fare is well managed, they usually make rapid progress during October and November. Some farmers recommend to give the *hoggets*, as they are now called, a daily run off from the turnip fold to a neighbouring pasture for the first few weeks after their being put to this diet. We have found it decidedly better to keep them steadily in the turnip fold from the very first. When they are once taught to look for this daily enlargement, they become impatient for it, and do not settle quietly to their food. If possible not more than 200 should be kept in one lot. The youngest and weakest sheep should also have a separate berth and more generous treatment. Turnips being a more watery food than sheep naturally feed upon, there is great advantage in giving them from the first, along with turnips, a liberal allowance of clover hay cut into half-inch chaff. When given in this form in suitable troughs, and in regular feeds, they will eat up the whole without waste, and be greatly the better for it. To economise the hay, equal parts of good oat straw may be cut up with it, and will be readily eaten by the flock. A liberal supply of this dry food corrects the injurious effects which are so often produced by feeding sheep on turnips alone, and at the same time lessens the consumption of the green food. We believe also that there is true economy in early beginning to give them a small daily allowance, say $\frac{1}{4}$ lb. each, of cake or corn. This is more especially desirable when sheep are folded on poor soil. This extraneous food both supplies the lack of nutrition in the turnips, and fertilises the soil for bearing succeeding crops. An immense improvement has been effected in the winter feeding of sheep by the introduction of machines for slicing turnips. Some careful farmers slice the whole of the turnips used by their fattening sheep, of whatever age; but usually the practice is restricted to hoggets, and only resorted to for them when their milk-teeth begin to fail. In the latter case the economy of the practice does not admit of debate. When Mr Pusey states the difference in value betwixt hoggets that have had their turnips sliced and others that have not, at 8s. per head in favour of the former from this cause alone, we do not think that he over-estimates the benefit. Those who slice turnips for older sheep, and for hoggets also as soon as ever they have taken to them, are, we suspect, acting upon a sound principle, and their example is therefore likely to be generally followed. There is no doubt of this, at least, that hoggets frequently lose part of the flesh which they had already gained from the slicing of the turnips being unduly delayed. By 1st December, their first teeth, although not actually gone, have become so inefficient, that they require longer time and greater exertion to fill themselves than before; and this, concurring with shorter days and colder weather, operates much to their prejudice. When the slicing is begun, it is well to leave a portion of growing turnips in each day's fold, as there are always some timid sheep in a lot that never come freely to the troughs; and they serve moreover to occupy the lot during moonlight nights, and at other times when the troughs cannot be instantly replenished. As the sheep have access to both sides of the troughs, each will accommodate nearly as many as they are feet in length. There should therefore be provided at least as many foot-lengths of trough as there are sheep in the fold. These troughs are usually placed on low cross feet, with a top-rail to keep the sheep from getting into them. It is better to raise them about 18 inches from the ground on feet standing well out, to prevent them from being overturned. This preserves their food from being dirtied and wasted, better than a top-rail. When corn or cake is given, it is best to use separate troughs for it of smaller dimensions, and to turn them over after each feed, to keep them clean and dry.

Putting hoggets to turnips.

Benefit of giving dry food along with turnips.

Slicing turnips for sheep.

Much discussion has taken place of late years, as to whether sheep can be fattened more economically in the open field or under cover. When the soil is at all dry, the preponderance of evidence is in favour of the former practice. There can be no doubt, however, of the propriety of providing some temporary shelter for fattening sheep against severe winter weather. This is done to some extent by forming the whole or part of the fold fence of wattled hurdles. A double row of common hurdles, set about a foot apart, and having the interstices daily stuffed with fresh straw, forms at once a screen from the weather, and a rack for dry fodder. In very inclement weather, a rude shed can

Sheepfeeding.

Live Stock. be constructed with stout double hurdles, stuffed between with litter, and having others laid across them, similarly covered with spadefuls of earth thrown on here and there to prevent the straw from being blown away. We have already, when treating of turnip culture, pointed out the advantage of having all that are to be consumed after Christmas secured in some way against bad weather and running to seed. To clear the ground in time for the succeeding grain crop, a portion of the turnip crop is usually stored on some piece of grass or fallow where the flock is folded until the pastures are ready to receive them. As the date of this varies exceedingly, it is well to lay in turnips for a late season, and rather to have some to spare than to be obliged to stock the pastures prematurely. If corn or cake has been given in the turnip field, it must be continued in the pasture. Hoggets that have been well managed will be ready for market as soon as they can be shorn, and may not require grass at all. They usually, however, grow very rapidly on the first flush of clovers and sown grasses, especially when aided by cake or corn. When the soil is of poor quality, it is expedient to continue the use of such extra food during summer. The best sheep are generally sent to market first, and the others as they attain to a proper degree of fatness. Store sheep or cattle are then purchased to occupy their places until the next crop of lambs is weaned.

*Management of Mountain Sheep.*—We have already taken notice of the extent to which Cheviot sheep have of late years been introduced in the Highlands of Scotland. Many of the immense grazings there are rented by farmers resident in the south of Scotland, who only visit their Highland farms from time to time, and entrust the management of their flocks and shepherds, which rival in numbers those of the ancient patriarchs, to an overseer, whose duty it is to be constantly on the grounds, to attend in all respects to the interests of his employer, see his orders carried into effect, and give him stated information of how it fares with his charge. We are happy at being enabled to submit to the reader the following account of Highland sheep-farming, with which we have been favoured by a gentleman who is extensively engaged in this business.

"The hills in the north of Scotland are mostly stocked with Cheviot sheep, except in the shires of Perth and Argyll, where the blackfaced breed are still considered the most suitable; and a considerable quantity of cattle also are reared. The farms in the high districts are often of great size, some of the largest extending even to 50,000 or 60,000 acres. The land, however, some few valleys excepted, is of a very barren description, much broken with rocks and large stones, or else, as in some parts of Sutherland, extending in vast ranges of moss, covered with the different heaths. It requires generally about three acres to keep a sheep through the season; they never get hay or any foreign feeding during winter, but some of the highest hirsels have sometimes to be driven off to lower ground in severe storms. As the sheep lie scattered over such a great extent of ground, their management entails much more fatigue on the shepherd than in more fertile districts. Many of these shepherds have been brought from the border counties; their wages are from L.16 to L.18, with house, two cows' grass, ground for potatoes, and 65 stones of oatmeal. The natives of the district get something less. In some cases the grazing of 60 or 70 sheep is given instead of money, but on account of the trouble they cause at sortings, wages in cash are now generally preferred. The number of sheep in a hirsel is about 500, but in some cases twice that number are under the charge of one man.

One of the most trying seasons for the shepherd is lambing-time, which begins about 20th or 25th April. The number of lambs reared on Mr Sellar's farm[1] is much above an average. Low-lying sheltered districts may commonly rear 15 or 16 lambs for every 20 ewes put to the tup; but on the high grounds, although the ewes there are much more careful of their lambs, yet from exposure to the weather and various casualties, there are seldom produced more than 13 or 14 lambs for every 20 ewes. On account of the difficulty of rearing lambs in these high districts, the farmers there find it more profitable to keep most of their land under wedders, and purchase what lambs they require from the low-lying farms near the coast, many of which are now under a ewe stock; there are not yet, however, enough of wedder lambs bred to supply this demand, as large lots are annually driven north from the border markets. The sale wedders (almost all of which are three years' old) are clipped as early as possible, say about the middle of June, the ewes, &c., in the beginning of July. Plenty of clippers are to be had from the villages at 1s. per day with victuals. The weight of the fleeces varies much; the average may be about 4 lb. of smeared wool. A great part of the wool and sheep of the northern counties is sold at the Inverness and Fort-William markets, or consigned to commission-agents in Liverpool. The highest prices for both are obtained by the Sutherland farmers. Everything is sold by character, no stock or samples of any kind are shewn; and it is said that no lawsuit has occurred from any disputed bargain. The principal lots of sheep are bought into Dumfries, Cumberland, and other western counties, and there has been an increasing demand of late years from Ireland. Those unsold are driven to Falkirk, travelling there from the most northern farms in about four weeks, at an expense of 1s. 6d. per head; some few lots have of late years been sent south by the west-coast steam-boats.

"Few Highland farms, like Mr Sellar's, contain any arable land; and one of the greatest difficulties the farmer has to contend with is getting the lambs wintered. The ewe-lambs are thought hardier than the wedders; it is also of consequence to have them thoroughly inured to the pasture and climate; so they are commonly kept at home, and either placed on the most suitable hirsels, or left following their mothers through the whole season; the loss during winter amounting to from 4 to 6 out of every 20. Great part of this loss is caused by braxy, which prevails over the whole Highlands, and is often worst in those places which, from their lowness and richness, are most suitable for wintering lambs. No preventive has yet been found.[2] Poverty and casualties make up the rest of the loss. About the beginning of November, all the wedder lambs are driven off to turnips grown on the east coasts (a few lots of them go to sheltered grazings). They are taken there from great distances, even from Lewis, and often suffer much from bad weather and fatigue during the journey. The expense of wintering them there is from 1¾d. to 2d. per week, but the loss seldom exceeds 2 out of every 20. They return to the hills again in March and April. The average loss of old sheep during a season may be about 2 out of every 20.

"There are some fine lots of tups bred in Sutherland, which have taken prizes in every district; large numbers also are taken every year from the border counties. In some wide-lying hirsels one tup is required for every 30 ewes; 45 being about the average number. All the sheep are smeared with tar and butter, at a cost of 4½d. or 5d. each; no substitute has yet been found for it, and attempts to keep them white have not been successful. The rents vary from 2s. to 2s. 9d. per sheep; on some low rich farms they are still higher. The capital required of late years has been 20s. or 25s. for each sheep kept."

The following remarks are from another extensive Highland sheep-farmer:—

"The management of flocks in the Highlands is much the

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[1] See *Farm Reports, or Accounts of the Management of Select Farms.* Sutherland. By Patrick Sellar.

[2] We have been informed by a gentleman who has recently entered upon sheep farming in the west of Ireland on a large scale, that the small farmers in his neighbourhood regularly shear their lambs in August, and assign as their reason for this apparently barbarous practice, that hoggets so treated stand the winter better, and are more exempt from braxy and other diseases than those that are allowed to retain their lamb's wool. The limited experiments hitherto made by our informant and several graziers of his acquaintance, have so far confirmed the propriety of this strange treatment.

Live Stock. same as on high and exposed farms in the higher districts of Roxburghshire, Dumfriesshire, and Selkirkshire, as regards the ewe hirsels; the ewe lambs either not being weaned, or that only for eight or ten days, so that they may continue to follow their mothers. The wedder lambs are sent to the wedder-ground about the beginning of August, and herded on the part of it considered most adapted for their keep, till about the middle of October, when they are sent to turnips mostly in Ross-shire, where they remain till the middle of March or beginning of April. This is one of the heaviest items of expense in Highland farming, amounting to fully 4s. per head; and thus, upon a farm equally stocked with ewes and wedders, adds just about one-third to the rental of the farm. On the return of the wedder hogs, they are put to particular parts of the wedder ground, at large amongst the other ages of wedder stock, where they remain until drawn out when three years' old at the usual season to send to market; with this exception, that the year following (when they are dinmonts), the smallest of them, those that are not considered capable of wintering at home, say to the extent of two or three to the score, are again drawn out and sent with the hogs to turnips.

"Mr Sellar, in his Report of the County of Sutherland, gives a very minute and detailed account of the mode of management as practised on his farms. This, however, does not apply to extensive West Highland farms, which have no arable farms attached, no fields to bring in the diseased or falling-off part of the stock to, nor is it ever practicable to shift any part of the stock to different parts of the farm from that on which they have been reared."

The farms occupied by Cheviot sheep on the hills inclosing the valley of the Tweed and its tributaries, and many similar localities elsewhere, usually include a portion of arable land, which is chiefly valued for the opportunity which it affords of providing a supply of turnips on which the ewes and young sheep are partially fed for six weeks or so immediately preceding the lambing season. The practice is to admit the flock to the turnip fold for four or five hours daily, and then turn them off to some neighbouring piece of heather or rough ground. On such farms the pastures are more devoid of nourishing herbage of any kind during the months of February and March than even in midwinter. A daily feed of turnips at this season, when the sheep are in reduced condition from previous privation, is therefore invaluable. The sown grasses on such farms are usually made into hay, which supplies the flock with fodder during snow-storms. The aftermath is also of great service in aiding late lambs, and other weakly sheep. As the culture of grain crops on such elevated grounds is usually anything but remunerative, the farmer may actually be at more expense in growing turnips at home than if he were to board his flock for the same length of time in some low-country farm. He is compensated, however, by having his flock less disturbed, and better attended to than if they were sent from home.

It is not at all unusual for one farm to be stocked partly with Cheviots, and partly with blackfaced sheep. The lowest and grassiest grounds are assigned to the pure Cheviots, and if there are enclosed fields of tolerably good grass, a portion of the ewes—the oldest class—are taken to breed crosses from the Leicester ram. The medium grounds, consisting partly of rough herbage mixed with heather, and partly of higher portions producing heather alone, are stocked with blackfaced ewes which are crossed with Leicester rams, while, on the highest and bleakest parts, covered chiefly with heather, pure blackfaced sheep are bred.

We begin our description of the management of such flocks with autumn, and assume that the yearly cast of lambs and aged ewes has been disposed of, only so many of the ewe-lambs being retained as are required to keep up the breeding stock. A former practice was to keep these ewe-lambs or hoggets by themselves on the best portions of the respective walks, or *rakes* as they are called on the borders. Now, however, they are kept apart from their dams only so long (eight or ten days) as suffices to let the milk dry up; Live Stock. whereupon they are returned to the flock or *hirsel* to which they belong, and at once associate again, each with its own dam. The hoggets, under the guidance of the ewes, are thus led about over the ground, according to varying seasons, and under the promptings of an instinct which far surpasses the skill and care of the best shepherd. The latter, indeed, restricts his interference chiefly to keeping his flock upon their own beat, and allows them to distribute themselves over it according to their own choice. When thus left to themselves each little squad usually select their own ground, and may be found—the same individuals, about the same neighbourhood—day after day. This plan of grazing the hoggets and ewes together has been attended with the best results. There are far fewer deaths among the former than when kept separate, and being from the first used to the pasturage and acquainted with the ground, they get inured to its peculiarities, and grow up a healthy and shifty stock, more easily managed and better able to cope with trying seasons than if nursed elsewhere, and brought on to the ground at a more advanced age. Each hogget and its dam may be seen in couples all through the winter and spring, and with the return of summer it is a pretty sight to see these family groups grown into triplets by the addition to each of a little lamb. As the autumn advances, the flock-master makes his preparations for smearing or bathing. The smearing material is a salve composed of tar and butter, which is prepared in the following manner:—Six gallons of Archangel tar and 50 lb. of grease-butter are thoroughly incorporated, and as much milk added as makes the salve work freely. This quantity suffices for 100 sheep. This salve destroys vermin, and by matting the fleece is supposed to add to the comfort and healthiness of the sheep. It adds considerably to the weight of the fleece, but imparts to it an irremediable stain, which detracts seriously from its value per lb. A white salve introduced by Mr Ballantyne of Hollylee, is now in repute on the borders. It is prepared as follows:—30 lb. butter, 14 lb. rough turpentine, and 3 lb. soft soap are melted and mingled in a large pot; 2 lb. soda, and ½ lb. arsenic are then dissolved in a gallon of boiling water, and this along with 12 gallons more of cold water is intimately mixed with the other ingredients, and yields enough for dressing 100 sheep, at the rate of a quart to each. Some persons believing the arsenic an unsafe application, substitute for it the juice from 10 lb. of tobacco-paper. Instead of the rough turpentine, some also use half-a-gill of spirit of tar for each sheep; this ingredient being mixed in each quart-potful at the time of application.

In applying these salves, the sheep are brought to the homestead in daily detachments, according to the number of men employed, each man getting over about sixty in a day. A sheep being caught and laid upon a stool, the wool is parted in lines running from head to tail, and the tar salve spread upon the skin by taking a little upon the fingers and drawing them along. The white salve is kept in a semifluid state by occasionally placing the large kettle in which it is concocted upon a slow fire, or by adding as needed a small quantity of boiling water. Each shepherd has a boy assistant who pours the liquid salve from a tin pot with a spout, while he holds the wool apart. This white salve destroys vermin, and is believed to nourish the wool and to promote its growth. It does not, however, cause the fleece to adhere like the tar ointment; and hence, the better to defend the hoggets from wet and cold, some flock-masters after salving them put a piece of coarse woollen cloth over the back of each, and sew it to the fleece all round the edges with worsted thread. This "brat" as it is called prevents the wool from parting over the spine, and protects the animal from wet and cold far more effectually than smearing the fleece with tar-salve.

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Where the *bratting* plan has been adopted, the usual rate of mortality has been reduced, and the vigour of the flock increased. This salving and bratting must all be accomplished before the 20th November, about which time the rams are admitted to the flock. Before this is done another preliminary is required. As the ewe hoggets graze with the flock, it is necessary to guard them from receiving the male, for which purpose a piece of cloth is sewed firmly over their tails, and remains until the rams are withdrawn. This is called *breeking* them. On open hilly grounds about forty ewes are sufficient for each ram. To insure the vigour and good quality of the flock it is necessary to have a frequent change of blood. To secure this by purchasing the the whole rams required would be very costly, and therefore each flock-master endeavours to rear a home supply. For this purpose he purchases every autumn, often at a high price, one or two choice rams from some flock of known excellence, and to these he puts a lot of his best ewes carefully selected from his whole flock. These are kept in an enclosed field until the rutting season is over, and after receiving a distinctive mark are then returned to their respective hirsels. From the progeny of these selected ewes a sufficient number of the best male lambs are reserved to keep up the breeding stock of the farm. The rams are withdrawn from the flock about 1st January, and are then kept in an enclosed field where they receive a daily feed of turnips. Except in heavy falls of snow and intense frosts, the flocks subsist during the entire season on the natural produce of their pastures. It is necessary, however, to be provided for such emergencies both as regards food and shelter. For this purpose each shepherd has at suitable parts of his beat several *stells* or artificial shelters such as are described at p. 358, and beside each of them a stack of hay from which to fodder the flock when required. So long as the sheep can get at heather or rushes by scraping away the snow with their feet, they will not touch the hay, but when the whole surface gets buried and bound up, they are fain to take to it. The hay is laid out in handfuls over the snow, twice a-day, at the rate of 22 lb. to each score of sheep. Much vigilance, promptitude, and courage are required on the part of shepherds in these wild and stormy districts, in getting their flocks into places of safety on the breaking out of sudden snow-storms. Where turnips are grown they are reserved for spring use, and are given to the ewes as already mentioned, for a few weeks before the lambing season commences, so as to encourage a flow of milk. This indulgence is bestowed only upon the Cheviots; the hardier blackfaces not only not requiring this artificial aid, but in general doing better without it. If the supply of turnips is ample, the whole of the Cheviot ewes get a daily feed, but if this indulgence cannot be afforded to the whole flock, the shearling ewes and such older ones as are in poorer condition than the average of the flock are drawn out from the general hirsel, and receive the benefits of the succulent food for the full period named above; the older and stronger ewes being kept upon the hill until near the lambing time. This turnip fare not only benefits the flock while they receive it, but their usual pasture in the meantime gets clean, and freshens against their return to it, which takes place as soon as lambs begin to drop. The flock-master usually endeavours to store a portion of his turnip crop, and to retain it for daily distribution, in a convenient enclosure, to such of the flock as stand in need of such indulgence, after the flock at large have been replaced on their respective *rakes*. The lambing season is one of much anxiety to the master: and to his shepherds and their faithful sagacious dogs one of incessant toil. They must be a-foot from "dawn till dewy eve," visiting every part of their wide range several times a-day, to see that all is right, and to give assistance when required.

Lambing season.

The ewes of these hardy mountain breeds seldom require man's assistance in the act of parturition, but still cross-presentations and difficult cases occur even with them. Deaths occur also among the newly-dropt lambs, in which case the dam is brought home, and a twin lamb (of which there are usually enough to serve this purpose) put in the dead one's place. The dead lamb's skin is stript off, and wrapt about the living one, which is then shut up beside the dam in a small crib or *parik*, by which means she is usually induced in a few hours (and always the sooner the more milk she has) to adopt the supposititious lamb. As the lambing season draws to a close, each shepherd collects the unlambed ewes of his flock into an enclosure near his cottage, and examines them one by one to ascertain which are pregnant. To the barren ones he affixes a particular mark, and at once turns them again to the hill, but the others are retained close at hand until they lamb, by which means he can attend to them closely with comparatively little labour. The lambs are castrated and docked at from 10 to 20 days old. For this and for all sorting and drafting purposes an ample fold and suite of pens, formed of stout post and rail, is provided on some dry knoll convenient for each main division of the flock. To this the flock is gently gathered, and penned off in successive lots of 10 or 12, taking care that each lamb has its own dam with it before it is penned, and to do this with as little dogging and running as possible. The male lambs of the pure blackfaced breed when designed to be kept as wethers are not castrated until they are eight or ten weeks old, partly because when done sooner their horns have a tendency to get so crumpled as to grow into their eyes, and partly because a bold horn is thought to improve the appearance of an aged wether.

Shearing.

On these elevated sheep-walks, shearing does not take place until July. It cannot, in fact, be performed until the young wool has begun to grow or *rise*, and so admit of the shears working freely betwixt the skin and the old matted fleece. The sheep are previously washed by causing them to swim repeatedly across a pool with a gentle current flowing through it. They are made to plunge in from a bank raised either naturally or artificially, several feet above the surface of the water. This sousing and swimming in pure water cleanses the fleece far more effectually than could be supposed by persons accustomed only to the mode pursued in arable districts. Shearing takes place three or four days after washing, and in the interim much vigilance is required on the part of the shepherd to prevent the sheep from rubbing themselves under banks of moss or earth, and so undoing the washing. To diminish the labour to the shepherd, and disturbance to his flock, consequent on frequent gathering, each hirsel is if possible shorn in one day. For this end the shepherds from neighbouring farms assemble, and by turns assist each other. Abundance of good cheer is provided for them by the masters on such occasions, which are usually characterised by much hilarity and keen discussion of the merits of their respective flocks. Each man usually shears about sixty sheep a-day. It is neither practicable nor expedient to shear these mountain sheep so closely as the fat denizens of lowland pastures. At these great *clippings* each shearer is provided with a low-legged sparred stool, having a seat at one end, or with a bench built of green turf, which are arranged in a row close in front of a pen, in which the unshorn sheep are placed. The shearers being seated, each astride his stool or bench, with their backs to the pen, a man in it catches and hands over a sheep to each of them. The sheep is first laid on its back upon the stool, and the wool shorn from the under parts, after which its legs are bound together with a soft woollen cord, and the fleece removed first from the one side and then from the other, by a succession of cuts running from head to tail. The fleeces

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Weaning. Weaning takes place in August or early in September. A sufficient number of the best ewe lambs of the pure breeds are selected for maintaining the flock, and are treated in the way already noticed. With this exception, the whole of the lambs are sold either to low-country graziers, or as fat lambs to the butcher. The wedder lambs usually go to the former, and the ewe lambs of the cross betwixt blackfaced ewes and Leicester rams to the latter. These ewes, being excellent nurses, make their lambs very fat in favourable seasons, in which case they are worth more to kill as lambs than to rear.

Immediately after the weaning, the ewes which have attained mature age are disposed of generally to low-country graziers, who keep them for another year, and fatten lamb and dam. To facilitate the culling out of these full-aged ewes, each successive crop of ewe lambs receives a distinctive ear-mark, by which all of any one age in the flock can be at once recognised.

*Wool* is such an important part of the produce of our flocks, that it seems proper to offer a few remarks upon it before leaving this section. We here insert with much pleasure the following communication from John Barff, Esq. of Wakefield, with which we have been favoured:—

"I willingly give you a reply to your various inquiries regarding wool as far as I am able. As to the kinds grown in the various counties of the United Kingdom, this I cannot fully answer, as there are some counties' wools which have not come much under my inspection; but generally I may remark that wherever the turnip can be cultivated and has been introduced, the Leicester, Lincolnshire, Coteswold, and the half-breds from Down and Cheviot are to be found; and in the same counties, in several instances, you have several kinds, if we except Lincolnshire, and Leicestershire, which have entirely the long-wool sheep. The great bulk also of York, Warwick, Oxford, Cambridge, Gloucester, Northampton, and Nottingham shires, have this description of sheep, but they have also Downs and half-breds. Kent has its own sheep called Kents; the wool being much finer than the real longwool sheep, running in quality and weight of fleece between these latter and the Down, something like your half-breds from Cheviot ewes by Leicester rams. They have somewhat of a similar sheep in Devon, Cornwall, Hereford, and Shropshire, but the quality in the two former counties scarcely so fine as the two latter, or the Kent wools. Norfolk has the original Down and the half-bred; Surrey, Suffolk, Essex, Sussex, and Hampshire, are nearly all Down wools, though in these counties, upon some of their best lands, where they can cultivate the turnip, the half-bred are being introduced; and I need to you scarcely say, the Leicester sheep, as well as half-breds and Cheviots are to be found in Durham, Northumberland, Berwickshire, Roxburghshire, Lothians, and other parts of Scotland where the turnip is cultivated, and in those parts where it is not, and on the hills, the Cheviot and blackfaced prevail. The blackfaced are used for low padding cloths, carpets, and horse-rugs. The Down wools were formerly all used for cloths and flannels; but now from the improvement in worsted machinery, one-third is used for worsted yarns, and goods; and as the portion suitable for combing purposes is more valuable for this purpose than for cloths or flannels, the grower aims at getting it as deep-stapled as possible; and this has led to a great increase in the weight of the fleece, but at the same time a deterioration in the quality. The Leicester, Lincolnshire, half-bred, and Coteswold, as well as the Kents and Devons are entirely used for worsted yarns and goods; and a very small portion of the wools imported come in competition with them. The nearest approach is a little imported from Holland and Denmark; but they partake more of your cross from a blackfaced ewe by a Leicester ram. The Irish wools are either the longwoolled sheep, similar to the Leicester, the mountain sheep similar to your Cheviot, or the small Welsh sheep. The Irish wools are generally open haired, and have not the richness of the Leicester or our English; and are not so much esteemed or valuable as English wool of apparently the same quality by ½d. to 1d. per lb. Richness of handle is now very desirable, as there is a demand for what are called *glossy* yarns, which wools fed on pasture or good new seeds can only produce, and cannot be obtained from the wools grown on chalk or hard lands, such as our midland counties, viz., Oxford, Bedford, and Northampton generally produce.

"In every fleece of wool there are two or three qualities, not more than two or three in the blackfaced, four to five in the longwoolled sheep, five or six in the half-bred, and seven or eight in a Down fleece, and I may say every fleece undergoes this sorting or separation, before being put into any process of manufacture. Of course the more there is of the best quality in any fleece, the more desirable and valuable the fleece is; in blackfaced, to be free from dead hair or kemps; and we find in all the other wools, that the closer the staple and *purly* the wool, the more it yields of the finer qualities, whilst the open-haired makes more of the lower quality. The breeder should, therefore, in selecting his tups with a view to good wool, choose them with a close purly staple. A great deal of the excellence, however, of wool depends upon the nature of the soil on which the sheep are fed. Upon the chalk and sandy hard lands, we always find the worst qualities of wool of its kind, whilst the best comes from the rich good lands, where there is plenty of old grass or seeds. Thus the wools of Roxburghshire, as a general rule, are better than Berwickshire or Lothian; Leicester, Lincolnshire, Nottingham and Warwickshire, superior to Oxford, Cambridge, Bedford, or Northampton; and, in Downs Sussex and Surrey better than Essex and Norfolk, from their downs being more grassy and the land better. The principal quality required in wool is a rich soft handle, as such is always found to improve in every process it is put through in the various stages of its manufacture, whilst the wools grown on chalk or hard lands, and which have a hard bristly handle, get coarser as they progess in the manufacture.

"With regard to the salves or baths used for destroying vermin, we do not know what kinds are used in the different localities, but of those used with you we dislike the spirit of tar and tobacco. Wilson of Coldstream's dip appears to answer, and one called Ballantyne's used in Selkirkshire; but in all these a great deal depends upon their being properly attended to, and being put on at the proper season. If put on in the autumn, we don't perceive that they have been used, and whenever we have to make a complaint on this head, we find it arises from the baths having been used in spring."

To the above interesting information we add the following items from Mr Southey's valuable pamphlet:—

"The manufacture of wool, besides being our oldest branch of in-door industry, may justly be considered as characteristic of the British Isles, and it has now reached an amount, as well as acquired a degree of importance, by no means duly appreciated. It is also more generally diffused throughout the country, although it flourishes most in the West Riding of Yorkshire; but, at the same time, other English counties have a proportionate share, and in Scotland it equally forms a prominent feature in the industrial enterprise of the inhabitants. To meet the growing demand for a continuous supply, consequently requires a large, and indeed, as fashions go, a varied producing power, and this fortunately we possess within ourselves, without being dependent, as in reality we are for cotton, upon foreign sources.

"When the manufacture of woollens commenced among us, the chief reliance of the undertakers was upon home production, but being once fairly started, this supply was found to be beneath the actual requirements. Parties concerned were thus

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compelled to call in foreign aid, and among other expedients resorted to, we became a kind of tributary to Spain, whence in 1815 we imported 6,927,934 lb. of wool, besides 3,137,438 from Germany; but in 1849 our importations of the same article from Spain dwindled down to 127,559 lb., and in the interval we ourselves became extensive exporters of certain qualities to Germany; notwithstanding we thence still continue to receive some supplies of the most marketable kind. To illustrate this striking change in the sources of our external supply, I beg to subjoin the following comparative statement of wools, imported at a remote and recent period:—

| | 1815. lb. | 1849. lb. |
|---|---|---|
| "Spain | 6,927,934 | 127,559 |
| Germany | 3,137,438 | 12,750,011 |
| Other parts of Europe | 3,416,132 | 11,432,354 |
| South America | 45,838 | 6,014,525 |
| Cape of Good Hope | 23,363 | 5,377,495 |
| British India | ... | 4,182,853 |
| Australian Colonies | 73,171 | 35,879,171 |
| Other Parts | 10,291 | 1,004,679 |
| | 13,634,167 | 76,768,647 |

"In 1699 it was computed that there were twelve millions of sheep in England and Wales, valued besides the skin at 7s. 4d. each, and the wool yearly shorn, worth, at 3s. 4d. per fleece, L.2,000,000, at which amount our exportation of woollens was then rated. This subject was afterwards much neglected, nor had we any satisfactory elucidations upon it till Mr Luccock published his *Treatise on English Wools*, drawn up with great diligence and research, and at the time entitled to much respect, but owing to the want of materials, evidently defective in many of its parts.

"Mr Luccock estimated that the total produce of our flocks in 1800 was 384,000 packs of 240 lb. each, or 92,544,000 lb.; and Mr James Hubbard, an experienced and extensive woolstapler of Leeds, when the subject was before the memorable committee of the House of Lords, and a searching inquiry going on, satisfactorily demonstrated, that supposing Mr Luccock's estimate to have been tolerably correct at the time it was made in 1828, the period to which his own researches were immediately directed, our total production of wool could not be less than 463,169 packs, being only an increase of 20 per cent. and corresponding in the aggregate to 111,623,729 lb. Relying upon these data, and taking into account the high price which this commodity subsequently attained, as well as the greater weight of both fleece and carcase, thus yielding to the farmer more profit than at any former period, Mr M'Culloch, writing in 1846, came to the conclusion that the total production of wool, in the British Isles, was then not less than 540,000 packs, or 130,140,000 lb.

"Considering that these data, however respectable, did not afford any just conception, under our altered circumstances, either of the increased number of sheep among us, or the advantage gained through the additional weight of fleece, I addressed letters of inquiry upon these two points to some of our most eminent breeders in the kingdom, and at the same time caused others to be forwarded, and to the same effect, to every part of the country, by long-established staplers and practical men, who readily volunteered to join me in so useful and reasonable a research.

"From all the evidence before me, founded upon information gathered from authentic sources, two important facts result,—1*st*, That our flocks in England, Wales, and Scotland, have gradually increased within the last twenty years; and 2*d*, That the fleece throughout is materially improved in weight.

"As far as I can judge, we annually clip forty millions of sheep, while the fleeces of fifteen millions more, slaughtered, pass through the hands of fellmóngers to the consumer. Hence it would follow that we have the yearly fleeces of fifty-five millions of domestic sheep to work upon, averaging, it may be safely admitted, 5 lb. each. The basis of our manufactures, as far as regards home-grown wool, would thus be about 275,000,000 lb., which little more than confirms my Bradford correspondent's estimate, and to these are to be added seventy-seven millions of pounds more imported. From these two amounts are to be deducted,—1*st*, 4,000,000 lb. of British wool exported, and 2*d*, 12,500,000 lb. of Colonial re-exported, thus leaving the balance annually consumed in our looms and for domestic purposes at about 335,000,000 lb., or nearly one-half of the total amount of the cotton which we import,"[1]

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GOATS.

Goats never occupied an important place among the domesticated animals of the British Islands, and, with the exception of Ireland, their numbers have been constantly diminishing. By the statistical returns it appears that in 1849 there were 1,777,111 goats in Ireland, which in 1850 had increased to 1,876,096. This increase is said to be "entirely owing to the impoverished state of the country, which has obliged persons to sell their cows, and to replace them with goats, on whose milk they subsist instead of that of cows." The value of goat's milk, as a source of household economy, is much greater than is usually supposed. This is so well shown by Cuthbert W. Johnston, Esq., in the *Farmer's Magazine* for April 1852, that we shall quote from his article:

"The comfort derived by the inmates of a cottage from a regular supply of new milk, need hardly be dwelt upon. Every cottager's wife, over her tea, every poor parent of a family of children fed almost entirely on a vegetable diet, will agree with me, that it is above all things desirable to be able to have new milk as a variation to their daily food of bread and garden vegetables. The inhabitant of towns and of suburban districts, we all know, is at the mercy of the milk dealer; the milk he procures is rarely of the best quality, and under the most favourable circumstances he receives it with suspicion, and his family consume it with sundry misgivings as to its wholesomeness.

"Having personally experienced these difficulties, and having about three years since commenced the attempt to supply my family with goat's milk, and as our experience is cheering, I desire in this paper to advocate the claims of the milch goat to the attention of the cottager, and the other dwellers in the suburban and rural districts.

"Few persons are perhaps aware of the gentleness and playfulness of the female goat—how very cleanly are its habits, how readily it accommodates itself to any situation in which it is placed. Confined in an outhouse, turned on to a common or into a yard, tethered on a grass plat, it seems equally content. I have found it readily accommodate itself to the tethering system, fastened by a leathern collar, rope, and iron swivel, secured by a staple to a heavy log of wood. The log is the best (and this with a smooth even surface at the bottom), because it can be readily moved about from one part of the grass plat to another. The goat too uses the log as a resting place in damp weather. The goat should be furnished with a dry sleeping place, and this, in case of its inhabiting open yards, can bo readily furnished; any thing that will serve for a dry dog-kennel will be comfortable enough for a goat.

"The milk of the goat is only distinguishable from that of the cow by its superior richness, approaching, in fact, the thin cream of cow's milk in quality. The cream of goat's milk, it is true, separates from the milk with great tardiness, and never so completely as in the case of cow's milk. This, however, is of little consequence, since the superior richness of goat's milk renders the use of its cream almost needless. The comparative analysis of the milk of the cow and goat will show my readers how much richer the latter is than that of the former; 100 parts of each, according to M. Regnault, gave on an average,—

| | Cow. | Goat. |
|---|---|---|
| "Water | 84·7 | 82·6 |
| Butter | 4·0 | 4·5 |
| Sugar of milk and soluable salts | 5·0 | 4·5 |
| Caseine (cheese), albumen, and insoluble salts | 3·6 | 9·0 |

[1] *The Rise, Progress, and Present State of Colonial Sheep and Wools*, by Thomas Southey. London, 1850.

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"So that, while the milk of the cow yields 12·6 per cent. of solid matters, that of the goat produces 17·10 per cent, goat's milk yielding rather more butter, rather less sugar of milk, but considerably more caseine (cheese) than that of the cow.

"It must not be supposed that the *taste* of the milk of the goat differs in any degree from that of the cow; it is, if anything, sweeter, but it is quite devoid of any taste which might very reasonably be supposed to be derivable from the high-flavoured shrubs and herbs upon which the animal delights to browse.

"The amount of the milk yielded by the goat varies from two quarts to one quart per day; it is greatest soon after kidding time, and this gradually decreases to about a pint per day,—a quantity which will continue for twelve months. This is not a large supply, it is true; but still it is one which is available for many very useful purposes; and, be it remembered, that when mixed with more than its own bulk of lukewarm water, it is then, in every respect superior to the milk supplied by the London dairymen.

"In regard to the best variety of goat to be kept, I would recommend the smooth-haired kind, which are quite devoid of beards or long hair. In this opinion I am confirmed by an experienced correspondent, Mr W. H. Place of Hound House near Guildford, who remarked, in a recent obliging communication,—'I found that the short-haired goats with very little beards were the best milkers; but from these I seldom had more than four pints a-day at the best (I should say three pints were the average), and this quantity decreases as the time for kidding approaches (the goat carries her young 21 to 22 weeks). They should not be fed too well near the time of kidding, or you will lose the kids. In winter I gave them hay, together with mangel-wurzel, globe, and Swedish turnips, carrots, and sometimes a few oats, and these kept up their milk as well as anything, but of course it was most abundant when they could get fresh grass. The milk I always found excellent, but I never had a sufficient quantity to induce me to attempt making butter except once, as an experiment: my cook then made a little, which was easily done in a little box-churn; the butter proved very good. I found the flesh of the kids very tender and delicate.'

"I can add little to Mr Place's information as to their food; mine have generally fed out of the same rack as a Shetland pony, with whom they are on excellent terms. The pony throughout the summer is soiled with cut-grass, and I notice that the goats pick out the sorrel, sow thistle, and all those weeds which the pony rejects.

"In the garden (if they are, by any chance, allowed to browse), I notice that they select the rose-trees, common laurels, arbutus, laurestinas, and the laburnum. Of culinary vegetables they prefer cabbages and lettuces; they also bite pieces out of the tubers of the potato. They carefully pick up the leaves, whether green or autumnal, of timber trees; of these they prefer those of the oak and elm, and delight in acorns and oak-apples. We are accustomed to collect and store the acorns for them against winter; spreading the acorns thinly on a dry floor, to avoid the mouldiness which follows the sweating of acorns laid in a heap. As I have before remarked, none of these astringent substances affect the taste of their milk; and I may here observe, that with ordinary gentleness, there is no more difficulty, if so much, in milking a goat than a cow.

"The he-goat engenders at a year old. The she-goat can produce when seven months old. She generally yeans two kids. The manure of the goat is perhaps the most powerful of all our domestic animals.

"Such are the chief facts which I have deemed likely to be useful in inducing the extended keeping of the milch-goat. It is an animal that, I feel well assured, may be kept with equal advantage by the cottager and the dwellers in larger houses. It is useless to compare it with the cow, or to suppose that the goat can supplant it in situations where the cow can be readily kept; but in the absence of pastures, and in places where there is too little food for cows, I feel well convinced that, with ordinary care and attention, and a moderate firmness in overcoming the prejudices of those unaccustomed to the goat (and without these are found in the owner, live stock never are profitable), the value and the comfort of a milch-goat are much greater than is commonly known.

"The waste produce of a garden is exceedingly useful in the keep of a goat. By them almost every refuse weed, all the cuttings and clearings which are wheeled into the rubbish yard, are carefully picked over and consumed. To them the trimmings of laurels and other evergreens, pea-haulm, and cabbage stalks, &c. are all grateful variations of their food. In winter a little sainfoin, hay, or a few oats, keeps them in excellent condition. In summer, the mowings of a small grass-plot, watered with either common or sewage water, as described in the following little account, will, with the aid of the refuse garden produce, keep a goat from the end of April until October."

HOGS.

Although occupying a less prominent place in the estimation of the farmer than the ox and sheep, the hog is nevertheless an animal of great value. He is easily reared, comes rapidly to maturity, is not very nice as to food, consuming offal of all kinds, and yields a larger amount of flesh in proportion to his live weight, and to the food which he has consumed than any other of our domesticated animals whose flesh is used for food. To the peasantry he is invaluable, enabling the labouring man to turn the scraps even from his scanty kitchen, and from his garden or allotment to the best account. On such fare, aided by a little barley or pollard, he can fatten a good pig, and supply his family with wholesome animal food at the cheapest possible rate. The breeds of swine in Great Britain are numerous, and so exceedingly blended that it is often impossible to discriminate or classify them properly. The original breeds of the country seem to be two, viz. "The old English hog," tall, gaunt, very long in the body, with pendant ears and a thick covering of bristles. The representatives of this old breed are found chiefly in the western counties of England, especially in Lancashire, Yorkshire, and Cheshire, where hogs of immense size are still reared, but greatly improved as compared with their ancestry. Their bones are smaller, their hair finer and thinner set, their skin thinner and with a pink tint, the ears still pendulous but much thinner, the carcase much thicker, and their propensity to fatten greatly increased. This large breed is exceedingly prolific, and the sows are excellent nurses, it being quite common for them to farrow and rear from 12 to 18 pigs at each litter. They are somewhat tardy in arriving at maturity, and do not fatten readily until that is the case. After sixteen months old, they, however, lay on flesh very rapidly, grow to very great weights, and produce hams of excellent quality, with a large proportion of lean flesh in them. The Berkshire and Hampshire hogs seem originally to have been from the same stock, but by some early cross acquired the thicker carcase, prick-ears, shorter limbs, and earlier maturity of growth, by which they are characterised. The other native breed is found in the Highlands and Islands of Scotland. They are very small, of a dusky brown colour, with coarse bristles along the spine, and prick-ears. They are exceedingly hardy and subsist on the poorest fare, being often left to range about without shelter, and support themselves as they best can on the roots of plants, shell-fish, seaweed, and dead fish cast up by the tide.

The improved breeds now so abundant have been obtained by crossing these old races with foreign hogs, and chiefly with the Chinese and Neapolitan. Our modern white breeds, with prick-ears, short limbs, fine bone, delicate white flesh, and remarkable propensity to fatten at an early age, are indebted for these qualities to the Chinese stocks. The improved black breeds, of which the Essex may be selected as the type, and which possess the qualities just enumerated in even a greater degree, are a cross from the Neapolitan. They are characterised by their very small muzzle, fine bone, black colour, and soft skin nearly destitute of hair. They can be brought to profitable maturity at from eight to twelve months old, the white breeds at from twelve to sixteen months. Both kinds are peculiarly suitable for producing small pork to be used fresh, or for pickling. The flesh of these smaller

Live Stock.

breeds produces, however, excellent bacon when used in that manner, and at less cost than that of the larger breeds, for this reason, that it is only from the flesh of a hog that has reached maturity that bacon of the first quality can be produced; and as these have reached that point at an age when the others are but ready for beginning the fattening process, it follows that the carcase of the former, in a state fit for curing, is produced at less cost than that of the latter. Sows of the Neapolitan breed and its crosses are better mothers and nurses than the Chinese. Both kinds require peculiar care, to prevent the pregnant sow from becoming hurtfully fat. Unless kept on poor and scanty fare they inevitably become useless for the purpose of breeding. The Berkshire hog combines the good qualities of the larger and smaller breeds already referred to so happily, that he deservedly enjoys the reputation of being as profitable a sort for the farmer as can be found. With proper treatment he arrives at maturity about sixteen months old, yields a good weight of carcase for the food which he has consumed, and his flesh is well adapted for being used either as fresh meat, pickled pork or bacon, according to the age at which he is slaughtered. A very profitable hog is also obtained by coupling sows of the larger breeds with males of some of the smaller *races*.

It too frequently happens that less care is bestowed on the breeding of pigs than of the other domesticated animals. From the early age at which they begin to breed, there is need for constant change of the male, to prevent the intermingling of blood too near akin. These animals, too, are exceedingly sensitive to cold, and often suffer much from the want of comfortable quarters. Whether for fattening hogs, or sows with young pigs, there is no better plan than to lodge them in a roomy house with a somewhat lofty *thatched* roof, the floor being carefully paved with stone or brick, and the area partitioned off into separate pens, each furnished with a cast-iron feeding-trough at the side next the dividing alley, and with adequate drainage, so that the litter in them may be always dry. The period of gestation with the sow is sixteen weeks, and as her pigs may be weaned with safety at six weeks old, she usually farrows twice in the year. In this climate it is desirable that her accouchement should never occur in the winter months. It is a common arrangement to have a pig-shed so placed that the store pigs lodged in it can have access to the cattle-courts, where they grub amongst the litter, and pick up scattered grains that have escaped the thrashing-mill, and fragments of turnips and other food dropped by the cattle. On such pickings, and the wash and offal from the farm kitchen, aided by a few raw potatoes, Swedes, or mangel, and in summer by green vetches, a moderate number of store pigs can be got into forward condition, and afterwards fattened very quickly, by putting them into pens and improving their fare. There is no cheaper way of fattening hogs than by feeding them on boiled or steamed potatoes, mashed and mixed with a portion of barley or pease meal. When barley-meal alone is used, it should be mixed with cold water, and allowed to soak for twelve hours before being given to the hogs. A few morsels of coal should be frequently thrown into their troughs. These are eaten with evident relish, and conduce to the health of the animals.

An interesting account of the most approved methods of cutting up, curing, and disposing of carcases of pork, is given in the *Journal of the Royal Agricultural Society*, vol. xi. p. 585.

### RABBITS.

It has been usual, in agricultural works, to take some notice of rabbits. We have so often witnessed the destruction of crops, and consequent vexation and quarrels caused by these creatures, that we regard them only as noxious vermin. It may be true that there are, in various parts of the country, tracts of sand so barren that it is more profitable to stock them with rabbits than anything else. Those who choose, whether for pleasure or profit, to keep such stock, ought, however, to be compelled to restrain them within the hutch or warren; for certainly they are intolerable anywhere else. A more useful and manageable class of live-stock claims our attention, viz.

### POULTRY,

which we consider worthy of more attention than farmers generally bestow upon it. There are, indeed, few farm-yards untenanted by fowls of some sort, and few homesteads without a place called a poultry-house. It is rare, however, to meet with an instance where the breeding and management of poultry is conducted with the care and intelligence so frequently bestowed on other kinds of live stock. Now, if poultry is kept at all, whether for pleasure or profit, it is surely worth while to use rational means for securing the object in view. To have good fowls, it is necessary to provide a dry, warm, well-ventilated house, in which they may roost and deposit their eggs. This house must be kept clean, and its tenants regularly supplied with abundance of suitable food. Constant and careful attention is also absolutely indispensable. On farms of the lesser sort, this duty is usually undertaken by the farmer's wife or daughters. It will, however, in most cases, be better to entrust the entire charge of the poultry to some elderly female-servant, who shall give her undivided attention to it. As unremitting attention and trustworthiness are the qualities chiefly required in a henwife, and the actual work connected with the office is not very heavy, it affords a fitting opportunity for pensioning a faithful domestic, or the widow of some esteemed farm-labourer, who is getting too old for heavier labour.

The kinds of poultry most suitable for a farm-yard are the common fowl, geese, and ducks. Turkeys and guinea-fowl are difficult to rear, troublesome to manage, and less profitable than the other sorts. Of the common fowl there are now many excellent and distinct breeds. The *Cochin-China* or *Shanghae* is the largest breed we have. They are hardy and very docile; their flesh is of good quality; their eggs, of a buff colour, are comparatively small, but excellent in flavour, and are produced in great abundance. The hens resume laying very soon after hatching a brood; sometimes so soon as three weeks. They are the more valuable from the circumstance that their principal laying season is from October to March, when other fowls are usually unproductive. The *Dorkings*, of which there are several varieties, as the speckled, the silver, and the white, are not excelled by any breed for general usefulness. The hens are peculiarly noted for their fidelity in brooding, and their care of their young. The *Spanish fowls* are very handsome in their plumage and form, have very white and excellent flesh, and lay larger eggs than any other breed. The *Polish* and *Dutch every-day layers*, are peculiarly suitable where eggs rather than chickens are desired; as the hens of both these breeds continue to lay for a long time before showing any desire to brood.

A competent authority recommends that, except in situations where 2s. can be got for a good chicken, the return should be sought for chiefly in eggs. He gives the following statement of the cost and produce of a given number of fowls:—

"The following is the weekly consumption of food, and the average produce of eggs of four hens of the Dutch every-day laying variety:—

| | s. | d. |
|---|---|---|
| 1·4 gallons of barley, at 20s. per quarter ....... | 0 | 6 |
| 26 eggs, at 1s. per score............................ | 1 | 3½ |
| Profit | 0 | 9½ |

being upwards of 150 per cent. The consumption of food in this case is very great, being upwards of 1½d. each per week. We are at present trying experiments with the Spanish breed. We find that three hens and a cock consume in a week—

| | |
|---|---|
| ½ gallon of oats, at 14s. per quarter ............ | 1·3125 |
| ½ stone of barley-meal, at 8d. per stone ....... | 4· |
| | 5·3125 |

or rather more than 1¼d. each per week. If the fowls had a free range, we would calculate on keeping them on one-fourth of this amount."[1]

A suitable stock of fowls being selected, pains must be taken to preserve their health and other good qualities by breeding only from the best of both sexes, and these not too near akin. A very simple plan for securing this is to select a cock, and not more than six or eight hens, of the best that can be got, to entrust these to the care of some neighbouring cottager, whose dwelling is sufficiently apart to prevent intercourse with other fowls, and then to use only the eggs from these selected fowls for the general hatching. There are many advantages in such a course. The whole stock of fowls can thus be had of uniform character, and superior quality. If it suit the fancy or object of the owner, his fowls may be of several distinct breeds without any risk of their intermingling; the select breeding stocks can be kept up by merely changing the cock every second year, and not more than one cock to thirty hens need be kept for the general stock, as it is of no consequence whether their eggs are impregnated or no. Besides having the run of the barn-door, cattle courts, and stack-yard, fowls are greatly benefited by having free access to a pasture or roomy grass-plot. If the latter is interspersed with evergreen shrubs, so much the better, as fowls delight to bask under the sunny side of a bush, besides seeking shelter under it from sudden rain. Their court should also be at all times provided with clean water, and a heap of dry sand or coal-ashes, in which they wallow, and free themselves from vermin. To keep them in profitable condition, they require, besides scraps from the kitchen, and refuse of garden stuffs, &c., a daily feed of barley or oats at the rate of a fistful to every three or four fowls. In cold weather, they are the better of having some warm boiled potatoes thrown down to them, as also chopped liver or scraps of animal food of any kind. There is an advantage in having the poultry-house adjoining to that in which cattle-food is cooked in winter, as, by carrying the flue of the furnace up the partition-wall, the fowls get the benefit of the warmth thus imparted to their roosting-place. Saw-dust, dried peat, or burnt clay, are suitable materials for littering poultry-houses, and are preferable to straw. By strewing the floor with such substances two or three times a week, each time carefully removing the previous application, and storing it with the mingled droppings of the fowls *under cover*, a manure little inferior to the best guano can be secured. When 100 common fowls, a score of geese, and a dozen or two of ducks, are kept, the quantity and value of the manure produced by them, if kept by itself and secured from the weather, will surprise those who have not made trial of such a plan.

Within the past two or three years, the breeding of poultry has in various parts of the kingdom become quite a passion. Not only have many separate treatises been published entirely devoted to this subject, but every agricultural periodical now bears evidence to the popularity of this pursuit. Our national agricultural societies, and many of the provincial ones, now offer numerous and liberal prizes to poultry. It is in connection with these shows that the public have been made aware of the extraordinary enthusiasm with which a numerous portion of the community have engaged in poultry-breeding. At the Birmingham show, held in December 1852, no less than 1200 pens of poultry were exhibited. A pen of Spanish fowls, consisting of a cock and four hens, was claimed by a purchaser, although the reserve price put upon it by the owner was fifty guineas. For a single Cochin China cock L.25 was refused. But the importance of the show is best shown by the receipts in money, which were—

| | | | |
|---|---|---|---|
| For admission of visitors............ | L.1842 | 19 | 0 |
| Sale of catalogues...................... | 279 | 4 | 0 |
| Do. of poultry ........................ | 1636 | 15 | 6 |
| | L.3758 | 18 | 6 |

Similar results occurred in connection with the more recent metropolitan show, when 695 pens of poultry were brought forward. On the first day of exhibition, each visitor was charged 5s., and yet, at this rate, several hundreds sought admission. Next day, at 1s. each, there were upwards of 5000 visitors, a greater number the following day; and on the fourth and last day of the show, they reached nearly to 12,000. The prize Cochin China cock and hen were sold for forty-seven guineas; a hen and pullet of the same breed brought eighteen guineas each; another pair twenty-five guineas; a pen of Poland fowls twelve guineas; and several pens of Aylesbury ducks from L.10 to L.14. The whole sales on this occasion realised upwards of L.1000. It is known that even these extraordinary prices have since been exceeded; a prize Cochin China cock having actually been sold for L.100. Not a few farmers who were fortunate in early securing good specimens of the popular breeds of poultry, have found the breeding of them more remunerative than that of bullocks. This will, of course, last only until the present poultry-mania abates; but, in the mean time, greatly improved breeds of this interesting and useful kind of live stock have been diffused over the country; more judicious modes of treating them than were formerly practised have been made known, and our markets will henceforward be more fully supplied with eggs and fowls of superior quality.

*Treatment of Live Stock under Disease.*—Time was when every such treatise as the present was expected to contain a description of the diseases to which the domesticated animals are most subject, and instructions for their treatment under them. But now that farriery is discarded, and veterinary medicine is taught in colleges, the handling of such a subject is obviously beyond the province of a practical farmer. A few general observations is all therefore that we offer regarding it. The province of the stock-master obviously is to study how to prevent disease, rather than how to cure it. For this end let him exercise the utmost care, first, in selecting sound and vigorous animals of their respective kinds, and then in avoiding those errors in feeding and general treatment, which are the most frequent causes of disease. When cases of serious disease occur, let the best professional aid that is available be instantly resorted to; but in all those cases which farmers usually consider themselves competent to treat, we advise that they should trust rather to good nursing, and to the healing power of nature, than to that indiscriminate bleeding and purging which is so commonly resorted to, and which, in the majority of cases, does harm instead of good. Those farmers who have the most implicit faith in their phlemes and physic balls, must admit that their treatment often fails, and that even when their patients do recover, they appear to have suffered more from the depletion than from the disease. We have proved this system fully, and know but too well its pernicious effects.

[1] *Essay on the Rearing and Management of Poultry*, by William Trotter; in Royal Agricultural Society's Journal, vol. xii. p. 198.

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We are glad, therefore, to be able to direct the attention of the owners of live stock to a safer and better one. Five years ago, at the urgent recommendation of a friend, we obtained a copy of Gunther's *Manual of Homœopathic Veterinary Medicine*, and a supply of the medicines there prescribed. Ever since doing so, we have relied upon this system alone, in treating such cases of disease as have occurred amongst our live stock. These have been both numerous and varied, including not a few of pleuro-pneumonia in cattle; and the success has exceeded our most sanguine expectations. We shall not attempt to discuss the merits of a system of medicine, which is at present so keenly controverted by members of the medical profession. We have simply to state, that we have had ample proof in our personal experience of the power of minute (but appreciable) doses of a variety of medicines, *when administered on the principle, that "like cures like,"* to arrest and cure disease in the lower animals; and we earnestly recommend to veterinary surgeons, and to the owners of live stock, to give this system a full and impartial trial.

## CHAPTER XIII.

### WASTE LANDS.

Notwithstanding the great progress which agriculture has made, and the immense amount of capital, energy, and skill, which for generations have been brought to bear upon the improvement of our soil, there are still large portions of the surface of our country lying in their natural state, and usually classed under the head of *Waste lands*, in contradistinction to those which are under tillage, or have at some time been subjected to the plough. Of this (so called) waste land, but a limited portion is absolutely unproductive. Much of it is capable of being converted into arable land, and doubtless will in course of time be so dealt with, but, in the mean time, this class of waste lands, and very much more that will never be tilled, is of great and steadily increasing value as sheep walks. Even for this purpose most of it is susceptible of great improvement, and would well repay for it. These lands are comprised under the following descriptions; 1*st*, Those hilly and mountainous parts of Great Britain which, from their steep and rugged surface and ungenial climate, are unfit for tillage; 2*d*, Those which lie uncultivated owing to natural poverty of soil, its wetness, or the degree to which it is encumbered with stones; 3*d*, Bogs and mosses; 4*th*, Lands so near the sea-level as to be more or less liable to be submerged; and 5*th*, Blowing sands.

High lying sheep pastures.

The lands referred to under the first of these heads are of very great extent, embracing the whole of the mountainous parts of Scotland and Wales, and much of the high grounds in the north of England and south of Scotland. These high grounds afford pasturage for innumerable flocks of sheep of our valuable mountain breeds. The business of sheep-farming has received a great stimulus of late years from the ever-growing demand for sheep to consume the green crops of arable districts. These upland sheep-walks are accordingly rising in value, and their improvement is becoming every day of increasing importance. The improvement of these hill grazings embraces these leading features, viz. drainage, shelter, and enclosure.

Drainage.

Until of late years our hill flocks were peculiarly liable to rot and other diseases arising from the presence of stagnant and flood water upon their pastures. Many grazings that had at one time an evil reputation on this account now yield sound and healthy sheep, solely from the care with which they have been drained. To guard against the pernicious effects of flooding, the courses of brooks and runnels which in heavy rains overflow their grassy margins, are straightened, deepened, and widened, to such an extent as is required to carry off all flood water without allowing it to overflow. Some grounds are naturally so dry, that this is all that is required to render them safe. But, in general, the slopes and hollows of hilly grounds abound with springs, and deposits of peat, and with flats on which water stagnates after rain. On well-managed grounds such places are covered with a network of open drains or shallow ditches, about 30 inches wide at top, and half as many deep, by which superfluous water is rapidly carried off. The cutting of these drains cost from 6s. to 8s. per 100 roods (of six yards each). In pastoral districts there are labourers who are skilled in this kind of work, and to whom the laying out of the lines is frequently entrusted, as well as the execution of the work. Where the ground slopes considerably, they are careful to avoid a run directly down the declivity, as a strong current of water in such circumstances gutters the bottom of the drain, and chokes those below with the debris thus produced. In cutting these drains, two men work together. After ripping the turf on either side at the proper width, one man, by means of a large triangular spade, nearly of the same width and depth as the drain, and having a cross handle to the shaft, which he grasps with both hands, cuts out, sod after sod, by first striking it down to the full depth, and then using it as a lever, while his assistant pulls out the pieces by striking a dung-drag into them, and deposits them in a regular row, green side uppermost, along one side of the drain. The bottom is afterwards cut even and shovelled out. When such drains have been properly made, it is necessary to have them statedly overhauled and kept in good order.

Shelter.

Next in importance to drainage is good and sufficient shelter. This, in the absence of natural coppices of birch or hazel, is provided by means of clumps and belts of fir plantation. These should always be of such extent that the trees may shelter each other as well as the sheep. Trees planted in a mass always shoot up faster than in narrow strips, and restrain the snow-drift which passes through the latter. A shepherd who knows the ground well should always be consulted about the sites of such plantations. The conditions requisite are, that the soil be such as trees will grow in; that it be so far removed from any brook, ravine, or bog, as to be accessible to the flock from all sides; that there be rough herbage, such as heather, gorse, or rushes near at hand, which the sheep may be able to get at in deep snow; that it be contiguous to the sheep-walk; and placed so as to afford defence against the most prevalent winds. A less costly shelter is formed by building what are called *stells*, which consist of a simple dry-stone wall, enclosing a circular space, twenty yards or so in diameter, with an opening on one side; or forming a cross, in one angle of which the sheep find shelter from whatever point the wind blows. A haystack is a necessary adjunct to such defences.

Enclosure by march fences.

It is a further point of importance to have such grazings surrounded with a ring fence, consisting either of dry-stone walls, turf walls with wire a-top, or a simple wire fence. This prevents trespass; and the sheep having freedom to range, without watching, up to the boundary, more of them can be kept on the ground than when they are ever and anon turned back by the shepherd. These needful and inexpensive improvements are now generally attended to over the wide pastoral districts of the Scottish border counties. In the remote Highlands they are still much neglected. There are few agricultural improvements which yield so quick and certain a return as these.

Reclaiming of muiry soil.

The improvement of the second class of these unreclaimed lands is now much facilitated by the readiness with which portable manures can be obtained for them. Draining and enclosing here necessarily demand the first attention. In some cases the land is so encumbered with stones,

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that careful trenching of the whole surface is the only way of getting rid of them. In Aberdeenshire, many thousands of acres, formerly useless, have been converted into valuable arable land by this means.

In nearly all parts of the country, there are extensive tracts of this muiry soil producing only a scanty and coarse herbage, which are susceptible of remunerative improvement. We are happy at being able to submit to the reader the following detailed account of a recent and successful instance of this, which has been kindly furnished to us by George A. Grey, Esq. of Millfield Hill, Northumberland.

THE RESULT OF PARING AND BURNING MOORLANDS.

Paring and burning.

"It is said that 'necessity is the mother of invention.' I was told by some of my friends that I had given too high a price for this estate, and that it would be a dearer farm to me now than when I rented it from Lord Grey. To overcome this opinion or fact, I thought of several plans of making it more remunerative, and decided on that which I am now about to describe,—

"On the high part of the farm, at an elevation of from 400 to 500 feet above the sea, I had upwards of 100 acres of moorland of a poor description, which had never been under plough. This consisted of short heath, bilberry bushes, and dry white bent grass, and a soft dry deep moss, delightful as a Turkey carpet under foot, and excellent excursive ground for old hunters, with a small portion of spratty grass and rushes in the damp hollows. The soil is of a free turnip and barley loam on the rotten whinstone. By planting on the west side, and in some places suitable for shelter, I reduced the quantity to about 100 acres. This I divided into three fields of about 33 acres each.

"My great dread was the length of time which such a rough dry surface would require to decompose sufficiently to allow of cultivation, having seen heathery moors in many parts of Scotland lying for two, three, and four years before crops could be obtained, owing to the great cover of coarse vegetation preventing the furrow from lying over, and keeping the land so open and dry through summer that if a *braird* of corn or green crop was obtained, it would wither away in dry weather.

"I had heard of paring and burning, but knew nothing of the process. I, however, obtained the necessary information very much from Mr Langlands of Bewick, who had practised it to a considerable extent. With what I saw there I was so much pleased, that I determined to proceed at once.

"I also saw Mr Langlands' work done by a paring-plough, such as is used in the south of England, with a wide plate to cut a furrow of 10 or 12 inches in width. On the point of this is an upright piece of steel which cuts and divides the heath,—the mould-board turns the furrow over flat on its back, and from end to end of the landing the furrows lay side by side like planks from a saw-mill, and were about half an inch in thickness.

"I must, however, remark, as a caution to others against falling into the same error as I did, that this land had been in tillage at some former time, and was in ridges with a regular surface, so that when the plough was *set*, it cut the whole furrow at a uniform depth, and was drawn by two horses with ease, and at an expense of about eight shillings per acre.

"I got this plough and gave it a fair trial, but from my land never having been laid smooth, it cut one part as thin as was wished, and the next yard, perhaps, six or twelve inches thick, which caused a great extra expense in drying, lifting, and burning, and wasted more soil than was necessary or desirable. Also my land having a great deal of small whinstone below the turf, the steel plate frequently got injured and broken. It was therefore with great reluctance laid aside, and the ordinary method of paring by hand adopted, which is slower and much more expensive, but very perfect. It saves soil, and cheapens the burning operation, the paring being so thin when the heath, &c. was divided, that light could be seen through the sod, which was only held together by the roots and fibres.

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"I began to No. 1 field in July 1849. I let the paring and burning to a company at 25s. per acre, but they made low wages, and after getting more than their work came to, gave up the job. I then got some experienced hands to pare, and paid them the usual wages at that time, 9s. per week, and gave them their food, say 13s. per week, the work being very hard. The total cost of this averaged me 24s. 9d. per acre. A portion of the top part of No. 1 was left undone owing to the lateness of the season. This was dry benty turf. It was ploughed in the common way and grew no oats in 1850. It was again ploughed and much harrowed and rolled, and sown with the remainder of the field in 1851 with rape, and has grown only a few plants at wide distances. It is still in such a dry undecomposed state, that although it is on the high part of the field where sheep draw to lie, I do not expect that it will grow a crop of corn next year; while a portion which was pared down the middle of it grew good corn and rape.

"A portion of No. 2 field was also ploughed in the ordinary way. This was moist land, growing shorter and sweeter grass than any other. It grew a very thin irregular crop of oats in 1850, not within four bolls per acre of the pared land, but is now (1851) bearing a good crop of oats, that field being a second time in oat crop. To return:

"I had a fair crop of rape in the autumn of 1849 on a considerable portion of No. 1, where it was sown in tolerable season during all August, after that it appeared to be too late. All was, however, ploughed up at once to secure the ashes, and was well harrowed and sown with oats in the spring of 1850. The pared land turned out to be much too thickly sown at four bushels per acre. Corn tillers so much on such land, that in some parts it prevented it from coming to maturity. I have since sown much thinner, say three bushels per acre, and even in some degree I find the same fault, there being from five to eight stems from one root. My crop of 1850 turned out to be 30 bushels per acre, but it was on the point of being cut when the high wind in August devastated this district, and that lying high and fully exposed to the wind, suffered most severely. I should say it was not below six quarters per acre, and the quality of the grain good.

"In June and July 1850, I pared No. 3 by the same hands who finished my work the previous year. I let the burning of it to an Irishman at 2s. 6d. per acre, binding him to burn it closely piled up in good-sized heaps like hay-cocks to prevent the escape of the ashes in the shape of smoke into the atmosphere.

"This, with the paring, cost me on 36 acres 19s. 6d. per acre. I got 20 acres of it ploughed and sown with white turnips, broadcast in July and August. I had a close nice crop, though the roots were small, which kept a large flock of sheep for several weeks. This had the good effect of treading down the land and making it plough up better for oats.

"Nos. 1 and 2 were limed at the rate of 7 loads per acre. In June 1851, No. 1 was sown broadcast with rape, by mixing 4 lb. of rape-seed with one bushel of oat shellings for an acre, and sowing them out of a grass-seed machine. The crop is very close and fine, and has kept twenty scores of sheep from an early day in August to this date (September 27th).

"No. 2 in 1851 was again sown with oats, which are a very fine crop, as is also No. 3. My men think them nine quarters per acre. They are very thick and tall, and have very long

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large heads; and the grain is plump and good, the stalks being strong, the crop is not lodged so as to injure the yield. I estimate it at certainly 7½ quarters per acre, but shall calculate it at 6 quarters.

"I sow on that land the sandy oat, being early, not liable to lodge nor to shake in moderately high winds, although it was not proof against that of 1850.

"Previously to breaking up, I drained with pipes all the land which required drying, of which I shall give a statement, along with the expenses and profits of the whole.

"The result shows, that if I had some years ago, when prices of grain were good, done as *a tenant* what I have done now, I should have been amply repaid by the first or second crops, and have had my farm for the remainder of a twenty-one years' lease worth fully L.100 a-year more than when I began.

"The result of my experience is, that I neither agree with the generality of Scotchmen nor with many Southerns; the former of whom are of opinion that burning wastes the vegetable matter, which should be kept to decompose and enrich the soil, not considering that at once the land receives a rich dressing of ashes quite equal to two quarters of bones, or 4 or 5 cwt. of the best guano; and that, during the several years which such a slow process would require to take place, the land might be much more enriched by growing, and having eaten upon it fine crops of rape and turnip, and by producing heavy corn crops which would in a much shorter space be returned to it in the shape of manure, and also that, by the process of burning, the land is freed from the larvæ of insects, such as grubs, slugs, wireworms, &c. &c., which are engendered among the rough grass, and fostered for a length of time under the rough, dry, undecomposed turf. To say nothing of the length of time which the speculator is kept out of a large amount of capital and interest, instead of having the former returned with the latter after the first or at most the second year.

"And the latter of whom (the Englishmen) are too much in the habit of repeating the operation of burning, even after the land has lain in grass only for a few years, when it might as well be ploughed and cultivated without such expense, thereby unnecessarily reducing the soil, there not being the same difficulties to be overcome, nor the same advantage to be gained from it.

"I should certainly burn all land with a rough harsh surface, and should as certainly plough and sow all land with a sweet grassy face upon it.

"In my opinion there are few farms in this country which do not contain certain portions of land capable of remunerative improvement, and I have shown that such improvement is quite within the scope of a tenant with a lease, without which no man can farm well, at least in the Northumbrian system. Would it not be better, then, for landlords, tenants, and the country generally, were tenants to employ labourers on works so speedily remunerative to themselves, rather than run to their landlord whenever they feel the screw, and ask for abatement of rent, or to be allowed to plough out some piece of valuable old grass, or otherwise cross crop their land with a view of obtaining some temporary advantage, but in the end to the inevitable injury of all concerned?

EXPENSES OF PARING, BURNING, &c.

| | | |
|---|---|---|
| No. 1. 33 acres pared and burned, at 25s. per acre ................. | | L.41 5 0 |
| 33 acres limed, 7 loads per acre, at 3s. 4d. per load... | | 38 10 0 |
| Cartage of ditto, at 3s......... | | 34 13 0 |
| Carry forward, | | L.114 8 0 |
| Brought forward, | | L.14 8 0 |
| Draining, where required, 3 feet deep, 27 feet apart, with two-inch pipes, &c. cost about L.3, 10s. per acre | | 27 1 0 |
| 2½ years' rent lost, at 5s. per acre per annum ........... | | 20 12 6 |
| Seed oats (1850), 33 acres, with 4 bush. per acre, at 13s. per boll ......................... | | 14 6 0 |
| Harvesting (1850)—67 acres cut by two Irishmen, per acre averaging 1s. 6d. per day, and food, say 2s. 3d. per day ........................ | L.0 4 6 | |
| ½ binder, 3s..................... | 0 1 6 | |
| | L.0 6 0 | |
| No. 1. Proportion of 67 acres cutting, at 6s. per acre .............. | | 9 18 0 |
| Carting, six carts per set, three days, at 8s. per day each ........................... | L.7 4 0 | |
| Forker 3s., stacker 3s., boy 1s............................. | 1 1 0 | |
| No. 1. Proportion of total carting... | L.8 5 0 | 4 1 4 |
| Thrashing nine stacks— 9 bolls coals—say........... | L.0 4 0 | |
| Carting of do. .................. | 0 2 0 | |
| 2 men at 1s. 6d. per day...... | 0 3 0 | |
| Women— high barn...... 2; low do.......... 1; straw do. ...... 3; at stack ...... 1; chaff-house ... 1; —8, at 8d. | 0 5 4 | |
| 2 boys and horses at stack, at 3s. 6d. ..................... | 0 7 0 | |
| Cost of thrashing per day ... | L.1 1 4 | |
| No. 1. Proportion of 3 days' thrashing, at L.1, 1s. 4d. per day, L.3, 4s.................. | L.1 11 6 | |
| Rape seed (1851) ........... | 1 4 0 | |
| | | 2 15 6 |
| Total Expenses, | | L.193 2 4 |
| Returns:— | | |
| No. 1. (1850) 33 acres, at 5 bolls per acre, or 165 bolls, at 13s. per boll....................... | L.107 5 0 | |
| No. 1. Proportion of straw to infield lands not to return to new lands, 67 acres, at 15s. ... | 25 9 9 | |
| 8 sc. ewes 7 weeks on rape, at 6d. per week ................ | 28 0 0 | |
| 12 sc. dinmonts and gimmers 7 weeks, at 5d. per week | 35 0 0 | |
| 12 sc. ewes (put to turnips) 8 weeks, at 6d. per week ... | 48 0 0 | |
| A quantity of meat left and spring eatage not counted | 0 0 0 | |
| Total returns, | | 243 14 9 |
| | | L.50 12 5 |
| No. 2. 34 acres paring and burning, at 25s. ...................... | L.42 10 0 | |
| 34 acres limed, 7 loads per acre, at 3s. 4d. per load ... | 39 13 4 | |
| Cartage of do. ................ | 35 14 0 | |
| Draining as in No. 1......... | 104 9 1 | |
| Carry forward, | | L.222 6 5 |

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| | | | |
|---|---|---|---|
| Brought forward, | | | L.222 6 5 |
| 2 years' rent lost, at 5s. per acre per annum ............ | | L.17 0 0 | |
| (1850) Proportion of harvesting as in No. 1 .............. | | 10 4 0 | |
| Carting proportion as in No. 1 | | 4 3 8 | |
| Thrashing proportion as in No. 1 ...................... | | 1 12 6 | |
| (1851) 70 acres cut by three Irishmen per acre averaging 1s. 6d. per day, and food, say 2s. 3d.... | L.0 6 9 | | |
| binding.............. | 0 1 6 | | |
| No. 2. Proportion of cutting 70 acres, at......... | L.0 8 3 | 14 0 6 | |
| | | | L.47 0 8 |
| Seed oats, 34 bolls (for 2 years), at 13s. per boll.............. | | L.22 2 0 | |
| No. 2. Proportion of (1851) carting, 6 carts per set, 8 days at 8s. each, forker 3s., stacker 3s., boy 1s. .................. | | 10 13 8 | |
| No. 2. Proportion of thrashing (1851) | | 4 13 3 | |
| | | | 73 8 11 |
| Total outlay, | | | L.306 16 0 |
| Return :— | | | |
| (1850) 34 acres, 5 bolls per acre, at 13s. .................. | | L.110 10 0 | |
| (1850) Proportion of straw as in No. 1 .................... | | 26 5 3 | |
| (1851) 34 acres, 8 bolls per acre, at 15s. per boll ...... | | 204 0 0 | |
| No. 2. Proportion of (1851) 70 acres straw, at 30s. per acre...... | | 51 0 0 | |
| | | | L.391 15 3 |
| | | | L.84 19 3 |
| No. 3. 36 acres pared and burned, at 19s. 6d. per acre ........... | | L.35 2 0 | |
| 36 acres limed, 7 loads per acre, at 3s. 4d. per load ... | | 42 0 0 | |
| Cartage of do. at 2s. 6d. per load ......................... | | 31 10 0 | |
| Draining as above ........... | | 93 19 2 | |
| Seed oats, 3 bush. per acre, at 13s. per boll.............. | | 11 14 0 | |
| 1½ year's rent lost, at 5s. per acre per annum ........... | | 13 10 0 | |
| Harvesting proportion as in No. 2......................... | | 14 17 0 | |
| Cartage proportion as in No. 2......................... | | 11 6 4 | |
| Thrashing proportion as in No. 2......................... | | 4 18 9 | |
| Outlay, | | | L.258 17 3 |
| Return :— | | | |
| No. 3. (1850) 8 scores gimmers on turnips 6 weeks, at 4d. per week ......................... | | L.16 0 0 | |
| 12 scores ewes 3 weeks, at 4d. | | 12 0 0 | |
| 36 acres oats, 8 bolls per acre, at 15s. ...................... | | 216 0 0 | |
| Straw proportion as in No. 2 | | 54 0 0 | |
| Return, | | | 298 0 0 |
| | | | L.39 2 9 |
| Return of No. 1................................ | | | L.50 12 5 |
| Return of No. 2................................ | | | 84 19 3 |
| Return of No. 3................................ | | | 39 2 9 |
| | | | L.174 14 5 |
| Fencing ........................................... | | | 35 0 0 |
| Total return, | | | L.139 14 5 |

"*P.S.*—I have not charged for spreading the lime, but charged all the carting as if it had been hired, whereas most of it was carted by my own carts, which carry much larger loads than hired carts, and the difference will more than outbalance the cost of laying on.

"I credit the land with the straw, as the dung will not be returned to that land, it being sufficiently rich with the ashes and lime, &c., to grow turnips and rape crops without manure, and those being eaten on, will make it almost too rich for corn crops.

"Any further information I shall be glad to give to the best of my power. (Signed) "G. A. Grey.

"*Millfield Hill, Dec.* 1. 1851."

Bogs.

The reclamation of extensive bogs, or deposits of peat, is a more arduous undertaking, requiring a considerable expenditure of capital and longer time before a return is obtained from it. The extent of land of this description in Great Britain and Ireland is very great. Very exaggerated statements of the profits to be derived from its improvement have often been published, and not a few persons have incurred serious loss by rashly undertaking this kind of work. On the other hand, when bogs are favourably situated with reference to a command of marl or other calcareous matter to assist in their decomposition and consolidation, and of manure to enrich them, their reclamation has proved a very profitable speculation. The well-known instance of Chat Moss in Lancashire affords so interesting an example of this that we shall here quote from a recent description of it.

Chat Moss.

"Chat Moss, well known as that black barren swamp between Liverpool and Manchester, contains 6000 acres, one-half of which is in the township of Barton, and the remainder in the townships of Bedford, Astley, and Worsley.

"The principal part of this moss which lies in Barton township, belongs to the Trafford family, and is entailed, but the ancestor of the present Sir Thomas de Trafford, appears to have obtained, at the latter end of the last century, an Act of Parliament to grant a ninety-nine years' lease of 2500 acres to a Mr Wakefield, who about the year 1805 disposed of his interest in it to the late William Roscoe of literary celebrity, who spent a large sum in a fruitless endeavour to improve it, failing in which, the lease was sold in 1821 to other parties. J. A. Brown, Esq. of Woolden Hall, brought 1300 acres; the late Edward Baines, M.P. for Leeds, purchased the remaining 1200 acres. The most extensive and successful efforts at improving this moss, have been made on a part of the 1200 acres bought by Mr Baines, who, besides occupying the part operated upon by Mr Roscoe, improved a considerable breadth himself, and let several portions to other parties, who have made considerable progress in improving small portions. The most extensive operations, however, upon the whole, have been carried out by a company to whom Mr Baines, in 1828, granted a lease of 550 acres for 68 years, the remainder of the original term, at a nominal rent for the first year, increasing gradually, till at the end of five years the rent attained its maximum of L.165 per annum, for the 550 acres. This company which was formed at the time the Liverpool and Manchester Railway was in progress of being made on the property, consisted, amongst others, of some practical farmers, and originated with William Reed, who for the three first years was the manager, and resided on this farm, which they called Barton Moss farm. During that period I had the pleasure of paying my friend Reed a visit, and of witnessing the skill and success attending his enterprise and various experiments.

"Travelling by the railway from Liverpool towards Manchester the Barton Moss farm is on the right hand, excepting a narrow strip of about six acres which is on the left, and abuts on the line for a quarter of a mile on each side of the Barton Moss station, which is seven miles from Manchester. The long narrow belts of fir and other trees and the quick-thorn hedges which run north and south, give it an appearance that would lead a casual observer to suppose that it was sound land, or at least that the moss was not so deep under it, as on the other

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parts over which the railway passes; its depth, however, is the same, and an iron rod may be thrust down by the hand to the depth of eighteen feet in almost any part of it.

"The first operation, that of draining, had been effected by opening side drains at intervals of fifty yards, into which were laid covered ones six yards apart, at right angles with, and emptying into the open side drains.

"The moss being in a semifluid state, it was necessary to proceed slowly with draining, taking out only one graft or depth at a time, allowing it to remain a week or a month, according to the state of the weather, before taking out the second graft; this admitted of the sides becoming consolidated, and of the second graft being taken out without the moss closing in. It was again allowed to remain as before, till sufficiently dry to admit of the third being removed.

"The open drains were made 3 feet wide and 3 feet 6 inches deep, and the covered drains 16 inches wide and 3 feet deep; the last graft of the latter being only about 6 inches wide at the top, tapering to 4 inches at the bottom, and being taken out of the middle of the cut, left a shoulder on each side. The sod or graft first taken out had by this time become tough and dry, and was placed with the heath side downwards in the shoulder, thus leaving the narrow spit at the bottom open for a depth of about 14 inches; the other square sod being put on the top completed the drain.

"The cost of this mode of draining, including the side drains, was about 38s. per acre. The drains first put in required to be renewed in a few years, in consequence of the moss becoming so much consolidated and reduced in height that the plough, as well as the horses' feet, broke through the roof, although the horses were shod with "pattens" or boards of about 10 inches square, with the angles taken off. The second draining, however, was more permanent, and would probably not have required renewing for many years, but for the moles, which have been very troublesome in working down to the drains, and filling them up in various places; so that the operation of draining has required to be partially renewed in every field, and in many of them entirely so; and thus, these little animals have been the cause of a very considerable increase in the cost of labour. It has subsequently been found advisable to put the under drains in at 4 yards, instead of 6 yards asunder, and the advantage in one crop has been quite sufficient to pay the extra cost. A two-horse engine was erected, which drives the thrashing machine, straw cutter, and crushing mill; and the escape-steam from it steams the horses' food.

"The buildings were erected principally of timber, covered with asphalted felt.

"After draining, making roads, and burning off the heath plant, the land was scarified lengthwise of the fields, by an implement, with knives shaped like coulters, reversed, sharp on the convex side, fixed in two bars, and drawn by three horses yoked abreast.

"The tough surface was by this means cut at every four inches; the land was then ploughed across the scarifying; a roller, surrounded with knives, was next passed across the ploughing; after this the land was well harrowed till sufficiently reduced.

"The next operation was that of marling, for which purpose a railway was constructed, at the joint expense of Mr Baines and the company, from the river Irwell on the south, running through a bed of marl, and through Mr Baines' farm, as well as the Barton Moss farm, to the Liverpool and Manchester railway, with which it is connected at the Barton Moss station. The length of this railway is about a mile and three quarters; it affords the opportunity of getting manure from Manchester, either by the river or by the railway, as well as the supply of marl or gravel. Further, to facilitate their operations, the company constructed also a *moveable* railway, to be laid down along the cross roads and on the fields, upon which about a cubic yard of marl was taken on each waggon, directed to the very spot where it was wanted: thus the marling could be proceeded with in all weathers, and much more rapidly than perhaps such work ever was done before, or could now be done, except by similar means.

"The iron for the rails was rolled expressly for the purpose, and weighed 14 lb. per yard. It was fitted longitudinally on the apex of a triangular wooden sleeper.

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"The permanent way cost L.520 per mile, and the moveable one L.280. The latter was in twelve feet lengths, and the pair of rails, with the sleepers and cross ties, weighed 1 cwt. 3 qrs. It was shifted from place to place on the land by two men at a cost of 2s. 6d. per acre.

"From 60 to 100 cubic yards of marl were put on an acre, and in the following summer the land was manured, also by means of the moveable railway, at the rate of fifty tons of black Manchester manure per acre, and planted with potatoes, which were followed by wheat, sown with red clover and rye-grass, for mowing for one or two years; then oats and potatoes, &c. as before. These were all flourishing crops, the wheat in particular looked bright and beautiful. The potatoes were sold for L.25 and L.30 per acre, which more than paid the whole cost of improvement. Mr John Bell, resident bailiff, has made many valuable experiments relative to the improvement of raw moss, one of which has resulted in a discovery likely to be of considerable importance, which is, that a mixture of lime and salt applied a while before seeding, with the addition of a good dressing of guano, in the proportion of four tons of lime and five cwt. of salt per acre, qualifies it to produce a crop of potatoes or oats equal to that after the application of 60 yards of marl per acre. It is essential that the mixture should be spread while it is hot. Mr Evans (one of the proprietors) is convinced that the peat on the surface ought never to be burned; he has always found that, when the heath sod is turned down to decay, much better crops have been obtained than when it has been burnt off, or than when the top has been taken away either for fuel or other purposes. What are termed moss-fallows, that is parts which have had the moss taken off for fuel, will never bear so good a crop as the upper surface, however deep the moss may be underneath."—(See *Notes on the Agriculture of Lancashire, with Suggestions for its Improvement*, by Jonathan Binns.)

Blair-Drummond moss.

Nearly a century ago the late Lord Kames, on becoming proprietor of the estate of Blair-Drummond, in the county of Perth, began the improvement of a large tract of worthless moss, by a totally different process from that now detailed. In this case the moss had accumulated upon a good alluvial clay soil. Instead, therefore, of attempting to improve the moss itself, it was floated off piecemeal into the neighbouring Frith of Forth. The supply of water required for this purpose was obtained from the river Teith, from which it was raised to the requisite height by a powerful water wheel. Being conveyed through the moss in channels, successive layers of peat were dug and thrown into these channels, which were shifted as occasion required, until the whole inert mass was removed. A thin stratum next the clay was burnt, and the ashes used as manure. An immense extent of moss has thus been got rid of on that estate, and on others in the neighbourhood, and "an extensive tract of country, where formerly only a few snipes and muirfowl could find subsistence, has been converted, as if by magic, into a rich and fertile carse of alluvial soil, worth from L.3 to L.5 per acre."

Fen lands.

We next notice the fen lands of England. "In popular language, the word *fen* designates all low wet lands, whether peat-bog, river alluvium, or salt marsh; but in the great Bedford level, which, extending itself in Cambridgeshire and five adjoining counties, is the largest tract of fen land in the kingdom, the farmer always distinguishes, and it is thought conveniently and correctly, between fen land and marsh land. By the former they mean land partly alluvial, and formed by river floods, and partly accumulated by the growth of peat. Such lands are almost invariably of a black colour, and contain a great per-centage of carbon. By marsh lands they mean low tracts gained from the sea, either by the gradual silting up of estuaries, or by artificial embankments." Low-lying peat occurs in small patches in nearly every maritime county of Britain, being usually separated from the sea or from estuaries by salt marsh or alluvium. There is a large extent of such land in Somersetshire, yet but partially drained, and a still larger breadth in Lancashire where its

Fen Lands. improvement makes steady progress. In Kent, on the seaboard of Norfolk, on both shores of the Humber, and stretching along the sides of its tributaries, there are immense tracts of this description of land. But these are all exceeded in importance by the "great level of the fens, which occupies the south-eastern quarter of Lincolnshire, the northern half of Cambridgeshire, and spreads also into the counties of Norfolk, Suffolk, Huntingdon, and Northampton. Its length is about 70 miles, its breadth from 3 or 4 to 30 or 40 miles, the whole area being upwards of 1060 square miles, or 680,000 acres. On the map the fens appear like an enlargement of the Wash, and in reality have the aspect of a sea of land, lying between that bay and the high lands in each of the above named counties, which seem to form an irregular coast line around it." This fen country has for centuries been the scene of drainage operations on a stupendous scale. The whole surface of the great basin of the fens is lower than the sea, the level varying from four to sixteen feet below high-water mark in the German Ocean. The difficulty of draining this flat tract is increased, from the circumstance that the ground is highest near the shore, and falls inland towards the foot of the slope. These inland and lowest grounds consist of spongy peat, which has a natural tendency to retain water. The rivers and streams which flow from the higher inlands, discharge upon these level grounds, and originally found their way into the broad and shallow estuary of the Wash, obstructed in all directions by bars and shifting sand-banks. These upland waters being now caught at their point of entrance upon the fens, are confined within strong artificial banks, and so guided straight seaward. These waters are thus restrained from flooding the low grounds, and by their concentration and momentum, assist in scouring out the silt from the narrow channel to which they are confined. The tidal waters are at the same time fenced out by sea-banks, which are provided at proper intervals with sluice doors, by which the waters escape at ebb-tide. To show the extent of these operations, it may be mentioned that the whole sea-coast of Lincolnshire, and part of Norfolk, a line of at least 130 miles, consist of marsh lands lower than the tides, and is protected by barrier banks, besides which there are hundreds of miles of river embankments. When this does not provide such a drainage as to admit of cultivation, the water is lifted mechanically by wind or steam mills into the main aqueducts. The number of windmills formerly at work on the whole of the fens between Lincoln and Cambridge, probably exceeded 700; at present there are about fifty mills in the Lincolnshire part of the level, and perhaps 170 in the Bedford level and adjacent fens, or a total of 220. The number of steam-engines may be estimated at sixty. They lift the water (almost universally by scoop-wheels, not pump) from six to sixteen or twenty feet, and the area of land thus drained may be computed at not less than 222,000 acres.

Great level of the fens.

Use of the steam-engine in draining the fens.

The first use of steam-engines for the purpose of draining was in Deeping fen, where, in 1824-5, two, of eighty and sixty horse-power respectively, were erected. By means of these two engines upwards of 20,000 acres have now a good drainage, whereas formerly, forty-four wind-mills, with an aggregate power of 400 horses, failed to keep them sufficiently dry. The scoop-wheel of the larger engine is twenty-eight feet in diameter, and the float-boards are five feet wide. It was intended to have a "dip" of five feet, but the land has subsided so much in consequence of the draining that it seldom has a dip of more than two feet nine inches. The water is lifted on an average seven feet high. When both engines are at work they raise 300 tons weight of water per minute.

The soil of the fens consists for the most part of dark coloured peat, from one to eight or ten feet in depth. The surface in general is not pure peat, but is mixed with silt or other soil. Under this there is in general a stratum of brown spongy peat, which sometimes rests upon gravel, but for the most part upon clay, which usually contains a portion of calcareous matter. The removal of the water has, of course, been the primary improvement; but subsidiary to this, the rapid amelioration and great fertility of the fen lands is largely due to this fortunate conjunction of clay and peat. The early practice of the fen farmers was to pare and burn the surface, grow repeated crops of rape, oats, wheat, &c., and burn again. The subsidence of the soil, subsequent to the draining and repeated paring and burning, brought the surface nearer to the subjacent clay, which the cultivators by and by, began to dig up and spread over the surface. This practice is now universal, and its continued use, together with careful cultivation and liberal manuring, has changed a not very productive peat into one of the most fertile soils in the kingdom. Nowhere in our country has the industry and skill of man effected greater changes than in the fens. What was once a dismal morass, presenting to the view in summer a wilderness of reeds, sedges, and pools of water, among which the cattle waded, and in winter almost an unbroken expanse of water, is now a fertile corn land. The fen men, who formerly lived upon the adjacent high lands, and occupied themselves with fishing, fowling, and attending to their cattle, have now erected homesteads upon the fen lands, divided them by thorn hedges, and brought them into the highest state of cultivation.

Marsh Lands.

Claying fen lands.

Marsh lands.

We referred at the outset to the distinction betwixt *fen* land and *marsh* land. In the district called Marsh land in Norfolk, extending between the Ouse and the Nen; in that called South Holland, in Lincolnshire, stretching between the Nen and the Welland; northward of Spalding, and also north-east of Boston, there is a considerable tract of marine clay soil. In Marsh land this is chiefly arable-land, producing large crops of wheat and beans; but in Lincolnshire it forms exceedingly fine grazing land. This tract lies within the old Roman embankment, by which the district was first defended from the ocean. Outside this barrier are the proper marsh lands, which have been reclaimed in portions at successive periods, and are still intersected in all directions by ranges of banks. The extraordinary feature of this tract is, that the surface outside the Roman bank is three or four feet higher than that in the inside, and the level of each new enclosure is more elevated than the previous one. The land rises step by step, as the coast is approached, so that the most recently reclaimed land is often twelve or even eighteen feet higher than the lowest fen land in the interior, the drainage from which must nevertheless be conveyed through these more elevated marshes to the sea.

Schemes for reclaiming more land from the sea.

The extent of this kind of land already rescued from the sea is very great, and is constantly augmenting. The whole Wash may, in fact, be regarded as a broad expanse of marsh in course of formation. A considerable portion of it is already so much raised as to be left bare at low water. The "Norfolk Estuary Scheme," now in progress, contemplates the enclosure of a large tract of these sands, and the "Victoria Level," if ever executed, will confine the waters to a channel four miles wide, running down the centre of the Wash, and add 150,000 acres to our territory. This would not be all, for if these works are accomplished, they will lower the water in all the fen rivers, and afford a natural drainage to the whole of the great level.

Warping.

Lands, such as some of those which we have just been describing, are often greatly improved, or rather may be said to be *made* by means of a peculiar mode of irrigation, called "warping." It is practicable only in the case of land lying below the level of high tide in muddy rivers. It is

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little more than a century since it was first practised in England, the first instance of it being near Howden, on the banks of the Humber. But although the practice is comparatively new in Britain, it has long been in use on the Continent of Europe, particularly in Italy, and is thus described by Mr Cadell:—"In the Val de Chiana, fields that are too low are raised and fertilised by the process called *colmata*, which is done in the following manner:—The field is surrounded by an embankment to confine the water. The dike of the rivulet is broken down so as to admit the muddy water of the high floods. The Chiana itself is too powerful a body of water to be used for this purpose; it is only the streams that flow into the Chiana that are thus used. This water is allowed to settle and deposit its mud upon the field. The water is then let off into the river at the lower end of the field, by a discharging course called *scolo*, and in French *canal d'ecoulement*. The water-course which conducts the water from a river, either to a field for irrigation or to a mill, is called *yora*. In this manner a field will be raised 5½ and sometimes 7½ feet in ten years. If the dike is broken down to the bottom, the field will be raised to the same height in seven years; but then in this case, gravel is also carried in along with the mud. In a field of 25 acres, which had been six years under the process of *colmata*, in which the dike was broken down to within 3 feet of the bottom, the process was seen to be so far advanced, that only another year was requisite for its completion. The floods, in this instance, had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodland. Almost the whole of the Val di Chiana has been raised by the process of *colmata*."[1]

This process of warping is now systematically practised on lands adjoining the Humber and its tributaries, and by means of it vast tracts of sterile, sandy, and peaty soils are yearly converted into arable land of the very best quality. The warping of such lands has this farther advantage, that it raises their level, and thus admits of their more perfect drainage. The operation is conducted thus:—

"The first step in the process is to erect a sluice on the bank of the Trent, or other tidal channel, and cut a main drain to the fields which are to be flooded. The sluice-doors point outwards, so as to exclude the tides, except when held open by rods and staples provided for the purpose, and the drain ought to have an area equal to three times that of the sluice, in order to prevent any considerable resistance to the flow of water. The land is then surrounded by an embankment of variable altitude, according to the level of the surface, and from two to three feet wide at the top, the usual slope of the banks being from 15 to 18 inches on each side for every 12 inches perpendicular rise. The tide flows rapidly in, and meeting with no obstruction to detain its current, holds in suspension the particles of sediment with which it is loaded; but directly it leaves the narrow channel, and spreads itself over the broad surface, the rapidity of motion is lost, and the atoms of warp, no longer projected forward, sink quietly to the bottom. A deposit is thus formed greatest near the mouth of the drain, and in order to equalize the amount of warp over the whole ground, the water is conducted to different parts of the compartments by smaller drains called 'inlets.' When the deposit is raised sufficiently high next to the end of these channels, the current is carried forward by extending the banks of the inlets in different directions, and thus, by a skilful and careful guiding of the water, the whole of the land is warped to an equal height. The water is conducted by a temporary drain, first to the further side of the plot, and, when the deposit there is sufficiently high, is allowed to escape at intervals along the side of this drain until the whole area is equally raised. The tide having thrown down much of its mud, returns by the warping-drain into the river, scouring out the sediment which might have accumulated in the drain." . . . . "Generally speaking, the spring-tides only are used, as they have sufficient volume of back-water to keep the warping-drains clear and open. The land is raised from one to three feet in one or two years." . . . . . "The expense of warping is very variable: Where the cost of the large drains and other works is included, the calculation would probably be L.12 to L.20 per acre; but on lands contiguous to the public warping-drains the expense of flooding is only about L.2, 2s. Within the last thirty years all the peat-lands within three miles of the Trent (in the isle of Axholme) have been warped, the drainage greatly improved, and the soil, from being almost worthless, made worth from L.60 to L.100 per acre." Taking both sides of Trent, about 16,000 acres have, since the year 1800, been covered with the richest soil to an average depth of two feet, and the process is still extending. (See *Prize Report on the Farming of Lincolnshire*, by John Algernon Clarke, in vol. xii. of *Royal Agricultural Society's Journal*, from which, and from article on "Fen Lands," by the same gentleman, in *Morton's Cyclopædia of Agriculture*, the foregoing information has been gleaned or quoted).

Blowing sands.

On many parts of our sea-coasts, and especially in the Hebrides, there occur extensive tracts of blowing sands, which are naturally not only sterile themselves, but a source of danger to better lands adjoining them, which in some instances have been quite ruined by the sand deposited upon them by the winds. This mischief is effectually prevented, by a process beautifully simple and useful, namely, planting the sand-banks with sea bent-grass (*Arundo arenaria*), the matting fibres and stems of which not only bind the sand, but clothe it with a herbage which is relished by cattle, and which being able to resist the severest winter weather, furnishes a valuable winter forage in those bleak situations. This bent-grass can be propagated by seed, but in exposed situations it is found better to transplant it. This operation is performed betwixt October and March, as it succeeds best when the sand is moist, and evaporation slow.

Use of sea bent-grass in fixing sand.

## CHAPTER XIV.

### GENERAL OBSERVATIONS.

General Observations.

According to the method proposed at the outset, we now offer a few observations on several topics connected with our subject.

*Of the Tenure of Land.*—The extent of land in Great Britain occupied by its owners for agricultural purposes bears a very small proportion to the whole area. The yeoman class is still numerous in several parts of England, but must have diminished greatly from that continuous amalgamation of small estates into large ones which has formed a marked feature in our social history for the past 50 years. This change, although to be regretted on public grounds, has had a favourable influence on the cultivation of the soil, for it almost invariably happens, that a larger produce is obtained from land when it is occupied by a tenant than when it is cultivated by its proprietor. As a matter of fact, the land of the country is now, with trifling exceptions, let out to professional farmers in quantities varying from the rood-allotment of the village labourer to the square miles of the Highland grazier. Farms of all sizes are usually to be found

Size of farms.

[1] *Journey in Carniola, Italy, and France*, by W. A. Cadell, Esq., F.R.S.

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in any district, and most important it is that this should be the case; but the extent of farms is chiefly determined by the amount of hired labour employed upon them, and the measure of personal superintendence on the part of the tenant which the kind of husbandry pursued upon them calls for. We accordingly find that in very fertile tracts, in the vicinity of towns, and in dairy districts, they seldom exceed 200 acres; where the ordinary alternate husbandry is practised, the average ranges from 300 to 400. In more elevated tracts, where a portion of natural sheep-walk is occupied along with arable land, it rises to 800 or 1000; while that of the sheep-grazings of our hills and mountains is limited only by the capital of the tenant. About a century ago there occurred, in various parts of Great Britain, a similar amalgamation of small holdings into farms of the sizes which we have now referred to, as is at present in progress in Ireland. This enlargement of farms, and the employment of increased capital in their cultivation, insures a more rapid reclamation of waste lands, and general progress of agriculture up to a certain point, than would otherwise take place. But as every step in advance beyond this point implies an increase of acreable outlay, and the need for closer superintendence, it seems likely that, in future, the size of arable farms will not further increase, but may rather be expected to approximate to that which at present obtains in suburban districts.

Farms are held either by yearly tenancy, or under leases for a specified number of years. The latter plan is that upon which nearly the whole lands of Scotland are let; and it obtains also to a considerable extent in the northern counties of England, in West Norfolk, and in Lancashire. But with these and other exceptions, amounting altogether to about a tenth part, the farms of England are held by yearly tenancy, which can be terminated by either of the contracting parties giving to the other a six-months' notice to that effect. This precarious tenure has been attended by far fewer changes than a stranger could suppose, owing to the highly honourable conduct for which English proprietors as a class have long been noted. On all the large estates it is quite common to find families occupying farms of which their ancestors for generations, or even centuries, have been tenants. The mutual esteem and confidence which usually subsists betwixt such landlords and tenants is undoubtedly much to the credit of both, but not the less has the system, as a whole, operated unfavourably for all concerned; for however numerous and striking the exceptions, it is yet the fact that under this system of tenancy-at-will, less capital has been invested in the improvement of farms, less labour has been employed, and less enterprise displayed in their ordinary cultivation, less produce has been obtained from them by the occupiers, and less rents have been received for them by the owners, than in the case of similar lands when let on leases for a term of years. These diverse results ensue, not because tenants with leases are abler men or better farmers than their neighbours who are without them, but solely because the one system recognises certain important principles which the other ignores. It is contrary to human nature to expect that any body of men will as freely invest their capital, whether in the shape of money, skill or labour, in a business yielding such slow returns as agriculture, with no better guarantee than the continued good-will of existing proprietors, or those who any day may succeed them, that they or their families shall reap the fruits of it, as they will do with the security which a lease for a term of years affords. It does, therefore, seem strange that a majority of the farmers of Great Britain should be tenants at will, and still more strange that they should be so of choice. It is nevertheless true, that a considerable portion of the tenantry of England are even less disposed to accept of leases than their landlords are to grant them. The latter cling to the system because of the greater control which they thereby retain over their estates, and the greater political influence with which it invests them; the former do so because low rents are one of its accompaniments. Since the removal of restrictions on the importation of foreign agricultural produce, there are indications that neither landlords nor tenants are so well satisfied with this system of tenancy-at-will as they once were. Not only is the granting of leases becoming more common than it has hitherto been, but there is a growing desire on the part of tenants to obtain the benefit of that guarantee for the realising of their capital which *tenant-right* affords to enterprising farmers who may have unexpectedly to quit their farms. In certain districts of England this claim, called *tenant-right*, has been recognised so long, that apart either from written stipulation or statutory enactment, it has, by mere usage, attained to something like a legal standing. In Lincolnshire, an away-going tenant can, by virtue of this usage, claim from his landlord or successor repayment, in certain definite proportions, of the cost of such ameliorations of a specified kind as he may have made during the last years of his occupancy, and the benefits of which his removal hinders him from realising in the natural way.

Tenancy-at-will.

Tenant-right.

Benefit of leases.

Tenant-right is certainly a valuable adjunct to tenancy-at-will, but still it does not meet the real exigencies of the case. There are feelings inherent in man's nature which cause him to recoil from exertions the fruits of which are as likely to be enjoyed by a stranger as by himself or his family. This repugnance, and its paralysing influence, is not to be removed by a mere "right" to pecuniary compensation. It is certainty of tenure—so far at least as human arrangements can be certain—which will really induce a farmer to throw his whole heart into his business. It is accordingly to this principle, that leases owe their excellence, and by it also that the only weak point in them is to be accounted for. The first years of a lease are usually characterised by an energetic performance of various improvements, whereas, towards its close, there is usually such a withdrawing even of ordinary outlay, as is unfavourable to the interests of either landlord or tenant. There is at present a very generally entertained opinion that this inconvenience would be obviated by engrafting the system of tenant-right upon that of leases. A proposal to this effect would probably be well entertained by the holders of existing leases; but we believe that it would be anything but popular with in-coming tenants. This view of the matter is confirmed by the experience which we have of the effects of having the straw and dung produced on farms *steel-bow*—that is the property of the landlord, and transferred by him free of charge to entering tenants on condition that they leave them so to their successors. This arrangement is generally admitted to be better for all parties, than when away-going tenants have a "right" to claim payment for these commodities from their successors, or to sell them off the farm if they prefer to do so. Scottish experience is therefore unfavourable to the system of tenant-right, in the only instance of it which obtains there. We know of no practicable remedy for the injurious lowering of the condition of farms at the close of leases, but in the parties renewing their contract in time to prevent it.

Duration of leases.

It seems to be generally admitted, that twenty one years is the proper duration for an agricultural lease. Such a term suffices to give confidence to the tenant in embarking his capital, and secures to the landlord his legitimate control over his property, and due participation in its varying value. It is generally felt by tenants that the lease, or document in which their agreement with their landlord is engrossed, might, with advantage, be much shortened, as well as simplified in its terms. When treating of the succession

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of crops, we have already expressed our views regarding those restrictive clauses which usually occupy a prominent place in such writings. Such restrictions are, of course, introduced with the view of guarding the property of the landlord from deterioration. But when he is so unfortunate as to meet in with incompetent or dishonest tenants they entirely fail to secure this object, and yet are a hindrance and discouragement to enterprising and conscientious ones. It is probable that the existence of the law of distraint, or hypothec, which gives to landlords a lien over the effects of their tenantry in security for the payment of the current year's rent, has had its influence in adding to the number and stringency of these clauses, and has encouraged the practice of letting lands by tender to the highest offerer. For the law in question, by rendering landlords to a considerable extent independent of the personal character and pecuniary circumstances of the occupiers of their land, has a direct tendency to render them less cautious who they deal with, than they otherwise would be; and to induce them, when tempted by the promise of high rents, to trust more to this legal security than to the moral character, business habits, professional skill, and pecuniary competency, of candidates for their farms.

Capital required for working a farm.

The amount of capital that is required in order that the business of farming may be conducted advantageously, is largely determined by the nature of the soil, &c., of each farm, the system of management appropriate to it, the price of stock and of labour, and the terms at which its rents are payable. In the case of land of fair quality, on which the alternate husbandry is pursued, and when the rents are payable as the produce is realised, L.5 per acre may be regarded as an amount of capital which will enable a tenant to prosecute his business with advantage and comfort. In letting a farm, a landlord not only does a just and prudent thing for himself, but acts as a true friend to his proposed tenant, when he insists upon being shown that the latter is possessed of available funds to an amount adequate to its probable requirements.

The importance of the topics to which we have thus referred, is happily expressed by Mr Pusey, when, after enumerating various agricultural desiderata, he says, "In some degree none of us carry out all that is in our power; but want of capital, or want of confidence in the tenure of farms are, I suppose, the two principal causes of this omission."

Education of farmers.

But the mere possession of capital does not qualify a man for being a farmer, nor is there any virtue inherent in a lease to insure his success. To these must be added probity, knowledge of his business, and diligence in prosecuting it. These qualifications are the fruits of good *Education* (in the fullest sense of that term), and are no more to be looked for without it than good crops without good husbandry. Common-school instruction will, of course, form the groundwork of a farmer's education; but to this should be added, if possible, a classical curriculum. It has been the fashion to ask, "Of what use are Greek and Latin to a farmer?" Now, apart from the benefit which it is to him, in common with other men, to know the structure of language, and to read with intelligence the literature of his profession which more and more abounds in scientific technicalities, we believe that no better discipline for the youthful mind has yet been devised than the classical course which is in use in our best public schools. Of this discipline we desire that every future farmer should have the advantage. But the great difficulty at present lies in finding appropriate occupation for such youths betwixt their fifteenth and twentieth years. In many cases the sons of farmers are during that period put to farm labour. If they are kept statedly at it, and are made proficient in every kind of work performed on a farm, it is a good professional training as far as it goes. The more common one—at least as regards the sons of the larger class of farmers—which consists of loitering about without any stated occupation, attending fairs and markets, and probably the race-course and hunting-field, is about the most absurd and pernicious that can well be imagined. Such youths are truly to be pitied; for they are neither inured to bodily labour, nor afforded the benefits of a liberal education. It need not surprise any one that such hapless lads often prove incompetent for the struggles of life, and have to yield their places to more vigorous men who have enjoyed the benefit of "bearing the yoke in their youth." Unless young men are kept at labour, either of mind or of body, until continuous exertion during stated hours, confinement to one place, and prompt obedience to their superiors have ceased to be irksome, there is little hope of their either prospering in business, or distinguishing themselves in their profession. Owing to the altered habits of society, there is now less likelihood than heretofore of such young persons as we are referring to being subjected to that arduous training to bodily labour which was once the universal practice; and hence the necessity for an appropriate course of study to take its place. Many Scottish farmers endeavour to supply this want by placing their sons for several years in the chambers of an attorney, estate-agent, or land-surveyor; partly in order that they may acquire a knowledge of accounts, but especially for the sake of the wholesome discipline which is implied in continuous application and subjection to superiors. It is also common for such youths to be sent to Edinburgh for a winter or two to attend the class of our accomplished professor of Agriculture, and perhaps also that of Chemistry and the Veterinary College. This is well enough in its way; but yet there is wanting in it an adequate guarantee that there is real study—the actual performance of daily mental work. The agricultural college at Cirencester appears to come more fully up to our notion of what is needed for the professional training of farmers than any other institution which we yet possess. We shall rejoice to see such opportunities of instruction as it affords multiplied in Great Britain. After enjoying the benefits of such a course of training as we have now indicated, young men would be in circumstances to derive real advantage from a residence with some experienced practical farmer, or from a tour through the best-cultivated districts of the country. We are well aware that what we have now recommended will appear sufficiently absurd to the still numerous class of persons who believe that any one has wit enough to be a farmer. But those who are competent to judge in the case can well afford to smile at such ignorance. They know that agriculture is at once an art, a science, and a business; that the researches of naturalists, chemists, geologists, and mechanicians are daily contributing to the elucidation of its principles and the guidance of its practice; and that while its pursuits afford scope for the acutest minds, they are relished by the most cultivated ones. As a business it shares to the full in the effects of that vehement competition which is experienced in every other branch of industry, and has besides many risks peculiar to itself. The easy routine farming of the olden time is gone for ever; and without a good measure of tact, energy, and industry no man can now obtain a livelihood by it. It were well that all this were better known; for nothing has been more common than for parents who have sons that are too dull for scholars, or too indolent for trade, to put them to farming; or than for persons who have earned a competency in some other calling, to covet the (supposed) easy life of a farmer, and to find it to their sorrow a harassing and ill-requited one.

Farm labourers.

The agriculture of a country must ever be largely affected by the condition and character of the peasantry by whom its labours are performed. An acute observer has recently shown that in England a poor style of farming and low

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wages—good farming and high wages usually go together; and that a low rate of wages is significantly associated with a high poor-rate. The worst paid and worst lodged labourers are also the most ignorant, the most prejudiced, the most reckless, and insubordinate. The eminence of Scottish agriculture is undoubtedly largely due to the moral worth and intelligence of her peasantry. For this she is indebted to the early establishment of her parochial schools, and to the sterling quality of the elementary education, based upon the Bible, which the children of her tenantry and peasantry have for generations received in them together. These schools are unfortunately now inadequate to the increased population; but still in the rural districts of the Scottish lowlands it is a rare thing to meet with a farm labourer who cannot both read and write. Apart from higher benefits the facilities which the services of such a class of labourers have afforded for the introduction and development of improved agricultural practices, the use of intricate machinery, and the keeping of accurate accounts cannot well be overrated. It is an interesting testimony to the value of a national system of Christian education that our Scottish peasantry should be in such request in other parts of the kingdom, as bailiffs, gardeners, and overseers. Let us hope that this inestimable blessing will speedily be enjoyed by our entire population.

Evil fruits of the law of settlement.

The pernicious influence of the present law of Settlement and Removal upon the English labourer, is now attracting that attention which it so urgently demands. The proprietors and tenants of particular parishes in various parts of England, at present combine to lessen their own share of the burden of the poor-rate, by pulling down cottages and compelling their labourers to reside out of their bounds. The folly and cruelty of such short-sighted policy cannot be too strongly reprobated. These poor people are thus driven into towns, where their families are crowded into wretched apartments, for which they must pay exorbitant rents, and where they are constantly exposed to moral and physical contamination of every sort. From these comfortless abodes the wearied and dispirited men must trudge in all weathers to the distant scene of their daily labours. One cannot conceive of a prosperous agriculture co-existing with such a system; nor feel any surprise that thieving, incendiarism, and burdensome rates should be its frequent accompaniments. It is pleasant to contrast with this close-parish policy the conduct of some of our English nobility, who are building comfortable cottages and providing good schools for the whole of the labourers upon their princely estates.

What the legislature should do for Agriculture.

The further progress of our national agriculture is undoubtedly to be looked for from the independent exertions of those immediately engaged in it; but important assistance might and ought to be afforded to them by the legislature, chiefly in the way of removing obstructions. What we desiderate in this respect is the repeal, or at least the important modification, of the law of distraint; the commutation of the burdens attaching to copyhold lands; the reformation of the law of settlement; the removal of the risk and costs which at present interfere with the transference of land; the establishment of a really *national* system of Christian education; the endowment of an adequate number of agricultural colleges, with suitable museums, apparatus, and illustrative farms; the authoritative collection and publication of agricultural statistics; and the compulsory adoption of a uniform standard of weights and measures. We desire also to see the *arterial* or *trunk-drainage* of the country undertaken by government. Until this is done, vast tracts of the most fertile land in the kingdom cannot be cultivated with safety and economy, nor attain to the productiveness of which they are capable. Our national interests surely require that its agriculture should be freed from such obstructions as these, and that it should receive the benefit of a fair share of such public provision as is made for training youths for the learned professions, and for the public service; and of such grants as are given in aid of scientific research, for the encouragement of the fine arts, and for the furtherance of manufactures and commerce.

On carefully comparing the present condition of British agriculture with what it was twenty years ago, the change for the better is found to be very great indeed. But on all hands indications are to be found, which warrant the anticipation, that the progress of discovery and improvement in future will be more steady, more rapid, and more general than it has hitherto been. There is not only a wider-spread and more earnest spirit of inquiry; but practical men instead of despising the aids of science, seek more and more to conduct their investigations under its guidance. Experiments are made on an ever-widening scale, and upon well-concerted plans; their results are so recorded and published, that they at once become available to all, and each fresh investigator, instead of wasting his energies in re-discovering what (unknown to him) has been discovered before, now makes his start from a well-ascertained and ever-advancing frontier. Hitherto the knowledge of the husbandman consisted very much of isolated facts, and his procedure often little better than a groping in the dark. As the rationále of his various processes is more clearly discovered, he will be enabled to conduct them with greater economy and precision than he can do at present. A clearer knowledge of what really constitutes the food of plants, and of the various influences which affect their growth, will necessarily lead to important improvements in all that relates to the collection, preparation, and use of manures. We appear to be at present on the very eve of a great revolution in agricultural mechanics. We noticed in its proper place the benefits which have already ensued from the use of improved implements and machines, but especially from the application of steam-power to much of the heavy work of the homestead. It is known, however, that zealous endeavours are being made by various parties, to render this power available for the tillage of the soil. Some persons are attempting to do this by applying it to the traction of the common plough, or rather of apparatus in which its principle is retained. Of these the Marquis of Tweeddale appears to be the most successful. Others, such as Mr Usher of Edinburgh, are attempting to solve this problem by attaching to a locomotive engine a rotating apparatus, by which the soil is at one operation so broken up and comminuted, as without more ado to be fit for a seed-bed. Mr Samuelson of Banbury has recently brought out what he calls a digging machine, adapted to work by means of horse-power, and of the efficacy of which the most encouraging reports have already appeared. If the improvements which Mr Usher announces that he has made upon his locomotive engine are verified on trial, these gentlemen have only to combine their respective inventions, and "cultivation by steam" is an accomplished fact.

The plough, the sickle, the flail, and the quern claim, we believe, an equal antiquity. We have seen the two last of these venerable compeers entirely superseded by steam-propelled mills. Who will say for how much longer the two first are to retain their time-honoured place as the insignia of agriculture? With such machines before him as Fowler's draining apparatus, Samuelson's digger, Usher's steam-cultivator, and Bell's reaper, a sober-minded man may warrantably expect that at no very distant day our fields will be drained, tilled, sown, and reaped by the same potent agency which already thrashes our crops, and prepares them for the use of man and beast. In speculating upon the future of our national agriculture, we do certainly cherish the anticipation

Report on East Lothian.

that, by the time another edition of the Encyclopædia Britannica is called for, the writer (for it) of the article "Agriculture" will be able to point to far greater achievements, and to a more prosperous state of matters than has fallen to the lot of any of his predecessors.

## Appendix A.

We have already directed attention to the most important features in the progress of British agriculture during the period which has elapsed since the publication of the last edition of this *Encyclopædia;* but with the view of presenting the results of this progress in a more definite and interesting form, we have much pleasure in submitting to the reader the following report on the farming of East Lothian, which has been kindly furnished to us for this purpose by Mr Patrick Sherriff, formerly of Mungoswells :—

### On the Agriculture of East Lothian.

"Haddingtonshire, or East Lothian, has long been celebrated as a grain-producing district, and this leading feature of its rural economy may perhaps have originated from the dry and early climate of the district. Here many practices which have distinguished Scotch husbandry were first introduced; and the farmers, profiting by the fortuitous circumstances under which they have been placed, are not slow in adopting discoveries which are likely to promote their interests. Accordingly, in this progressive age, the recent changes in the agricultural system have been very striking, and may be well illustrated by what has taken place in the parish of Dirleton since 1836, when the Rev. John Ainslie wrote an excellent description of the parish, and which forms a part of the new Statistical Account of Scotland.

"The parish of Dirleton is situated on the shores of the Firth of Forth, and in soil and climate may be considered a fair specimen of the parishes in the county which are bounded by the sea. The surface embraces soils of every texture from adhesive clay to drift sand; the latter, which exists to a considerable extent along the whole line of coast, is consigned to permanent pasture, and chiefly stocked with rabbits. The land under cultivation extends to between 5000 and 6000 acres. Since 1836, when the new Statistical Account of Scotland was published, no land has been reclaimed, in the common acceptation of the term, neither has any permanent pasture been subjected to the plough; and as the surface may be considered unchanged in extent as well as in aration, the increase of disposable produce which has since taken place must be regarded as the results of improved farming.

"From a statistical report of the parish of Dirleton for 1627, it appears that farms were then held by leases of considerable length, and at corn-rents. Afterwards rents payable in money seem to have been introduced; and in the early part of the present century, nearly all the land in the parish was so rented. During this period, when the lease of a farm expired, the increase of rent was great; generally keeping pace with, and often exceeding, the rise which had taken place in the price of agricultural produce during the war with France. The fall of prices which followed the return of peace and the passing of Peel's currency bill, joined to deficient crops for a succession of years, commencing with 1826, involved the occupiers of land in severe distress. Many individuals were unable to meet their liabilities, fell into arrears of rent, and ultimately became unable to cultivate the land in a proper manner for want of capital. This crisis brought about a return to corn-rents, payable in money at fiars prices; and at present there is only one farm in the parish differently rented. The change from money to corn rents took place subsequent to 1830, and the new arrangements having been made with liberality and kindness on the part of landowners, and carried out with energy by the tenantry, the results have proved beneficial to the contracting parties as well as to the public. Ferrygate, one of the best farms in the parish, was held in 1836 at a mitigated rent of 406½ quarters, was re-let in 1852 at 525 quarters of wheat, payable in money at fiars prices. The farm of Chapel having been leased in 1814, was rented in 1832 at L.1150, and re-let in the following year at 260 quarters of wheat, the landlord engaging to drain the farm; and in 1852 the farm was again re-let at a rent understood to be 180 quarters of wheat and L.495 of money, with the addition of 4 per cent. upon any outlay which may be required for draining. Assuming 40s. per quarter as the price of wheat, this would indicate an advance of 64 per cent. upon the previous letting. This farm had been unusually low rented in 1832, in consequence of a panic that then prevailed among farmers.

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"In 1836 Mr Ainslie states, 'now there is hardly one open field in the parish.' The original fences chiefly consisted of thorn hedges, there being few stone walls, with a ditch to carry off water. The hedges had been so long neglected, that, with their wide-spreading branches, they often resembled a row of trees; and a considerable portion of ground remained uncultivated under the branches of the hedges, as well as on the margin of the ditch opposite to the hedge. Within these sixteen years past, the ditches have been transformed into covered drains, and the straggling hedge into a straight line, the roots being regularly dug and freed from weeds. The hedge and ditch of 1836, with the uncultivated land on their margins, often occupied a space 18 feet in width; the fences of the present time seldom exceed 2 feet wide. Taking the fields of the parish, which were bounded by hedge and ditch, to average 25 acres in size, more than two per cent. has been added to their arable surface of late years, and perhaps the fences of the present day do not occupy more than one-half per cent. of the surface.

"Mr Ainslie states, that 'the drainage of the parish is in the course of being made very complete. Springs have long since been laid dry, and tiles are now extensively employed to carry off the surface water. On the soft muirish land, a drain is made every second furrow or 36 feet asunder.' This drainage was soon found to be insufficient for drying the land, and in consequence drains were placed 16 or 18 feet distant; and on this scale the drainage of nearly all of the wet soils has been completed. About the time Mr Ainslie wrote, tiles were occasionally brought a considerable distance by sea for the purpose of draining, but soon afterwards two works for the manufacturing and sale of tiles were erected within the parish; and on the draining of the neighbourhood being completed, they have been removed, and the ground on which they stood restored to fertility. Such has been the progress of knowledge in respect to draining, that a farmer in the parish who asked and obtained from his landlord a grant of L.300 to complete the drainage of the lands which he occupied, and which had been previously drained on the system of deep cross cuts, actually expended this sum, and upwards of L.2000 of his own capital in furrow-draining the farm.

"Mr Ainslie mentions, that in 1835 a few bones and about 100 tons of rape cake were used within the parish. The manures brought into the parish and applied to crop 1851, consisted of about 1600 tons of street manure, 277 tons of guano, 33 tons of rape cake, 30 tons of charcoal, 5 tons of sulphate of ammonia, 5 tons of bones, 2 tons of superphosphate of lime, and 2 tons of nitrate of soda. There were also 150 tons of oil-cake, and 37 tons of grain used in fattening animals, and which, like extraneous manures, increase the productiveness of the farm.

"In 1836, the parish contained nine stationary steam-engines for thrashing grain; in 1852 the number had increased to fourteen.

"The statistical account of 1836 shows, that there were about 468 cattle and 2000 sheep fed within the parish, both kinds of stock being chiefly bred in other districts. The turnip and grass crops of 1850, aided by oil-cake and grain, fatted 779 cattle and 4070 sheep. When it is considered that permanent pasturage is unchanged in all respects, and that the home consumption of grass and turnip by milch cows and farm horses is nearly the same, the increase of animal food since 1836 resulting from improved farming may be taken to exceed 100 per cent.

"The buildings connected with farms have generally been enlarged and improved since 1836. In several instances they

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have been entirely re-built, and in general they embrace substantial accommodation for the machinery and animals essential to high farming. In alluding to the peasantry, Mr Ainslie states, that 'their cottages have also been materially improved in comfort and cleanliness. The pigsty and dunghill form no longer the foreground decorations; and in many places, especially in the village of Dirleton, have been supplanted by roses and evergreens. In some of the late-built cottages there are two rooms, an example well worthy of imitation, as eminently conducive to the morality, no less than to the comfort and health of the people.' The dwellings of two apartments, so properly commended by Mr Ainslie, were soon followed by houses of three rooms; and more recently, cottages of one story have been built for farm-servants, containing a kitchen, three sleeping apartments, dairy and scullery, with a sink and rain-water pipe. Each cottage has a garden, pigsty, and other conveniences; and there is a pump-well and bleaching-green common to all. In Somerville's Survey of East Lothian, published in 1812, the dimensions of a labourer's cottage are stated to be 20 feet by 17, with walls 7 feet high, and the area undivided. The dimensions of a good cottage of the present time are 21 feet by 31, outside measure, with walls 8 feet high, and the area divided into four or more compartments. The improvement of the cottages has led to improved habits of personal cleanliness in the families of the labourers, as well as to improved floral taste. To 'the roses and evergreens' of Mr Ainslie's time, have been added fuchsias and the most choice creepers, while more tender plants growing in pots are displayed inside of the large-sized windows. In one instance the buildings connected with a farm of moderate size must have cost in erecting between L.4000 and L.5000, exclusive of the haulage of materials. Such accommodation cannot fail of being favourable to the health of the indwellers, rational and irrational, of making farmers and labourers discharge their respective duties more cheerfully, and of increasing the rentals of landholders.

"The alternate system of white and green crop continues to be followed; but of late years summer fallow has been diminished in extent, and the growth of turnips increased. Less land is devoted to clover and ryegrass, in consequence of pasturing being generally restricted to one year; while the bean and pea have, to a considerable extent, been supplanted by the potato.

"The assistance which nature has of late years received from drainage and extraneous manures, combined with improved implements, increased skill and industry amongst farmers and labourers, have produced important results on the productiveness of the parish. We have ascertained by enumeration, that the production of meat has been doubled in fifteen years; and although this mode of estimating quantity is not practicable with all the other products of the parish, there is no doubt of the increased productiveness being great. On some farms where nearly the whole of the surface is annually dressed with extraneous fertilizers supplementary to the ordinary manure of the farm, where the home consumption is taken from the home produce, and where the growing of potatoes has been extensively substituted for the bean and pea, the marketable produce has been increased fourfold. High farming has not, however, been universally practised, and therefore it cannot be said that the disposable produce of the whole parish has been more than doubled in the time specified.

"The inhabitants are either employed in the cultivation of the soil, or are chiefly dependent for employment on those connected with agriculture. By the census of 1841 the population of the parish was 1497, and in 1851 the inhabitants numbered 1646. At the present time there is an increasing demand for agricultural labour; but the addition to the number of inhabitants does not show forth all the increased employment arising from the improved state of agriculture since 1836. Many people residing beyond the parish must be employed in preparing and bringing forward the extraneous fertilizers and fattening auxiliaries now so extensively used, in the transport and manufacturing of the increased disposable produce of the land, as well as in the production and distribution of commodities required by the increased numbers and the improved condition of the resident population.

"The progress of agriculture in the land-bound parishes has been similar to what has been detailed in connection with Dirleton. Throughout the whole of the county the improvement of cottages, farm buildings, and fences can be traced. Furrow-draining has been extensively practised, the application of extraneous fertilizers and the use of fattening auxiliaries generally carried out. The application of lime to the soil has long been decreasing. With the exception of a few spots being reclaimed on the slopes of the Lammermuir hills, lime is now seldom used in agriculture.

"Within these last sixteen years little difference is observable in the breeds of sheep fatted within the county, with the exception of the introduction of a few South-downs; but a striking change has taken place with regard to cattle. For the fine and mature-aged animals from the northern counties of Scotland, which formerly graced the feeding courts during winter, have been substitued young and inferior descriptions of short-horns from Ireland and the north of England. This change has perhaps been owing to more of the northern cattle being now fatted where they are bred, and sent direct for the English shambles; but there is no reason for supposing that the farmers of East Lothian have sustained a loss by this change of breeds, as the young short-horn is considered to grow more in size while under the fatting process. In the modes of fattening animals changes have recently crept in. With cattle there has been introduced box feeding and an extended use of auxiliary foods. Sheep are fatted in July, August, and September by folding off winter and spring tares approaching ripeness, with addition of oil-cake; and also from the middle of August onwards by means of early sown turnips. The cultivation of winter tares upon a considerable scale has hitherto been confined to the neighbourhood of Ormeston where they were successfully grown by Mr Wight 130 years ago.

"The improvement in implements and machinery has hitherto been slow; but a spirit of inquiry has lately been directed towards this department of agriculture. The thrashing machine, which was first invented in this country in 1786, continues to be used with some of its defects uncorrected. Within fourteen years, as a substitute for the scutching drum, the American peg drum has been tried and laid aside; and very recently the English bolting drum has been introduced. The bolting drum and concave, from acting by a union of beating and rubbing, preserves the straw nearly unbroken, facilitates the shaking and winnowing processes, extracts the corns from the ears whatever may be the position of the sheaf on entering the machine, and is easily propelled. From combining so many good properties the bolting drum and concave is likely to supersede Meikle's scutching drum.

"The first properly authenticated attempt to construct a thrashing machine was made in this country in 1732, by Mr Michael Menzies; and the machine now in use was introduced by an inhabitant (Mr Andrew Meikle) in 1786. No individual has laid claim to the invention of the rubbing drum and concave now so generally found in the southern parts of England, and there is every reason to believe that they originated with Mr (afterwards Sir Francis) Kinloch of Gilmerton in this county. Evidence of this fact may be obtained in the *Survey of East Lothian*, by Mr Buchan Hepburn, in 1794, and in a letter from George Rennie, Esq., of Phantassie, published in the *Farmer's Magazine* for 1811.

"No change deserving of notice has lately taken place with regard to ploughs and harrows. Scoullar's and Tennant's grubbers, both recent inventions, are much esteemed. In some instances they have supplanted Finlayson's harrow, which has been the favourite grubber in the county since 1826.

"Several improvements in corn drills have lately been effected by Hunter of Samuelston, and Sheriff of Westbarns, in this county; but the drilling of corn crops is far from being general in East Lothian. The practice has not increased of late years, a belief existing amongst farmers that drilling affords no increase of produce unless the ground is hoed when infested with annual weeds. Garret's and Sheriff's horse-hoes for drilled corn crops are used by a few farmers.

"After reaping machines having engaged the attention of some of the inhabitants of this county for nearly half a century, the harvest of 1852 brought into the field six or seven of

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Hussey's American reapers manufactured by Crosskill; all of which were laid aside after the first trial, with exception of one, the owner of which successfully persevered throughout the harvest. Bell's reaping machine was also exhibited at work within the county, and met with general approbation, after having been neglected for nearly a quarter of a century. The cutting of crops by machinery having been publicly demonstrated, there is reason to believe that reaping machines will be much used in time to come. Hitherto the extensive harvests of East Lothian have been chiefly cut down by people from other districts, enticed by the hope of high wages, and who return to their homes when the harvest is over. The recent increase of commercial and manufacturing employment, resulting from freedom of trade and consequent improved state of the lower classes, joined to an extensive and extending emigration of labourers, also the result of free trade, has so diminished the number of itinerating harvesters, that, in future, East Lothian farmers must either employ reaping machines or allure assisting hands by extravagant wages.

"Within these last sixteen years no striking advance has perhaps been made in improving the implements of the farm; but considerable changes are taking place in the uses to which they are applied. Of late years the plough and the roller are seldomer, and the grubbers are oftener, employed in preparing soils for green crops, and in extracting root-weeds from them, whether the cleaning process is performed in spring or in autumn. It frequently happens that clay soils, which were formerly ploughed four or five times, and received perhaps as many harrowings and rollings to fit them for a turnip-crop, are now prepared by one ploughing: natural agencies being more effectual than the implements of man in pulverizing such soils.

"Hunter's, Hopetoun, and Fenton wheats all originated in East Lothian; and at the present time are the standard wheats of the county. Many new varieties of the different grains are introduced from time to time, and generally find a short-lived reputation; but although no very marked improvement of agricultural plants has lately taken place, there are no signs of degeneracy in the oldest kinds of grain. At the shows of seed corn under the auspices of the East Lothian Agricultural Society, in the case of the mentioned wheats the prizes are occasionally carried off by parcels grown upon the farms where the variety was first propagated, and where it has been since cultivated without a change of seed from the time of discovery; proving beyond question that, when soil and climate are congenial to the wheat plant, change of seed is unnecessary. Vast and increasing quantities of seed corn are annually sent from East Lothian to other districts. With turnips, Skirving's purple-top yellow has supplanted, in many instances, the white globe and the Swede, having been found to answer well both for early and late consumption.

"In the rotations of cropping, or in the relative extent which one description of crop bears to another, the chief change has taken place with the turnip and the potato; the one having supplanted the bean, and the other naked fallow. The increased growth of these plants is chiefly owing to drainage, and the application of extraneous manures—the one having supplied nourishment, and the other a fitting condition of soil. Without a union of these improvements, the cultivation of such crops could not have been successfully extended.

"The potato disease which has been so prevalent of late years throughout Britain, and more especially on its western shores, has been comparatively little felt in East Lothian, and hence the extended growth of this root. Whatever may be the cause of the potato being less affected by disease in East Lothian than in the surrounding districts, the fact is unquestionable. So fine has been the quality of this root, that large quantities of potatoes have been annually sent to the markets of England, Ireland, and Wales.

"Amongst the recent changes affecting agriculture, railways ought not to be forgotten. The North British Railway and its branches intersect East Lothian, and afford a cheap and an expeditious conveyance for manures and farm produce, whether in a raw or manufactured state, and more especially for the potato, which is one of the most perishable and cumbrous commodities of the farm.

"However great the advances of East Lothian agriculture may have been of late years, its future progress is likely to be still more rapid. Without placing undue reliance on the discoveries which the intelligence and enterprise of the age are likely to effect, there is much to be expected from what is now at command. Unrestricted competition, which has been found so beneficial with other classes, will urge agriculturists to adopt, and energetically to employ, all agencies within their reach. Naked summer fallow, which at one time was considered so beneficial, that a monument was proposed to be erected to John Walker, who first practised it in East Lothian, must be entirely laid aside. The occupiers of clay soil, by substituting the grubber for the plough, and early for late green crops, will vie with the possessors of light land in the fattening of animals, without diminishing the corn crops which such soils are so pre-eminently calculated to yield. By an extended use of portable manures, combined with early sowing of early varieties, much of the uplands, now yielding scanty returns, will equal soils near the level of the sea in the production of butcher meat and grain, with an increase of sustenance for the breeding flocks, which constitute the staple commodity of such districts. In the genial climate of East Lothian, annual applications of fertilisers to the whole arable surface of the farm could not fail of proving advantageous. And with the adoption of the changes enumerated the disposable produce of the county would be vastly increased in a few years.

"It will be found that the state of the population connected with farming is often affected by the security of tenure granted to, and the amount of rent paid by, the occupiers of the soil. Leases have long been general in East Lothian, and in some cases the rents of farms have always been quantities of corn either delivered in bulk or payable in money at fiars prices. The money-rents contracted previous to 1830 were soon afterwards generally changed into quantities of corn payable at fiars prices, and nearly all the corn-growing farms of the district are held at such rents. The succession of deficient crops formerly noticed, and consequent distress amongst farmers, extended over the county generally, and arose from the severe drought of 1826, followed by the ravages of the wheat fly for several consecutive years, when the yield of wheat on some of the best farms did not reach 16 bushels per statute acre; and in 1828 the wheat crop on the farm of Wintonhill was offered to and refused by the incoming tenant at 12⅞ bushels, exclusive of the expense of harvesting and marketing the crop. About that time many farmers were impoverished, and without security of tenure from being in arrears of rent. With a view of meeting their pressing liabilities, retrenchment was carried into every department of the farm. The productive powers of the soil were drawn upon, fewer people were employed, the wages of labour fell, and depression overshadowed the industrial classes connected with agriculture. The change of money-rents into quantities of corn payable at fiars prices, coupled with the return of more productive seasons, altered the prospects and policy of farmers. Knowing that, under the altered terms of their contracts, security of tenure was restored, and that all the proceeds of augmented crops would not be absorbed in paying rent; and having experienced the evils of parsimonious management, they set about increasing the productiveness of their farm by every available means. To accomplish this object, soils were deepened, drained, and enriched, by employing more capital and labour; better crops were obtained, and the working-classes became enabled to purchase with the wages of labour a greater share of farm-produce.

"From what has been experienced in East Lothian, it would appear that when landowners for a length of time exacted too much rent, farmers employed little capital and labour, inferior crops were reaped, and the state of cultivation retrograded. On the other hand, when a moderate rent was paid, much capital and labour were employed, augmented crops were obtained, and agriculture was progressive.

"In the metayer system which prevails in some countries, the miserable crops are equally divided between the owner and occupier of the soil; and other parties are but little interested in the division. With an improved state of agriculture, such as now exists in East Lothian, matters became very different; and it is the province of the farmer to distribute the produce, or rather its money value, amongst the parties entitled to it. Every individual who aids the productive powers of the soil by his labour, or otherwise, becomes entitled first to be paid; and the landowner ought to receive as rent only what remains after disbursing the legitimate expenses of production. Much of the augmented produce of the present time goes to the non-agricultural population—such as ingenious mechanics and manure merchants. The results of high farming form a large fund for rewarding many classes of the community, and with a good understanding existing between the owners and occupiers of the soil, that fund will progressively increase.

"Viewing the farmer simply as a distributor of the fruits of the earth, it may appear that he has no pecuniary interest in the quantity gathered or the division of it beyond what falls to his own share. He will, however, find as a general rule, that without large crops his portion will be small, and that the larger the produce distributed amongst the number of individuals aiding in producing the crop, the greater will be the happiness diffused amongst the population."

## Appendix B.

After the foregoing article was partly put to press, we became aware that *the two gold medals offered by the Highland and Agricultural Society of Scotland, for the best plans of farm-buildings for large and small farms,* had been awarded to Mr James Cowie, Mains of Haulkerton. From the novelty of the principle adopted by Mr Cowie, and the skilful manner in which he has worked it out, we felt desirous to include an illustration of it in the present treatise. This he has kindly enabled us to do by placing at our disposal the specifications and descriptions of plans. (Plates XIV., XV., and XVI.)

"The plan, Plate XIV., is calculated for a farm of 400 acres, and can be erected at a cost of about L.1200, exclusive of carriages. I have given full sections and elevations along with a ground plan of it, accompanied by full specifications, which will enable readers to understand it fully, and in fact to make it available and ready for tradesmen to work by, if required. Notwithstanding, to those not accustomed to judge of buildings from drawings, a few explanations may not be unacceptable, as leading to a more ready understanding of the arrangements. It will be seen that the two granary lofts, upper and lower, are attached to the sheaf-loft and corn-room. The division between them can be made to shift, so as one can be lessened or enlarged as may be required. The adjacent house has, in the ground-floor, a boiling-house and hay or grass shed, which may extend above the water-wheel to the corn-room wall. The floor above can be occupied as an auxiliary sheaf-loft or granary, or for erecting machinery for bruising corn or other food, &c. The straw barn is placed in the centre of the building, and allows two kinds of straw to be deposited separately. The hay shed and infirmary, when not occupied, can serve as a store for straw or chaff if need be. The turnip sheds are placed quite adjacent to the cattle, which can be fed from a small waggon on a railway, by the arrangement adopted here, in nearly half the time required by employing the common wheel-barrow. The sheds or boxes for the loose cattle are placed four feet below the level of the rest of the interior, and are immediately behind the stalls, so as to admit of the dung being removed from the tied-up cattle with the least labour. The cow-byre is in a separate division, and the calves-house is in proximity to it. The stable, which has two doors opening externally for more ready access to the horses, is conveniently situated as regards proximity to the boiling-house, corn-room, straw-barn, dung-shed, and cart-sheds; and there is a room provided over the turnip-shed for a sleeping apartment for the persons in charge of the cattle and horses. There are two large loose boxes, carpenter's shop, pig-sties, an ample tool-house, and an enclosed shed, which is capable of containing two carts, or can be employed in a temporary way as a guano or potato house. The poultry-house has a yard, part of which can, as occasion may require, be staked off as an exterior area for an invalid beast requiring fresh air. The saddle-horse stable and gig-house may be simply referred to in concluding the description. This steading thus embraces within a comparatively compact circle, all the conveniences required for a farm of the size specified; and it is not the least recommendation to it that the farmer can see almost at a glance, in any part of the interior, all his 10 or 12 horses, his 50 stall cattle, his 60 shed cattle, and his 30 or more calves; and from the position of, and ready access to them all, he can at once see how they are supplied with food and litter. The whole homestead with its contents, live and dead stock, are in fact as much within the visible scope of its owner, and manual access of the servants, as anything of the kind can, or requires to be.[1]

"The plan, Plate XV., is that of a farm on the small property of Calvennan, in Wigtownshire. It was built last season at a cost of about L.500. It has three roofs, and the arrangements, which are similar to those in the plan just described, will be understood by a reference to the accompanying plan and sections."

### "Specification for Steading of Farm-Offices.

### "*Mason Work.*

"All necessary excavations will be performed by the tenant.

"The walls will be founded at the depth shown by the sections, or as much more as will insure a firm and solid foundation. The contractor must satisfy himself as to the extent of the necessary depths, as no addition will be allowed for extra building.

"The foundation course of the walls are to be laid with large flat-bedded stones laid close together, and their joints hard packed with stone-shivers and lime mortar, and having a toe or ledge from 3 to 4 inches broad, projecting beyond the thickness of the walls on each side. The walls are to be of good coursed and well banded and packed common rubble work. The stones composing the outside courses are to be well axe-dressed on the face, and to have beds of not less than 7 inches of breadth, and not to exceed 12 inches in height, having headers laid in each course at from 5 to 6 feet apart, extending at least two-thirds the thickness of the walls, and the whole to be particularly snecked on the outside, and back-snecked. All corners, outband door and window rybats, to be 26 inches in length, and squared on the ends; and inband rybats to go through the walls; and the whole to have heads not less than 8 inches broad. The rybats of the large doors will have checks $1\frac{1}{2}$ inches by $2\frac{5}{8}$ inches on the outside all round. All other doors opening to the outside will have checks $1\frac{1}{2}$ inch by $2\frac{1}{2}$ inches; and the other door and window rybats will have checks 2 inches deep, and one inch check on the lintels. All the corners of the buildings, door and window rybats, soles, and lintels, tabling and put stones, and arch stones, are to be well droved and jointed, and the pillars of the cart sheds are to be close jointed, and all rybats to have a margin of 3 inches round the outside faces, and on each of the external corners. The heel-posts of the byres are to be of stones 8 inches square, to be well droved, and to have a groove cut in each $1\frac{1}{2}$ inch square, for the travis-boards, and to be well sunk in the ground, 2 feet at least, and to stand $3\frac{1}{2}$ feet above the saddles as shown.

"The feeding-troughs of the byres are to be raised above the causewaying 6 inches, and bottomed with well droved and jointed stones; and the wooden posts of the stable and byres are to have proper stone bases. The urine under drains are to be laid with glazed socket-pipes to communicate with the urine tank, as shall be pointed out.

"The internal walls of the corn-room, sheaf-loft, and granaries are to have one good coat of plaster, and the walls of the same are to be beam filled between the couples.

"Such of the houses and passages as shall be pointed out for causewaying shall be done in a proper and sufficient manner by the contractor at the rate of threepence per yard.

[1] In Plate XIV. the plan of an ark for a water-mill is given, but should a steam-engine be required the erections for it can be made in place of the ark in the same situation.

"The foundation of the underground walls of the ark are to be laid with large flat-bedded stones, all well laid and packed, and the whole of the water walls are to be of well-sized stones squared up, axed on the face and well jointed, to have full beds, and built in courses, and every third stone to be a header of at least 2 feet in length. All openings are to have squared up scuncheons. There will be a projecting course laid at centre 9 inches thick, and at least 1 foot 9 inches in breadth, well droved and jointed. The bottom of the ark is to be slabbed with good quarry stones, and the tail race through an arched opening 3 feet square, the thickness of the wall. The size and form of the stones for hanging the machinery, and all the necessary cuttings, boring, and levellings, &c., must be executed at the sight, and to the satisfaction of the mill-wright or inspector.

"All the lime for the building is to be of the best English shells, well slaked and made into a stong composition of mortar with clean sharp sand, and all the joints of the outside work are to be well ripped out and pointed with Scotch lime mortar, in a proper season, and the ark is to be pointed with Roman cement.

"All necessary raggles are to be made, window frames bedded and pointed in, and the lead and the running in of the hinge crooks of the doors, also the laying of the urine-pipes, and all inferior jobs necessary for the completion of the mason-work, must be done at the sight, and to the satisfaction of the inspector without any additional charge.

### "*Carpenters' Work.*

**Lintels.** "Safe lintels throughout the buildings to have 1 inch of thickness to every foot of extreme length, and to have 9 inches of wall-hold, and closely fitted up to the out-side stone lintels. All inside doors to have wood lintels.

**Joists.** "Joists and sleepers to be laid as shown, 18 inches from centres. Joists to have 9 inches of wall-hold.

**Trimmers.** "To have one row of trimmers in centre 10 inches by 1.

**Mill-beams.** "Mill beams to be laid as shown, to have 12 inches of wall-hold; to be double mortised, and fixed with a $\frac{7}{8}$th-inch joining bolt.

**Roofs.** "The main couples on wide roofs will be framed as shown, and secured at the joinings with iron plates; the rafters to be placed 21 inches from centres, checked at joinings, and securely nailed.

"The wide roofs will be supported by cast-iron columns as shown. These columns to have large bases and capitals, and to have 6 inches diameter at the centre, and not less than $\frac{5}{8}$ inch thick of metal, fixed at the top to a dressed beam 11 inches square, and let into the stone base at the bottom $\frac{1}{4}$ inch. The other roofs to be framed up as shown—roofing to be checked at joinings, and properly nailed.

**Slate-lath.** "Slate-lath to be nailed on to answer slates 16 inches by 8 inches, or as near to that size as can be conveniently got.

**Gutters.** "Gutters between the roofs to be formed as shall be shown; all to be properly bracketed up and laid with ploughed flooring.

**Luffer windows.** Luffer-windows for granary and ventilators to have frames 3 inches by 2 inches, boards one inch thick, and made to open and shut with a rod and wood brackets, as shall be shown.

**Windows.** "The window-frames to be two inches thick, and to be made to open on pivots 12 inches from the top, and to be filled with strong rough plate glass.

**Doors.** "All the large doors to be in two halves, bound with four bars each, 7 inches by $1\frac{1}{8}$ inch, and all to have margin stiles in both edges $3\frac{1}{2}$ inches by $1\frac{1}{8}$ inch. Covering to be $\frac{7}{8}$ inch thick, ploughed, and all beeded on the joints. Each door to have two slipping bolts 18 inches long, $\frac{3}{4}$ inch diameter, made to work on strong iron plates; hinges to be $2\frac{1}{4}$ inches broad, $1\frac{1}{2}$ inch at neck, and each hinge to be two-thirds the width of the door, and to have three screw bolts each.

"Corn-room door to be cut across the centre horizontally. All the other outside doors to be in one piece, and all to be framed on the back-side with stiles and bars; stiles $3\frac{1}{2}$ inches, bars 7 inches by $1\frac{1}{8}$ inch. Each door to have four bars covered with $\frac{7}{8}$th inch deals, either to be ploughed and beeded on the joints, or plain joints separated $\frac{3}{8}$th inch between deals, as shall be required: hinges 2 inches broad, $\frac{1}{4}$ inch thick, and two-thirds the breadth of the door, and each to have a screw-bolt at neck. Such of the doors as shall be pointed out to have a sliding board 9 inches square at bottom to admit air at pleasure. All the doors to have strong ring latches, and those on the outside to have home-made locks of the value of 5s. each, to be put on with three screw bolts each. Keys of stable-doors to have rings. The doors for granaries and sleeping apartments to be made similar to the others, but hung on posts with good hinges, and to have locks same as the others. All the doors, luffer and other windows to have three coats of white lead paint, finished to a taint to be approved of.

**Crooks.** "Crooks to be feather-tailed, pins for large doors $1\frac{1}{8}$ inch, for small doors 1 inch.

**Flooring.** "Mill-loft and granaries to be floored with $1\frac{1}{8}$ inch thick deal, not broader than 7 inches, clean dressed on face, grooved and tongued, and nailed down with 14 lb. spikes, and the bye wood all cleaned off. Dressed skirting boards fixed to ducts round all the walls of granaries, corn-room, and sheaf-loft, 7 inches deep and 1 inch thick.

**Stable-mangers.** "The mangers to be 16 inches deep, and sloped from the back to 20 inches, and in addition to have a 3 inch deal biting tree of hard wood. The front and bottom to have $1\frac{3}{4}$ inch deal, the back 1 inch deal.

**Stable-posts.** "The posts to be octagon, 8 inches diameter at foot, and 7 inches at top, grooved for travis $1\frac{1}{2}$ inch deep and 2 inches broad; to be fixed at top to a run-joist 7 inches by $2\frac{1}{2}$ inches, with a large oak pin, and at bottom with an iron pin 5 inches long, 1 inch diameter. Front posts same size, split up the centre and similarly fixed. Posts and run-joists to be clean dressed.

**Stable-racks.** "Hay-racks to be fitted up in the stable 36 inches broad. The splits to be $2\frac{1}{4}$ inches by $1\frac{1}{8}$ inch, and to be 4 inches between. Rails to be 4 inches by 2 inches, and checked for splits, and properly nailed.

**Travis boards.** "Travis to be 2 inches thick, to be clean dressed, close jointed, each joint to have 3 iron dowels $\frac{3}{8}$th inch diameter; and to be fixed between the front posts by screw-bolts. The gable walls to be lined the length of the stalls with 1 inch deal, ploughed and fixed to straps 1 inch by 2 inches. Travis to be finished on the top with an ogee, and strapped with thick iron hoop.

**Harness pins.** "Harness-pins and saddle-rests to be fitted up as shall be pointed out, each post to have an iron hook for hanging harness. Two rings to be fixed into each post for binding horses.

**Corn-chests.** "Two corn-chests to be fitted up in recesses in walls of stable, of 1 inch ploughed deal, 4 feet long each, 2 feet wide inside, and 3 feet deep; provided with proper locks and hinges. One corn-chest 3 feet long for riding stable, similar to the others.

**Byre-troughs.** "Fronts and backs of byre-troughs to be 2 inches thick and 12 inches deep, to slope towards the cattle, and rounded on the edge.

**Byre-posts.** Post to be fitted up as shown, to be fastened at bottom and top same as stable, to be $5\frac{1}{2}$ inches diameter, champhered in corners. The front post to be grooved for receiving travis, the other one to be in two, and travis fixed to them same as stable. Run-joists to be 6 inches by 3 inches. Iron sliding rods 14 inches long, $\frac{3}{4}$ inch thick, to be fixed in the posts with screw-bolts for cattle bindings.

**Byre-racks.** "Racks to be fitted up 30 inches deep on the side next the cattle, and 24 inches on the other side. Same dimensions as stable racks, and fitted up in the same way; splits to be 6 inches between.

**Byre-travis.** "Travis boards to be $1\frac{1}{4}$ inch thick, $4\frac{1}{2}$ feet high at front, and 3 feet 3 inches at back; and front-bar 5 inches broad, and 2 inches thick, to be nailed to the front posts, and 2 feet above the edge of the troughs.

**Cattle-shed troughs.** "Troughs to be made into proper lengths for convenience in shifting. Sides to be 14 inches deep and 2 inches thick; bottom $1\frac{1}{2}$ inch, to be properly secured by longitudinal spars, nailed to bottom and framing, frame 3 inches by 2 inches, and made to stand on feet. Width of troughs to be $2\frac{1}{2}$ feet; all to be firmly nailed.

**Cribs.** "One straw-crib to be made for each division of sheds; posts to be 4 inches square, to have 3 rails on each side, 4 inches by 2 inches; to stand 4 feet high, 8 feet long, and 4 feet wide.

"Two traps to be made for corn-room, loft, and stable, of such length and dimensions as shall be pointed out.

"All scaffolding, centring, and moulds, are to be furnished to the contractor for the mason-work. All inferior jobs not specified, nor shown in sections necessary for the proper completion of the carpenter work, shall be done without any additional charge, unless from its nature and extent such shall be alllowed by the inspector of the work.

"All the timber shall be of good Baltic timber, or American red pine, and must be well seasoned.

"*Scantlings of Timber.*

"Sleepers, 6½ inches by 2½.

Joists, 10½ inches by 2½.

Rafters, narrow roof, 6 inches at bottom, 5 inches at top, 2½ inches thick.

Baulks or ties, 6½ inches by 2.

Cross beam for thrashing-mill, 10 inches by 14.

Longitudinal beams, 7 inches by 14.

Safe lintels for large shed-doors, 10 inches by 10.

Slate lath, 1½ inches by 1.

Rafters of main-couples, 5 inches by 8.

Tie beams of do. 9 inches by 5.

King posts of do. 5 inches by 5.

Spurs or anglers, 5 inches by 5.

Purlins, 5½ inches by 5½.

Intermediate rafters, wide roofs, 6 inches by 2.

"*Slater Work.*

"The roofs to be covered with blue Welsh slates, size 16 inches by 8 inches; to have 2-inch cover or overlap, and all to be fair and closely laid. To be nailed to laths with nails weighing eight pounds per thousand, steeped in oil when red hot, and each slate to have two nails. Skylights to be put in as shown, of strong sheet-glass of the size of 12 inches by 18 inches, fitted into zinc frames, weighing 16 ounces per square foot. The valley gutters to be covered with lead weighing 6 lb. per square foot, and 12 inches in breadth. The flat gutter between the roofs to be covered with lead weighing 6 lb. per square foot.

"The gutter at the narrow ends will be 9 inches in breadth, and the lead to rise up on the roof the usual height.

"Gutters will have declivities of 1½ inch on every 10 feet of length, and to have boxes formed where shown, 5 inches deep; to have 3-inch lead pipes soldered into the same, and carried through the beam below into the cast-iron columns. All the roofs to be upheld sound and water-tight for eighteen months after being finished.

"The whole of the work, including materials, but excluding carriages, must be performed by the day of in a most substantial and workmanlike manner, to the entire satisfaction of or any other person to be named by the employer. Any alterations that may be made in the progress of the work at the suggestion of the inspector shall be paid for, or deducted according to his estimate."

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# AGRICULTURAL CHEMISTRY.

The application of chemistry to the development of the principles of agriculture, though it has only of late years attracted general attention, is by no means new. It dates as far back as the period at which agriculture, after remaining for ages almost stationary, received that stimulus which has led to its recent progress. The earliest reference to the composition of vegetables, and the source of their food, in an agricultural point of view, we owe to Jethro Tull; and though his conclusions are no doubt often erroneous, as indeed they could scarcely fail to be, in the then imperfect state of our knowledge of vegetable chemistry and physiology, and with his limited acquaintance with what was even then known, yet some of his observations are unquestionably both ingenious and valuable. They were, however, incidental merely, for he attributed the benefits of his improved method of culture to mechanical, and not to chemical principles, and deliberately denies the statement put forth by Van Helmont, and some of the chemists of his own time, that plants derive their food from the air.

While we thus fix the work of Jethro Tull as the earliest in which allusion is made, though only indirectly, to the chemical principles of agriculture, its effect was rather to turn attention from, than direct it to the investigation of the subject; and it was not till the close of the last century that its importance was brought distinctly before the agricultural public by the publication of Lord Dundonald's *Treatise on the intimate connexion between Chemistry and Agriculture.* Almost simultaneously with its publication appeared the earlier researches of De Saussure, which, extending over a long series of years, have the merit of laying the foundation of all that has been recently done, and of opening up the field which has been since so successfully cultivated. Saussure investigated, in every point of view, and with a care and accuracy which have never been surpassed, the principal phenomena of the life of plants, and directed attention to the important bearings which many of the facts he substantiated had upon the practice of Agriculture. Neither Saussure's investigations nor the work of Lord Dundonald, appear to have excited that attention which they deserved, or to have produced any immediate effects in the progress of agriculture; but a lively interest was excited by a course of lectures on agricultural chemistry given by Sir Humphry Davy, in the year 1812, at the instance of the Board of Agriculture, and afterwards published. These lectures, written with all the elegance and precision which characterised their author's style, brought prominently before the public the results of Saussure's experiments, and contained a number of useful practical suggestions, many of which have been adopted into our everyday practice, and become so thoroughly incorporated with it, that their scientific origin has been altogether forgotten. The interest which Sir Humphry Davy's work awakened was only temporary: it soon died out, and the whole subject lay in abeyance for a considerable number of years. The truth is, that at that time agriculture was not ripe for science, nor science ripe for agriculture. The necessities of a rapidly increasing population had not then begun to compel the agriculturist to use such means as would increase the amount of production to its utmost limit; and that branch of chemistry which treats of the nature and constitution of the various components of animals and vegetables was still entirely uncultivated, and the whole science in a comparatively imperfect state. We cannot be surprised, therefore, that matters remained with but little change during the comparatively long period of nearly thirty years. Indeed, with the exception of the investigation of soils by Schübler, and some other inquiries of minor importance, and which, in this country at least, excited no attention on the part of the agriculturist, nothing was done until the year 1840, when Liebig published his treatise on *Chemistry, in its application to Agriculture and Physiology.* Few works have ever created a more powerful impression. Written in a lively and attractive style, and essentially a popular work, dealing with scientific truths in a bold and original manner, and impressing, by its earnestness and the importance of its conclusions, it was at once received by the agricultural public, with the full conviction that the application of its principles was to be immediately followed by the production of immensely increased crops, and by a rapid advance in every branch of practical agriculture. The disappointment of those extravagant expectations, which *chemists* themselves foresaw, and for which they vainly attempted to prepare the agriculturist, was followed by an equally rapid reaction; and those who had embraced Liebig's views, and lauded them as the commencement of a new era, but who had absurdly expected an instantaneous effect, changed their opinion, and contemned, as strongly as they had before supported, the application of chemistry to agriculture. Taking all things into account, this effect is scarcely to be wondered at, and part of it is even to some extent attributable to Liebig himself; for in place of bringing always prominently before his reader the fact that agricultural chemistry was still in its early youth, and burthened with all the faults and errors of youth, he treated it too much as if it were already perfect in all its parts. Conclusions, ingenious, but founded on insufficient evidence, and sometimes altogether hypothetical, were stated as if they were fully demonstrated scientific truths; and when these proved, as they sometimes did, to be at variance with practice, it is not surprising that they should have produced a feeling of distrust on the part of persons incapable, from an imperfect and still oftener from no knowledge of science, of drawing the line of demarcation, which Liebig frequently omitted to do, between the positive fact and the ingenious hypothesis founded upon it. This omission, which would be of no consequence with scientific men, becomes a source of serious misapprehension in a work addressed to persons unacquainted with science, and who adopt indiscriminately both the facts and the hypotheses of the author. Be this as it may, Liebig's work, though rather too much of a popular character, has had perhaps all the more on that account a very powerful influence in awakening attention to the improvement of agriculture through means of science.

Liebig's work was followed, in the year 1844, by the publication of Boussingault's *Economie Rurale*, a work which, though it excited at the time infinitely less interest than Liebig's, is really quite as important a contribution to scientific agriculture, and in some respects even surpasses it; for it contains the accumulated results of a large number of investigations, both in the laboratory and the field, by the author himself, which have served to establish a great many important truths. Boussingault possesses the qualification, at present somewhat rare, of combining a knowledge of practical agriculture with extended scientific attainments; and his investigations, which have been made with direct reference to practice, and their results tested in the field, must be considered as the foundation of a large part of our correct knowledge of scientific agriculture.

The same year was marked by an event of equal importance in the history of scientific agriculture, namely, the foundation of the Agricultural Chemistry Association of Scotland, which was instituted through the exertions of a small number of practical farmers, for the purpose of pursuing investigations in agricultural chemistry, and affording to its members assistance in all matters connected with the cultivation of the soil. That institution has formed the model of similar associations in London, Dublin, Belfast, and in Germany, and it is peculiarly creditable to the intelligence, energy, and zeal of the practical farmers of Scotland, that with them commenced a movement, which has already found imitators in so many quarters, and has conferred so many benefits on agriculture. Within the last six or eight years, and mainly owing to the exertions of these associations, great progress has been made in accumulating facts on which to found an accurate knowledge of the principles of agricultural chemistry, and the number of chemists who have devoted themselves to agriculture, has considerably increased, though still greatly less than the exigencies of the subject require. Even now, we are but on the threshold of the subject, and are only, as the result of numerous and laborious investigations, becoming acquainted with the path which may be most advantageously followed in elucidating the applications of chemistry to agriculture. Much still remains to be done, and it behoves the agricultural public to adopt such measures as shall be most likely to advance the study of the principles of their art. What these means are will be afterwards indicated. Meanwhile it admits of no question, that with all the faults and errors of a science still in its infancy, the progress which has been made is sufficiently encouraging to induce practical men to turn their attention towards it.

## THE ORGANIC CONSTITUENTS OF PLANTS.

When a plant, or any of its parts, is exposed to a high temperature, it catches fire, burns, and is gradually consumed, until at length there is left behind a quantity of a white earthy matter, which undergoes no further change, however long the heat be continued. The action of heat thus divides the constituents of plants into two great classes, the *organic* constituents, contained in that part which is volatilised by burning, and the *inorganic* constituents which are found in the residual white matter or *ash*. All plants contain both classes of substances, and though their relative proportions vary considerably, the former greatly exceed the latter, and invariably form the principal part of the plant. The organic constituents are four in number:—

| | |
|---|---|
| Carbon. | Hydrogen. |
| Nitrogen. | Oxygen. |

The *inorganic* constituents, though smaller in amount, are much more numerous, not less than twelve having been observed as essential to the plant, while one or two others have been detected under certain circumstances, although they appear to be only accidentally present, and form no part of its living tissues. Those which have been clearly ascertained to be essential constituents are:—

| | |
|---|---|
| Potash. | Silicic Acid. |
| Soda. | Phosphoric Acid. |
| Lime. | Sulphuric Acid. |
| Magnesia. | Chlorine. |
| Peroxide of Iron. | |

and more rarely:—

| | | |
|---|---|---|
| Manganese. | Iodine. | Fluorine. |

None of these substances occur in the plant in their elementary or uncombined state, but exist as compounds of greater or less complexity formed by the union of two or more of them; which compounds are extremely varied in their properties, and are especially adapted for performing the various functions of the plant.

*The Organic Constituents of Plants.*—It would be out of

Agricultural Chemistry.

place to enter here into full details regarding the properties of the organic elements, which fall to be considered under the head of pure chemistry, but a few words regarding their more important characteristics, are essential to a right understanding of what is to follow.

*Carbon*, in the pure state, is found only in the diamond. It is left as charcoal in a less pure condition when vegetable and animal substances are heated in close vessels, and is then obtained as a black substance insoluble in water, which burns in the air, and, by its union with oxygen, is converted into a transparent and colourless gas called carbonic acid. Carbon is the largest constituent of plants, and forms, in round numbers, nearly 50 per cent. of their dry substance.

*Hydrogen* is only met with in nature in combination with other substances, and its principal compound is water, of which it forms one-ninth, the remaining eight-ninths being oxygen. It is separated from water by a well known process, and then appears as a transparent and colourless gas, remarkable for its lightness. It catches fire in the air, burns with a pale flame, and is converted into water by combining with oxygen. It is a constituent of all plants, and of all their parts, and though in much smaller quantity than carbon, is equally essential. Dry plants rarely contain more than 5 or 6 per cent. of hydrogen, and sometimes considcrably less.

*Nitrogen*, like hydrogen, is a gas, but unlike it, is found in great abundance in an uncombined state. It exists in large quantities in atmospheric air, of which it forms nearly four-fifths, or more correctly 79 per cent., of its volume. When separated from the oxygen with which it is mixed in the air, it forms a transparent gas, which is incombustible and extinguishes flame. It is a remarkably inert substance, and is incapable of directly entering into combination with the other elements, although it can be made to do so by indirect processes, a peculiarity which has very important bearings on many points which we shall afterwards have to consider. Nitrogcn is found in plants to the extent of from 1 to 4 per cent.

*Oxygen* is one of the most widely distributed of all the elements, and, from its powerful affinities, is the most important agent in almost all natural changes. It is found in the air, of which it forms 21 per cent., and in combination with hydrogcn and various other substances. When obtained in the pure state it possesses very remarkable properties. All substances burn in it with greater brilliancy than they do in atmospheric air, and its affinity for most of the elements is extremely powerful. It supports the respiration of animals, but only for a short time, for it excites a violent inflammation in the system, which proves fatal after the lapse of an hour or two. It is found in plants, in quantities varying from 30 to 36 per cent.

Now, in order that a plant may grow, all its four organic constituents must be presented to and absorbed by it, and that this absorption may take place, it is essential that thcy be presented to it in suitable forms. A seed may be planted in pure carbon, and supplied with unlimited quantities of hydrogen, nitrogen, oxygen, and inorganic substances, and it will not germinate; and a plant, under similar circumstances, will not only not increase, but will soon die. These substances cannot then be absorbed when in the *elementary* state, but when they have entered into certain forms of combination, they acquire the property of being readily taken up, and assimilated by the organs of the plant.

It has been ascertained by numerous experiments, that the forms of combination in which these elements must exist for this purpose, are by no means numerous; and though great difference of opinion formerly existed, it is now generally admitted that the most important compounds are—for the carbon, carbonic acid; for hydrogen, watcr; for nitrogen, ammonia and nitric acid; and for oxygen, water and carbonic acid. The properties and general chemical relations of these substances are fully treated of in the article CHEMISTRY, and need not be specially disscussed here; it will be enough to remind the reader that carbonic acid is a compound of carbon and oxygen, water a compound of hydrogen and oxygen, ammonia of hydrogen and nitrogen, and nitric acid of nitrogen and oxgen; and that all these substanccs, with the single exception of ammonia, may supply the plant with oxygen as well as with that element of which it is the particular source.

There are only two sources from which these substances can be obtained by the plant, viz. the atmosphere, and the soil, and it is necessary that wc should here consider the mode in which they may be obtained from these sourccs.

*The Atmosphere as a source of the organic constituents of Plants.*—Up to the middle of the last century the atmosphere was universally considered to be one of the great chemical elements, but at that time suspicions of its complex nature began to be entertained, which were afterwards substantiated by the experiments of Priestley, Rutherford, and other observers. It has been clearly established that the main bulk of the atmosphere is formed of a mechanical mixture of oxygen and nitrogen, along with certain other ingredients which, though in extremely minute proportion, are as essential to it as its larger constituents. It has been shown by many experiments that 100 volumes of air deprived of moisture and minor constituents, contain

| | |
|---|---|
| Oxygen | 21 |
| Nitrogen | 79 |
| | 100 |

Though only in mechanical mixture, the proportion of these ingredients is fixed and invariable. Experiments, entirely corresponding in their results, have been made by Humboldt, Gay-Lussac, and Dumas at Paris, by Saussure at Geneva, and by Lewy at Copenhagen; and similar results have also been obtained from air collectcd by Gay-Lussac during his ascent in a balloon at the height of 21,430 feet, and by Humboldt on the mountain of Antisano in South America at a height of 16,640 feet. In short, under all circumstances, and in all places, the relation subsisting between the oxygen and nitrogen is constant; and though no doubt many local circumstances exist which may tend to modify their proportions, these are so slow and partial in their operations, and are so counterbalanced by others operating in an opposite direction, as to retain a uniform proportion between the main constituents of the atmosphere, and to prevent any undue accumulation of one or other of them at any one point. It is different with the minor constituents, which are liable to have their proportion varied to some extent under different circumstances. Of these minor constituents the most important is carbonic acid.

*Carbonic Acid.*—The proportion of carbonic acid in the air has been carefully investigated by Saussure. From his experiments it appears that the mean quantity in 10,000 volumes of air, at the village of Chambeisy, near Geneva, amounts to 4·15 volumes; and this quantity was not constant, but varied between 3·15 and 5·75 volumes. The variations in question are dependent on different circumstances. It was found that the quantity was greater during the night than during the day, the mean quantity in the former case being 4·32, in the latter 3·38. The largest quantity found during the night was 5·74, during the day 5·4. Heavy and continued rain had the effect of diminishing the quantity of carbonic acid, by dissolving and carrying it down with it into the soil. Saussure found that in the month of July 1827, during the time when nine millimetres of rain fell, the average quantity of carbonic acid amounted to 5·18 volumes in 10,000; while in September 1829, when 254 millimetres fell, it was only 3·57. On the other hand, continued frosts, by retaining the atmosphere and soil in a dry state, had an opposite effect. High winds increase the carbonic acid to a small extent. It was also found to be greater over the cultivated lands than over the lake of Geneva; greater at the tops of mountains than at the level of the sea; in towns than in the country. The differences observed in all these cases are but small, but they are beyond the limits of error in the experiment, and have been confirmed by subsequent experimenters.

*Ammonia* is also an invariable constituent of the atmosphere, but in extremely minute quantity. Its amount appears to vary within wider limits than any of the other components; but it admits of question whether the very variable, and indeed almost conflicting, statements of different observers may not be to some extent dependent on the mode of experimenting, and the care which has been devoted to it. Our observations on this constituent of the air are less numerous than on any other; for though it has long been known that ammonia exists there, it is only recently that it has been ascertained to be invariably present, and that the recognition of its importance has led to the determination of its quantity. Dr Kemp determined the quantity present in 1,000,000 parts of air to be 3·68; Graeger found in the same quantity no more than 0·323; while Fresenius obtained only 0·098 parts by day, and 0·169 by night. The experiments of the latter observer appear to have been conducted with great care; those of Kemp probably give too high a result; but the number of experiments we at present possess is too small to permit us to draw any general conclusions as to the average proportion of ammonia, although they all concur in proving its invariable presence. It is easy to prove that it is present in the air, by collecting the first few drops of a shower, and applying to them the well-known tests for ammonia; but the accurate determination of its quantity is extremely difficult and tedious.

*Water.*—The air always contains a quantity of watery vapour, which varies greatly at different times and places, and is dependent to a great extent upon the atmospheric temperature, being largest in hot weather and least in cold. It is increased also by the proximity of the sea, of lakes and rivers, evaporation from which moistens the superincumbent air, and is diminished in dry districts. It is deposited on the surface of the earth in the form of rain and dew, and is connected with many very important natural changes. One thousand volumes of air contain, on the average, about eight volumes of watery vapour; but under certain circumstances this quantity may be greatly increased or diminished.

*Carburetted Hydrogen.*—Gay-Lussac, Humboldt, and Boussingault have shown, that when the whole of the moisture and carbonic acid have been removed from the air, it still contains a small quantity of carbon and hydrogen; and Saussure has rendered it probable that they exist in a state of combination as carburetted hydrogen gas. No definite proof of this position has, however, as yet been adduced, and the function of the compound is entirely unknown. It is possible that the presence of carbon and hydrogen may be due to a small quantity of organic matter; but, whatever be its source, its amount is certainly extremely small.

*Nitric Acid* is sometimes, but not invariably, found in the atmosphere. It has been detected after thunder-storms, during which it is apparently formed by the electric spark causing the combination of its elements. Its proportion is extremely minute.

*Sulphuretted Hydrogen and Phosphoretted Hydrogen.*—The proportion of these substances is almost infinitesimal; but they are pretty general constituents of the atmosphere, and are apparently derived from the decomposition of animal and vegetable matters.

From the preceding statements, it is apparent that the atmosphere may prove a source of all the organic constituents of plants; for not only does it contain nitrogen and oxygen in a pure state, but likewise in those forms of combination in which they are most readily absorbed; and it affords also a supply of carbon in the form of carbonic acid. No doubt the quantity of these substances appears trifling, but it is only relatively and not absolutely small; for, if we take into account the enormous mass of air surrounding the globe, it will be at once apparent, that even the minute fraction of ammonia, amounting, according to Fresenius, to less than a ten-millionth of the atmosphere, corresponds to a very large total quantity. It has been found, by a simple calculation, that the atmosphere must weigh in round numbers

5,050,000,000,000,000 tons,

and it must consequently contain

Carbonic acid,..............3,300,000,000,000 tons,
Ammonia, ................. 50,000,000 tons,

quantities sufficiently large to afford an abundant supply of these elements to all the plants on the surface of the earth.

*The Soil as a Source of the Organic Constituents of Plants.*—When a portion of soil is subjected to heat, it is found that it, like the plant, consists of a combustible and an incombustible part; but while in the plant the incombustible part or ash forms only a small proportion of the whole, the reverse is the case with the soil, which rarely contains more than 5 or 6 per cent. of organic matter, and sometimes much less. The organic matter exists in the state of what has been called humus, a substance which must be considered here as a source of the organic constituents of plants, independently of the general composition of the soil, which will be afterwards discussed.

The term *humus* is generic, and is applied by chemists to a rather numerous group of substances, very closely allied in their properties, of which several are generally present in all fertile soils. They have been submitted to examination by various chemists, but by none more accurately than by Mulder and Herman, to whom, indeed, we owe almost all the precise information we possess on the subject. The organic matters of the soil may be divided into three great classes; the first, containing those substances which are soluble in water; the second, those which are extracted by means of caustic potash; and the third, those which are insoluble in all menstrua. When a soil is boiled with a solution of caustic potash, a deep brown fluid is obtained, from which acids precipitate a dark brown flocculent substance, consisting of a mixture of at least three different acids, to which the names of humic, ulmic, and geic acids have been applied. The fluid from which they have been precipitated contains two substances, crenic and apocrenic acid, while the soil still retains what has been called insoluble humus.

The chemical characters of all the acids above named are pretty closely allied. They have, however, been divided into three groups, the humic, geic, and crenic groups, which present some differences in properties and composition. They are all compounds of carbon, hydrogen, and oxygen, and are characterised by their affinity for ammonia, which is so great that they are with difficulty obtained free from that substance, and generally exist in the soil in combination with it. They are all products of the decomposition of vegetable matters in the soil, and are produced in succession by the gradual progress of their decay. This decomposition may be easily traced by observing what takes place when a piece of wood, or any other vegetable substance is exposed to air and moisture. It first acquires a dark brown, and finally a black colour, and is then converted into two substances, named ulmin and humin. These are insoluble in alkalies, and are apparently identical with the insoluble humus of the soil. As the decay advances, the products become soluble in alkalies, and then contain humic, ulmic, and geic acids, and finally, by a still further progress, crenic and apocrenic acids are formed by a process of oxidation, which goes on during the decay.

In fact, these substances are representatives of the different stages of decomposition of plants; and that this is actually the source of all the humus compounds, is obvious from the fact that they are only found in the soil itself, that is to say, in the upper foot or two of the earth's surface, and only in those parts of it on which plants grow. Numerous analyses of the different substances already mentioned have been made, and have served to establish a number of minor differences in the composition even of those to which the same name has been applied; and these differences are manifestly attributable to the fact, that, as their production is the result of a gradual decomposition, at no time can it be possible to extract from the soil one pure substance, but only a variable mixture of several. For this reason it is that such discrepancies exist in the statements of the most careful observers. As far as the composition of these substances is concerned, little need be said, as we shall immediately see that it has no very direct bearing upon agricultural questions. It will suffice, therefore, to give the names and chemical formulæ of those which have been analysed and described,—

| | | | |
|---|---|---|---|
| Ulmic acid from long Frisian turf......... | $C_{40}$ | $H_{18}$ | $O_{16}$ |
| Humic acid from hard turf ................ | $C_{40}$ | $H_{15}$ | $O_{15}$ |
| Humic acid from arable soil ............... | $C_{40}$ | $H_{16}$ | $O_{16}$ |
| Humic acid from a pasture field ......... | $C_{40}$ | $H_{14}$ | $O_{14}$ |
| Geic acid ..................................... | $C_{40}$ | $H_{15}$ | $O_{17}$ |
| Apocrenic acid .............................. | $C_{48}$ | $H_{12}$ | $O_{24}$ |
| Crenic acid.................................... | $C_{24}$ | $H_{12}$ | $O_{16}$ |

Humus was formerly considered a much more important constituent of the soil than chemists are now inclined to suppose. It was believed to be the exclusive, or at all events the chief source of the organic constituents of plants, and by absorption through the roots to yield to them the greater part of their nutriment. This view is still supported by some chemists and vegetable physiologists, among whom Mulder is the most distinguished; but notwithstanding their authority, there is little doubt that humus is not a *direct* source of the organic constituents of plants, and is not absorbed as such by their roots; but it is so *indirectly*, in as far as the decomposition which it is constantly undergoing in the soil yields carbonic acid, which can be absorbed. The older opinion is refuted by many well-ascertained facts. As regards the exclusive origin of the carbon of plants from humus, it is easy to see that this at least cannot be true. The humus, as we have already stated, is itself derived solely from the decomposition of vegetable and animal matters; and if the plants on the earth's surface were to be supported by it alone, the whole of their substance would have to return to the soil as humus, in order to supply the generation which succeeds them. We know, however, that this is not the case; for the respiration of animals, the combustion of fuel, and many other processes, are annually converting a large quantity of these matters into carbonic acid; and if there were no other source of carbon but the humus of the soil, the amount of vegetable life would gradually diminish, and at length become entirely extinct. Schleiden, who has discussed this subject in full, has made an approximative calculation of the total quantity of humus on the earth's surface, and of the quantity of carbon annually converted into carbonic acid by the respiration of man and animals, the combustion of wood for fuel, and other minor processes; and he draws the conclusion that, if there were no other source of carbon except humus, the quantity of that substance existing in the soil would only support vegetation for a period of sixty years. So far from humus being the only source of carbon, it is obvious that a great part of it must be derived from other sources; for Boussingault has shown that cultivated crops carry off, on the average of years, about one ton more carbon than they receive in the manure applied to them, and without any corresponding diminution on the quantity of humus. A still more convincing evidence of the same nature is given by Humboldt. He states that an acre of land, planted with bananas, yields annually about 155,000 pounds weight of fruit, containing about 32,000 pounds, or upwards of 14 tons of carbon; and as this production goes on during a period of twenty years, there must be withdrawn in that time no less than 280 tons of carbon. But the soil on an acre of land weighs, in round numbers, 1000 tons, and supposing it to contain 4 per cent. of humus, the total weight of carbon in it would amount to little more than 20 tons.

It is manifest from these facts that the influence of humus must be very small, and while no one now supposes it to be the sole source of carbon, as was once believed, it has been contended, that there really is a certain, though small, absorption. Numerous facts are, however, at variance even with this opinion. It is found that the conditions which insure the solubility of the humus are by no means the most suitable to vegetation, though we should expect them to be so were humus absorbed. Peat soils, for instance, which contain large quantities of it in solution, so far from being favourable, are positively injurious to most plants. On the other hand, innumerable examples are found of plants growing luxuriantly in soils and places where no humus exists. The sands of the sea-shore, and the most barren rocks, have their vegetation, and the red-hot ashes which are thrown out by active volcanoes, are no sooner cool than a crop of plants springs up on them.

The conclusions to be drawn from these considerations have been further confirmed by the direct experiments of different observers. Boussingault sowed pease, which weighed 15·60 grains, in a soil composed of a mixture of sand and clay, which had been heated red-hot, and consequently contained no humus, and after 99 days growth, during which they had been watered with distilled water, he found the crop to weigh 68·72 grains, so that there had been a fourfold increase. Similar experiments have been made by Salm Horstmar, on oats and rape. He sowed them in a soil which had been previously ignited, and found that they grew readily and arrived at complete maturity. One oat straw grew to a height of three feet, and bore 78 grains; another bore 47; and a third 28, in all 153. These when dried at 212° weighed 46·302 grains, and the straw 45·6 grains. The most satisfactory experiments, however, are those of Weigman and Polstorff, who found that, provided care were taken to produce an artificial soil without humus, but having the *physical* characters of a fertile soil, it was possible to obtain a two-hundred-fold produce of barley. They prepared a mixture of six parts of sand, two of chalk, one of white bole, and one of wood charcoal; to this was added a small quantity of felspar, which had been fused up with marble and some soluble salts, so as to imitate as closely as possible the inorganic parts of a soil, and in it they planted twelve barley plants. The plants grew luxuriantly, reaching a height of three feet, and each bearing nine ears; the ears gave 22 pickles each. The grain of the twelve plants weighed 2040 grains, the straw 2449 grains. On the other hand, experiments have been made which show that even when present, humus is not absorbed. The first experiments of this sort we owe to Saussure, who allowed plants of the common bean and the Polygonum Persicaria to grow in solutions of humate of potash, and found a very trifling diminution in the quantity of humic acid present; but the value of his experiments is invalidated by his having omitted to ascertain whether the diminution of humic acid which he observed were really due to absorption by the plant. This omission has been supplied by Weigman and Polstorff. They grew plants of mint (Mentha undulata) and of Polygonum Persicaria in solutions of humate of potash, and placed beside the glass containing the plant, another perfectly similar, and containing only the solution of humate of potash. The solution, which contained in every 100 grains, 0·148 grains of solid matter, consisting of humate of potash, &c. was found to become gradually paler, and at the end of a month, during which time the plants had increased by 6½ inches, the quantity of solid matter in 100 grains had diminished to 0·132. But the solution contained in the other glass, and in which no plant had grown, had diminished to 0·136, so that the absorption could not have amounted to more than 0·004 grains for every 100 grains of solution employed. This quantity is so small as to be within the limits of error of experiment, and we are consequently entitled to draw the conclusion that humus, even under the most favourable circumstances, is not absorbed by plants.

While it appears, then, that humus is not directly a food of plants, it must not be supposed that it is altogether devoid of importance. The decompositions which it is constantly undergoing in the soil, make it a source of carbonic acid, which may be absorbed by the plants; and it consequently has indirectly an important bearing on their nutrition. Its functions in the soil are also important, but these we leave for future consideration.

Carbonic acid, ammonia, and water, are the great organic foods of plants. But while the plant has afforded to it an inexhaustible supply of the last, the quantities of the two former, both in the atmosphere and the soil, which are available as food, are limited, and insufficient to sustain its life for a prolonged period. It has been shown by Chevandrier, that an acre of land under beech wood accumulates annually about 1650 lb. of carbon. But the column of air resting upon an acre of land contains only about 15,500 lb. of carbon, and the soil may be estimated to contain 1 per cent., or 22,400 lb. per acre, and the whole of this carbon would therefore be removed, both from the air and the soil, in the course of little more than 23 years. But it is a familiar fact, that plants continue to grow with undiminished luxuriance year after year in the same soil, and they do so because neither their carbon nor their nitrogen are permanently absorbed; they are there only for a period, and when the plant has finished its functions and dies, they sooner or later return into their original state. Either the plant decays, in which case its carbon and nitrogen pass more or less rapidly into their original state, or it becomes the food of animals, and by the processes of respiration and secretion, the same change is effected. In this way a sort of balance is sustained; the carbon which at one moment is absorbed by the plant, passes in the next into the tissues of the animal, only to be again expired in that state in which it is fitted to commence again its round of changes.

But while there is thus, as it were, a continuous circulation of these constituents through both plants and animals, there are various changes which tend to diminish the quantities of carbonic acid and ammonia at the earth's surface, carbon being separated from plants and animals under certain circumstances in the elementary state, and the decomposition of nitrogenous matters yielding nitrogen, which is incapable of returning into the state of ammonia except in small quantity and by very circuitous processes. The elements carbon and nitrogen being, as we have already mentioned, incapable of direct absorption by plants, a gradual though slow diminution in the amount of vegetable life would necessarily occur were it not that nature has provided against this by establishing sources of carbonic acid and ammonia so as to sustain their quantity. The most important of these sources is perhaps volcanic action, both ammonia and carbonic acid being evolved from active volcanoes to an extent which may appear trifling when superficially examined, but is really very large. The production of nitric acid during thunder-storms, apparently by the combination of the nitrogen and oxygen of the atmosphere, which either directly or indirectly ministers to the growth of plants, is another mode in which the supply of these substances is sustained, and the small annual loss of the available food of plants counterbalanced.

*Source of the Inorganic Constituents of Plants.*—The nature of the inorganic constituents of plants, their being solid and fixed substances, sufficiently indicate that there can be but one source from which they may be derived. That source is the soil, which, as we shall afterwards see, contains all these substances in greater or less abundance, and has always been admitted to be the only substance capable of supplying them. The older chemists and physiologists, however, attributed no importance to these substances, and looking to the small quantities in which they are found in plants, imagined that they were there present merely as accidental impurities which had been absorbed from the soil along with the humus, which was at that time considered to be their organic food. This opinion, sufficiently disproved by the constant occurrence of the same substances, and in the same proportions, in the ash of each individual plant, has been further refuted by the experiments of Prince Salm Horstmar, who has established the fact of the origin of all these substances from the soil, and of their importance to vegetation, by experiments upon oats grown on artificial soils, in each of which one inorganic constituent was omitted. He found that, without silica, the grain vegetated, but remained small, pale in colour, and so weak as to be incapable of supporting itself; without lime, it died when it had produced its second leaf; without potash and soda, it grew only to the height of three inches; without magnesia, it was weak and incapable of supporting itself; without phosphoric acid, it was weak but upright; and without sulphuric acid, it was weak though normal in form, but produced no fruit.

*Manner in which the Constituents of Plants are Absorbed.*

*Water.*—The absorption of water by plants takes place in great abundance, and is connected with many of the most important phenomena of vegetation. It is absorbed by the roots alone, and passing into the tissues of the plant, a part of it is decomposed, and goes to the formation of certain of its organic compounds; but by far the larger quantity does not remain in the plant, but is again exhaled by the leaves. The extent to which this takes place is very large. Hales found that a sunflower exhaled in twelve hours about 1 lb. 5 oz. of water, but this quantity was liable to considerable variation, being greater in dry, and less in wet weather, and was greatly diminished during the night. Saussure made similar experiments, and found that the quantity of water exhaled by a sunflower amounted to about 220 lb. in four months. The subject of the exhalation of water by plants has recently been examined with great accuracy by Lawes. His experiments were made by planting single plants of wheat, barley, beans, pease, and clover, in large glass jars capable of holding about 42 lb. of soil, and covered with glass plates, furnished with a hole in the centre for the passage of the stem of the plant. Water was supplied to the soil at certain intervals, and the jars were carefully weighed. The result of the experiments, continued during a period of 172 days, is given in the following table, which shows the total quantity of water exhaled in grains:—

Wheat ........................................113,527
Barley ........................................120,025
Beans ........................................112,231
Pease ........................................109,082
Clover, cut 28th June .................... 55,093

It was found, further, that the exhalation was not uniform, but increased during the period of active growth of the plant, and diminished again when that period was passed. These variations are shown by the subjoined tables, of which the first gives the total exhalation during certain periods, and the second the average daily loss of water during the same periods.

TABLE I.—*Showing the Number of Grains of Water given off by the Plants during stated divisional Periods of their Growth.*

| Description of Plant. | 9 Days. From Mar. 19 to Mar. 28. | 31 Days. From Mar. 28 to Apr. 28. | 27 Days. From Apr. 28 to May 25. | 34 Days. From May 25 to June 28. | 30 Days. From June 28 to July 28. | 14 Days. From July 28 to Aug. 11. | 27 Days. From Aug. 11 to Sept. 7. |
|---|---|---|---|---|---|---|---|
| Wheat, | 129 | 1268 | 4,385 | 40,030 | 46,060 | 15,420 | 6235 |
| Barley, | 129 | 1867 | 12,029 | 37,480 | 45,060 | 17,046 | 6414 |
| Beans, | 88 | 1854 | 4,846 | 30,110 | 58,950 | 12,626 | 3657 |
| Pease, | 101 | 1332 | 2,873 | 36,715 | 62,780 | 5,281 | ... |
| Clover, | 400 | 1645 | 2,948 | 50,100 | ... | ... | ... |

TABLE II.—*Showing the average daily Loss of Water (in Grains) by the Plants, within several stated divisional Periods of their Growth.*

| Description of Plant. | 9 Days. From Mar. 19 to Mar. 28. | 31 Days From Mar. 28. to Apr. 28. | 27 Days. From Apr. 28 to May 25. | 34 Days. From May 25 to June 28. | 30 Days. From June 28 to July 28. | 14 Days. From July 28 to Aug. 11. | 27 Days. From Aug. 11 to Sept. 7. |
|---|---|---|---|---|---|---|---|
| Wheat, | 14·3 | 40·9 | 162·4 | 1177·4 | 1535·3 | 1101·4 | 230·9 |
| Barley, | 14·3 | 60·2 | 445·5 | 1102·3 | 1502·0 | 1217·6 | 237·5 |
| Beans, | 9·7 | 59·8 | 179·5 | 885·6 | 1965·0 | 901·8 | 135·4 |
| Pease, | 11·2 | 42·9 | 106·4 | 1079·8 | 2092·7 | 377·2 | ... |
| Clover, | 44·4 | 53·0 | 109·2 | 1473·5 | ... | ... | ... |

Similar experiments were made with the same plants in soils to which certain manures had been added, and with results generally similar. If, now, a calculation be made from these results of the quantity of water exhaled by the plants growing on an acre of land, it will be found greatly to exceed the annual fall of rain; but we know that of all the rain which falls only a small proportion can be absorbed by the plants growing on the soil, for a large quantity is carried off by the rivers, and never reaches their roots. It has been calculated, for instance, that the Thames carries off in this way at least one-third of the annual rain that falls in the district watered by it, and the Rhine nearly four-fifths. The exhalation which takes place to so great an extent must therefore be dependent on the repeated absorption of the same quantity of water, which, after being exhaled, is again deposited on the soil in the form of dew, and passes repeatedly through the plant. This constant percolation of water is of immense importance to the plant, as it forms the channel through which some of its other constituents are carried to it.

*Carbonic Acid.*—While thus the whole of the water which a plant requires is absorbed by its roots, exactly the reverse is the case with carbonic acid, of which only an inconsiderable quantity is so absorbed. It passes into the plant by the leaves, as has been clearly shown by Boussingault, by a very simple experiment. He took a large glass globe having three apertures, through one of which he introduced a branch of a vine, with twenty leaves on it. With one of the side apertures a tube was connected, by means of which the air could be drawn slowly through the globe, and into an apparatus in which its carbonic acid could be accurately determined. He found, in this way, that while the air which entered the globe contained 0·0004 of carbonic acid, that which escaped contained only 0·0001, so that three-fourths of the carbonic acid had been absorbed.

*Ammonia.*—The absorption of ammonia, so far as we at present know, takes place entirely by the roots; and although a quantity of it no doubt exists in the air, which is important to the plant, there is little doubt that even that reaches it through the root, being carried down by the rain, and absorbed in that way. The greater part of the ammonia, being derived from the organic matter of the soil, is undoubtedly absorbed by the roots.

*Inorganic Constituents.*—These are likewise absorbed by the roots; and it is as a solvent for these substances that the large quantity of water that passes through the plants is so important. The inorganic constituents exist in the soil in particular states of combination, in which they are only sparingly soluble; so much so, indeed, that many of them are considered to be almost absolutely insoluble in water. But in the soil their solubility is increased by the presence of carbonic acid, which being absorbed by the water causes it to dissolve, to some extent, substances otherwise insoluble. It is in this way that lime, which occurs in the soil principally as the insoluble carbonate, is dissolved and absorbed. Phosphate of lime is dissolved in water containing carbonic acid, or even common salt in solution; and generally we have some solvent substance always present. The amount of solubility produced by these substances is extremely small; but it is sufficient for the purpose of supplying to the plant as much of its mineral constituents as are required, for the quantity of water which, as we have already seen, passes through a plant is very large when compared with the amount of inorganic matters absorbed. It has been shown by Lawes that about 2000 grains of water pass through a plant for every grain of mineral matter fixed in it, so that there is no difficulty in understanding how the absorption takes place. There is no doubt that the substances, before they can pass into the plant, must be dissolved, experiment having distinctly shown that the spongioles or apertures through which this absorption takes place are too minute to admit even the smallest solid particle.

### THE PROXIMATE CONSTITUENTS OF PLANTS.

The substances which are absorbed by the plant undergo within it a series of complicated changes, and produce a number of complex organic compounds, of which the mass of the plant is composed. These substances may be divided into three great classes, of widely different properties, composition, and functions.

1*st*, *The Saccharine and Amylaceous Constituents.*—These substances are compounds of carbon, hydrogen, and oxygen, and all possess a certain degree of similarity in composition. The quantities of hydrogen and oxygen which they contain are always in the proportion to form water, so that they may be considered as compounds of carbon and water; not that it can be asserted that they actually do contain water, as such, for of that we have no evidence, but only that its constituents are there in the proportion to form it.

*Cellulose.*—This substance forms the fundamental part of all plants. It is the principal constituent of woody fibre, and is found in a state of purity in the fibre of cotton and flax, and in the pith of plants; but in wood it is generally contaminated with another substance, which has been called incrusting matter, as it is deposited in and around the cells, of which the plant is in part composed. Cellulose is insoluble in all menstrua, but, when boiled for a long time with sulphuric acid, is converted into a substance called dextrine. Cellulose consists of—

| | From pith of Elder-tree. | Spongioles of roots. |
|---|---|---|
| Carbon | 43·37 | 43·00 |
| Hydrogen | 6·04 | 6·18 |
| Oxygen | 50·59 | 50·82 |
| | 100·00 | 100·00 |

It is represented chemically by the formula, $C_{24}\ H_{21}\ O_{21}$, which shows it to be a compound of 24 atoms of carbon with 21 of hydrogen and 21 of oxygen.

*Incrusting matter.*—Of this substance, large quantities enter into the composition of all plants; but of its chemical nature little is known, as it cannot be obtained separate from cellulose. It is, however, of analogous composition, and probably contains hydrogen and oxygen in the proportion to form water.

*Starch.*—When a quantity of the flour of wheat, or of many other seeds, is exposed to a gentle stream of water, there is separated from it a fine white powder, which is common starch. This powder, when examined by the microscope, is found to be composed of minute grains, formed of concentric layers deposited on one another. These grains vary considerably in size and structure in different plants; but in the same plant they are generally so much alike as to admit of their recognition by a practised observer. These grains were formerly believed to be composed of an external coating of a substance insoluble in water, and containing in their interior a soluble kernel. This opinion has, however, been refuted, and distinct evidence been brought to show that the exterior and interior of the globules are identical in chemical properties. If boiled with water, starch dissolves to a thick fluid; and if heated in the dry state, to a temperature of about 390° Fahr., it becomes soluble in cold water. It is distinguished by giving a brilliant blue compound with iodine. Starch contains—

| | |
|---|---|
| Carbon | 44·47 |
| Hydrogen | 6·28 |
| Oxygen | 49·25 |
| | 100·00 |

and its composition is represented by the formula $C_{12}\ H_{10}\ O_{10}$. It differs, therefore, but little from cellulose in composition, but its chemical functions in the plant are extremely different. It is connected with some of the most important changes which occur in the growing plants, and by a series of remarkable transformations is converted into sugar and other important compounds.

*Lichen Starch* is found in most species of lichens, and is distinguished from common starch by producing a green colour with iodine. Its composition is the same as that of ordinary starch.

*Inuline.*—The species of starch to which this name is given is characterised by its dissolving in boiling water, and giving a white pulverulent deposit in cooling. It is found in the tuber of the dahlia, in the dandelion, and some other plants. Its composition is identical with that of cellulose, and its formula is $C_{24}\ H_{21}\ O_{21}$.

*Gum* is exuded from various plants in the form of a thick fluid, which dries up into a resinous mass. Its composition is the same as that of starch. It differs considerably in its properties when derived from different plants, but in all cases its chemical composition is the same.

*Dextrine.*—When starch is exposed to a heat of about 400°, or when treated with sulphuric acid, or with a substance extracted from malt called *diastase*, it is converted into dextrine. The same substance may also be obtained from cellulose by a similar treatment. The dextrine so obtained has the same composition as the starch from which it is obtained, but in its properties more nearly resembles gum. It is a highly important constituent of all plants, and may be converted into sugar on the one hand, and into starch on the other.

*Sugar.*—Under the general name of sugar are included four or five different substances which chemists have distinguished. Of these the most important are cane sugar, grape sugar, and an uncrystallisable sugar found in most plants.

*Cane Sugar* is met with in the sugar-cane, the maple, and many other plants. It is extremely soluble in water, and may be obtained in large crystals, as in common sugar-candy. Its composition is—

| | |
|---|---|
| Carbon | 42·22 |
| Hydrogen | 6·60 |
| Oxygen | 51·18 |
| | 100·00 |

and its chemical formula is $C_{12}\ H_{11}\ O_{11}$.

*Grape Sugar* is met with in the grape, and most other fruits. But it is also produced when starch is boiled for a long time with sulphuric acid, or treated with a large quantity of diastase. It is less soluble in water than cane sugar, and crystallises in small round grains. Its composition, when dried at 284°, is—

| | |
|---|---|
| Carbon | 40·00 |
| Hydrogen | 6·66 |
| Oxygen | 53·34 |
| | 100·00 |

and its formula is $C_{12}\ H_{12}\ O_{12}$.

The uncrystallisable sugar of plants is closely allied to grape sugar, and so far as we know, its composition is the same.

*Mucilage* is the name applied to the substance existing in linseed, and in many other seeds, and which communicates to them the property of swelling up and becoming gelatinous when treated with water. It is found in a state of considerable purity in gum tragacanth, and some other gums. Its composition is not known with absolute certainty, but it is either $C_{24}\ H_{19}\ O_{19}$, or $C_{12}\ H_{10}\ O_{10}$; and in the latter case it must be identical with starch and gum.

All the substances belonging to this class are obviously very closely related in chemical composition, some of them, indeed, as starch and gum, though easily distinguished by their properties, are identical in constitution, and the others only differ in the quantity of water, or of its elements which they contain. In fact, all these substances may be considered as compounds of carbon and water, and their relations are, perhaps, more distinctly seen when their formula are written so as to show this, as is done in the following table, in which they are all supposed to contain 24 equivalents of carbon, so as to make them comparable with cellulose:—

| | | | Water. |
|---|---|---|---|
| Grape sugar, | $C_{12}\ H_{12}\ O_{12}$ | $C_{24}\ H_{24}\ O_{24}$ | $C_{24} + 24$ |
| Cane sugar, | $C_{12}\ H_{11}\ O_{11}$ | $C_{24}\ H_{22}\ O_{22}$ | $C_{24} + 22$ |
| Cellulose, . | $C_{24}\ H_{21}\ O_{21}$ | $C_{24}\ H_{21}\ O_{21}$ | $C_{24} + 21$ |
| Inuline, . | $C_{24}\ H_{21}\ O_{21}$ | $C_{24}\ H_{21}\ O_{21}$ | $C_{24} + 21$ |
| Starch, . | $C_{12}\ H_{10}\ O_{10}$ | $C_{24}\ H_{20}\ O_{20}$ | $C_{24} + 20$ |
| Dextrine, . | $C_{12}\ H_{10}\ O_{10}$ | $C_{24}\ H_{20}\ O_{20}$ | $C_{24} + 20$ |
| Gum, . | $C_{12}\ H_{10}\ O_{10}$ | $C_{24}\ H_{20}\ O_{20}$ | $C_{24} + 20$ |
| Mucilage, . | $C_{12}\ H_{10}\ O_{10}$ | $C_{24}\ H_{20}\ O_{20}$ | $C_{24} + 20$ |

The differences being thus so slight, it will not be difficult to understand how one of these compounds may pass into the other. Thus, for instance, cellulose has only to absorb an atom of water to become cane sugar, or to lose an atom in order to be converted into starch; changes which, we have every reason to believe, actually do occur in the plant.

*Pectine and Pectic Acid.*—These substances are met with in many fruits and roots, as, for instance, in the apple, the carrot, and the turnip. They differ from the starch group of substances, in containing a larger quantity of oxygen than is required to form water along with their hydrogen; but their exact composition is still uncertain, and they undergo numerous changes during the ripening of the fruit.

2d, *Fatty Matters.*—The fatty constituents of plants form a rather extensive group of substances all closely allied, but distinguished by minor peculiarities in properties and differences in constitution. Some of them are of very frequent occurrence, but others are almost peculiar to individual plants. They are all compounds of carbon, hydrogen, and oxygen, and are at once distinguished from the preceding class, by containing oxygen in greatly less quantity than is required to form water with their hydrogen. The principal constituents of the fatty matters and oils of plants are three substances, called stearine, margarine, and oleine, the two former solids, the latter a fluid. These substances rarely if ever occur alone, but are mixed together in variable proportions, and the fluidity of the oils is due principally to the quantity of the last which they contain. If a quantity of olive oil be exposed to cold, it is seen partially to congeal; and if it be then pressed, a fluid flows out, and a crystalline solid remains, the former is oleine, though not absolutely pure, and the latter margarine. The separation of these substances involves a variety of troublesome chemical processes; and when it has been effected, it is found that each of them is a compound of a peculiar acid with another substance called glycerine, or the sweet principle of fats. Glycerine, as it exists in the fats, appears to be a compound of $C_3\ H_2\ O$, and its properties are the same from whatever source it is obtained. The acids separated from it are known by the names of margaric, stearic, and oleic acids.

*Margaric and Stearic Acids.*—These substances are white crystalline solids insoluble in water, and fusing at a low temperature. They were formerly believed to be different in composition, but the more accurate analyses of later chemists have shown, that they have both the following composition:—

| | |
|---|---|
| Carbon | 75·64 |
| Hydrogen | 12·71 |
| Oxygen | 11·65 |
| | 100·00 |

and are both represented by the formula $C_{34}\ H_{34}\ O_4$.

*Oleic Acid.*—Under this name two different substances appear to be included. It has been applied generally to the fluid acids of all oils, while it would appear that the drying and non-drying oils actually contain substances of different composition. The acid extracted from olive oil appears to have the formula $C_{36}\ H_{34}\ O_4$, while that from linseed oil is $C_{46}\ C_{38}\ O_6$, but this is still doubtful.

Other fatty acids have been detected in palm oil, cocoanut oil, &c. &c., but they are of minor importance, and so closely resemble margaric and stearic acids, as to be easily confounded with them, although their composition is undoubtedly different.

*Wax* is a substance closely allied to the fats. It consists of two substances, cerine and myricine, each of which is extremely complex in its composition. The former consists principally of an acid similar to the fatty acids, called cerotic acid, and containing $C_{54}\ H_{54}\ O_4$. The latter has the formula $C_{92}\ H_{92}\ O_4$. These substances are separated from one another by boiling with alcohol, in which the former is more soluble. The wax found in the leaves of the lilac and other plants appears to consist of myricine, while that extracted from the sugar-cane is said to be different, and to have the formula $C_{48}\ H_{50}\ O_2$. It is probable that other plants contain different sorts of wax, but their investigation is still so imperfect, that nothing definite can be said regarding them. Wax and fats appear to be produced in the plant from starch and sugar; at least it is unquestionable that the bee is capable of producing the former from sugar, and we shall afterwards see that a similar change is most probably produced in the plant.

3d, *Nitrogenous or Albuminous Constituents of Plants and Animals.*—The nitrogenous constituents of plants and animals are so closely allied, both in properties and composition, that they may be most advantageously considered together.

*Albumen.*—Vegetable albumen is found dissolved in the juices of most plants, and is abundant in that of the potato, the turnip, and wheat. In these juices it exists in a soluble state, but if its solution be heated to about 150° it coagulates into a flocky insoluble substance. It is also thrown down by acids and alcohol. Coagulated albumen is soluble in alkalies and in nitric acid. Animal albumen exists in the white of eggs, the serum of blood, and the juice of flesh; and from all these sources is scarcely distinguishable by its properties from vegetable albumen. The composition of both varieties is the same—

| | From Wheat. | From Potatoes. | From Blood. | From White of Egg. |
|---|---|---|---|---|
| Carbon | 53·7 | 53·1 | 53·4 | 53·0 |
| Hydrogen | 7·1 | 7·2 | 7·0 | 7·1 |
| Nitrogen | 15·6 | ... | 15·5 | 15·6 |
| Oxygen | 23·6 (Oxygen, Sulphur, Phosphorus) | ... | 22·1 | 22·9 |
| Sulphur | | 0·97 (Oxygen, Sulphur, Phosphorus) | 1·6 | 1·1 |
| Phosphorus | | ... | 0·4 | 0·3 |
| | 100·0 | | 100·0 | 100·0 |

Closely allied to vegetable albumen is the substance known by the name of *glutin*, which is obtained by boiling the gluten of wheat with alcohol. It appears to be a sort of coagulated albumen, and its composition is the same as that given above.

*Vegetable Fibrine.*—If a quantity of wheat flour be tied up in a piece of cloth, and kneaded for some time under water, the starch it contains is gradually washed out, and there remains a quantity of a glutinous substance called gluten. When this is boiled with alcohol, *glutin* above referred to is extracted, and vegetable fibrine is left. It dissolves in dilute potash, and on the addition of acetic acid is deposited in a pure state. Treated with hydrochloric acid, diluted with ten times its weight of water, it swells up into a jelly-like mass. When boiled or preserved for a long time under water, it cannot be distinguished by its properties from coagulated albumen.

*Animal Fibrine* exists in the blood and the muscles, and agrees in all its characters with vegetable fibrine, as is seen by the subjoined analyses—

| | Wheat Flour. | Blood. | Flesh. |
|---|---|---|---|
| Carbon | 53·1 | 52·5 | 53·3 |
| Hydrogen | 7·0 | 6·9 | 7·1 |
| Nitrogen | 15·6 | 15·5 | 15·3 |
| Oxygen | 23·2 | 24·0 | 23·1 |
| Sulphur | 1·1 | 1·1 | 1·2 |
| | 100·0 | 100·0 | 100·0 |

*Caseine.*—Vegetable caseine is abundantly found in most plants, and is met with in the juice from which albumen has been precipitated by heat, and may be separated from it in flocks by the addition of an acid. It has been obtained for chemical examination, principally from pease and beans, and from the almond and oats. That prepared from the pea has been called *legumine*, that from almonds *emulsine*, and that from oats *avenine;* but they are all three identical in their properties, although formerly believed to be different, and distinguished by these names. Vegetable caseine is best obtained by treating pease or beans with hot water, and straining the fluid. On standing, the starch held in suspension is deposited, and the caseine is retained in solution in the alkaline fluid; by the addition of an acid it is precipitated as a thick curd. Caseine is insoluble in water, but dissolves readily in alkalies; its solution is not coagulated by heat, but, on evaporation, becomes covered with a thin pellicle, which is renewed as often as it is removed.

*Animal Caseine* is the principal constituent of milk, and is obtained by the cautious addition of an acid to skimmed milk, by which it is precipitated as a thick white curd. It is also obtained by the addition of rennet, and the process of curdling milk is simply the coagulation of its caseine. It is soluble in alkalies, and is precipitated from its solution by acids, and in all other respects agrees with vegetable caseine.

The composition of animal caseine has been well ascertained, but considerable doubt still exists as to that of vegetable caseine, owing to the difficulty of obtaining it absolutely pure. The analyses of different chemists give rather discordant results, but we have given those which appear most trustworthy—

| | From Pease. | |
|---|---|---|
| Carbon | 50·6 | 50·7 |
| Hydrogen | 6·8 | 6·6 |
| Nitrogen | 16·5 | 15·8 |
| Oxygen | 25·6 | 23·8 |
| Sulphur | 0·5 | 0·8 |
| Phosphorus | ... | 2·3 |
| | 100·0 | 100·0 |

Other results differ considerably from these, and some observers have even obtained as much as eighteen per cent. of nitrogen and fifty-three of carbon.

The composition of animal caseine differs from this principally in the amount of carbon. Its composition is—

| | |
|---|---|
| Carbon | 53·6 |
| Hydrogen | 7·1 |
| Nitrogen | 15·8 |
| Oxygen | 22·5 |
| Sulphur | 1·0 |
| | 100·0 |

It will be at once manifest that a very close relation subsists between the different substances just described. Indeed, with the exception of vegetable caseine, they may be said all to present the same composition; and, as has been mentioned above, there are analyses of it which would class it completely with the others. While, however, the quantities of carbon, hydrogen, nitrogen, and oxygen are the same, differences exist in the small quantities of sulphur and phosphorus they contain, and which are indubitably essential to them. Much importance has been attributed to these constituents by various chemists, and especially by Mulder, and he has endeavoured to make out that all the albuminous substances are compounds of a substance to which he has given the name of *proteine*, with different quantities of sulphur and phosphorus. The composition of proteine, according to his newest experiments, is—

| | |
|---|---|
| Carbon | 54·0 |
| Hydrogen | 7·1 |
| Nitrogen | 16·0 |
| Oxygen | 21·4 |
| Sulphur | 1·5 |
| | 100·0 |

and is exactly the same from whatever albuminous compound it is obtained. Although the importance of proteine is probably not so great as Mulder supposed, it affords an important illustration of the close similarity of the different substances from which it is obtained. There is every reason to believe that the different albuminous compounds are capable of changing into one another, just as starch and sugar are mutually convertible; and the possibility of this change throws much light on many of the phenomena of nutrition in plants and animals. Indeed, it would seem probable that these compounds are formed from their elements by plants only, and are merely assimilated by animals to produce the nitrogenous constituents they contain.

*Diastase* is the name applied to a substance existing in malt, and obtained by macerating that substance with cold water, and adding a quantity of alcohol to the fluid, when the diastase is immediately precipitated in white flocks. It is produced during the malting process, and is not found in the unmalted barley. Its chemical composition is unknown, but it is nitrogenous, and is believed to be produced by the decomposition of gluten. If a very small quantity of diastase be mixed with starch suspended in hot water, the starch is found gradually to dissolve, and to pass first into the state of dextrine, then into that of sugar. The change thus effected takes place also in a precisely similar manner in the plant, for diastase is produced during the process of germination of all seeds and tubers, for the purpose of effecting this change, and to fulfil other functions less understood, but no doubt equally important. Diastase is found in the seeds only during the period when the starch they contain is passing into sugar; as soon as that change has taken place, its function is ended, and it disappears.

THE CHANGES WHICH TAKE PLACE IN THE FOOD OF PLANTS DURING THEIR GROWTH.

1*st*, *Changes which occur during germination.*—When a seed is placed in the soil under favourable circumstances, it becomes the seat of an important and remarkable series of chemical changes, which result in the production of the young plant. Experiment and observation have shown that heat, moisture, and air, are necessary to the production of these changes. In all instances these three requisites must be combined, with the further addition, that at the earliest period the seed must be protected from the light. The elevation of temperature required for germination is very different with different seeds; some germinate at a few degrees above the freezing point, and others require a tolerably high temperature. The presence of oxygen is also essential, for it has been shown that if seeds are placed in a soil exposed to an atmosphere containing no oxygen, or if they be buried so deep that the air does not reach them, they may lie for an unlimited period without sprouting; but so soon as they are exposed to the air, germination immediately takes place. This phenomenon is frequently observed where earth has been thrown up from a considerable depth, when it is often covered by plants unknown in the neighbourhood, and which have sprung from buried seeds.

When all the necessary conditions are fulfilled, the seed first absorbs moisture, swells up, and sends out a shoot which rises to the surface, and a rootlet which descends, to form the organ by which nourishment is by and by to be absorbed. Until this takes place, however, the young plant derives its

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whole nutriment from the seed. When the seed begins to swell, oxygen is absorbed, and re-acting upon the gluten of the seed, causes its conversion into diastase. The diastase in its turn acts upon the starch, and converts it first into dextrine, and then into cellulose, which being deposited in the form of organised cells, produces the first little shoot of the plant. The germ continues to derive the whole of its nutriment from the seed until leaves are produced, and during this time the substances laid up in it undergo a series of complicated changes. From the first moment of growth oxygen is absorbed, and carbonic acid evolved, and at the same time water also is formed from the organic constituents of the seed, which gradually diminishes in weight. The amount of this diminution is different with different plants, but is always considerable. Boussingault found that the loss of dry substance in the pea amounted in 26 days to 52 per cent., and in wheat to 57 per cent. in 51 days. Against this, of course, is to be put the weight of the young plant produced, but this is always much less than the loss of weight of the seed, for Saussure found that a horse bean and the plant produced from it weighed, after 16 days, less by 29 per cent. than the seed before germination. The same phenomenon is seen in the process of malting, which is in fact the artificial germination of barley, the malt produced always weighing considerably less than the grain from which it was obtained. It was believed by Saussure, and the older investigators, that the carbonic acid evolved was entirely produced from starch and sugar. These substances, as we have already stated, may be looked upon as compounds of carbon and water, and the carbon was supposed to be simply oxidised to carbonic acid, and its water eliminated. The action cannot, however, be so simple as this, for the woody fibre contains more carbon than the sugar from which it is produced; and we have, moreover, every reason to believe that the nitrogenous substances are also oxidised. In fact, all the constituents of the seed appear to take part in this change, and the process of germination may in some respects be compared to decay or putrefaction, which, like it, is attended by the absorption of oxygen and evolution of carbonic acid; but while in the latter case the residual substances remain in a useless state, in the former they at once become part of a new organism.

*Changes which occur during the after-growth of the plant.*—So soon as the plant has exhausted the store of materials laid up for it in the seed, it begins to derive its subsistence from the surrounding air, and to absorb carbonic acid, water and ammonia, and to decompose and convert them into the different constituents of its tissues. Each of these substances, of course, undergoes a different series of changes, which we shall separately consider.

*Decomposition of Carbonic Acid.*—Carbonic acid is absorbed by the leaves and stems of plants, and in their interior is entirely decomposed, its carbon being retained, while its oxygen is again evolved in the gaseous state. For the production of this change, the influence of the sun's rays is essential, and the stronger the light the greater is the amount of oxygen exhaled, and consequently of carbonic acid decomposed. The separation of oxygen is observed only in the green parts of plants; the flowers and roots, and the fruits when approaching ripeness, produce an exactly opposite effect, absorbing oxygen and evolving carbonic acid. The absorption of carbonic acid and escape of oxygen has been proved by numerous direct experiments by Saussure and others, in which both atmospheric air and artificial mixtures containing an increased quantity of carbonic acid have been employed. Saussure allowed seven plants of periwinkle (*Vinca minor*) to vegetate in an atmosphere containing 7·5 per cent. of carbonic acid for 6 days, during each of which the apparatus was exposed for 6 hours to the sun's rays. The air was analysed both before and after the experiment, and the results obtained were—

| | Volume of the Air. | Nitrogen. | Oxygen. | Carbonic Acid. |
|---|---|---|---|---|
| Before the experiment, | 5746 | 4199 | 1116 | 431 |
| After „ | 5746 | 4338 | 1408 | 0 |
| Difference, | 0 | +139 | +292 | −431 |

There were therefore absorbed 431 volumes of carbonic acid, and 292 volumes of oxygen evolved. Had the whole oxygen of the carbonic acid been evolved, its volume would have been equal to that of the acid, or 431; so that the deficiency of 139 volumes of oxygen must have been retained in the organs of the plant. Similar results have been obtained with other plants, and in all of them it was observed that after the experiment the nitrogen was increased in amount. It might be supposed that this nitrogen had been produced from the nitrogenous constituents of the plant, but Saussure has effectually disproved this, and rendered it probable that it had simply been retained in the interstices of the plant, and dissolved in the water in which they grew. The absorption of carbonic acid takes place only during the day; at night or in the dusk, exactly the opposite occurs, oxygen being absorbed and carbonic acid evolved from all parts of the plant. Saussure found that the oak, the horse-chesnut, and other plants, absorb oxygen and give off carbonic acid in less volumes than the oxygen, while the house-leek, the cactus, and other plants, absorb oxygen without evolving carbonic acid. While then this action is exactly the reverse of that occurring during the day, it must not be supposed that it is due to the carbon which has been fixed during the day being again eliminated in absence of light. On the contrary, it appears to be a purely mechanical and not a chemical action. The carbonic acid is absorbed along with the moisture which day and night is passing into the plant by the roots, but in the absence of the sun it passes through the plant and is exhaled by the leaves without undergoing any change.

The absorption of oxygen during the night, however, appears to be a true chemical process; were it mechanical it would not be confined to oxygen alone, but would take place also with the other gases in contact with the plant. Moreover, the absorption is extremely different in different plants, in some scarcely appreciable, in others very abundant. The plants containing volatile oils, which pass readily into resins by absorption of oxygen, and those which contain tannine and other readily oxidisable substances, taking up the largest quantity. Thus the leaves of the *Agave americana* after 24 hours' exposure in the dark, have absorbed only 0·3 of their volume of oxygen. The leaves of the fir which contain abundance of volatile oil have absorbed 10 times as much, and those of the oak which contain much tannine, 18 times as much oxygen.

In the flowers, both by day and night, there is a constant absorption of oxygen and evolution of carbonic acid. In fact, an active oxidation is going on attended by the evolution of heat, which in the *Arum maculatum*, and some other plants, is so great as to raise the temperature 10° or 12° above that of the surrounding air.

*Decomposition of water in the Plant.*—In addition to the function which water performs in the plant, as the solvent of the different substances which form its food, and hence as the medium through which they pass into its organs, it serves also as a direct food, undergoing decomposition, and yielding hydrogen to the organic substances. Its constituents, along with those of the carbonic acid absorbed, undergo a variety of transformations, and form the principal part of the non-nitrogenous constituents. We have already stated that starch, sugar, and the other allied substances may

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be considered as compounds of carbon with water, and their formation might be conceived to be effected by the carbonic acid losing all its oxygen, and then direct combination ensuing between the residual carbon, and a certain proportion of water. This, of course, would imply that no change takes place in the water, and though probably the simplest view of the case, it is by no means the most probable. It is much more likely that the carbonic acid is only partially decomposed, half its oxygen being removed, and, at the same time the oxygen being separated from a quantity of water, its hydrogen takes the place of the oxygen which has been removed from the carbonic acid. Thus, for instance, sugar may be produced from twelve equivalents of carbonic acid and twelve equivalents of water, twenty-four equivalents of oxygen being eliminated as thus represented:—

| | | | | | |
|---|---|---|---|---|---|
| 12 equivalents of Carbonic Acid, | $C_{12}$ | | $O_{12}$ | $O_{12}$ | |
| 12 „ Water, | | $H_{12}$ | $O_{12}$ | | |
| 1 „ Sugar. & 24 of Ox. | $C_{12}$ | $H_{12}$ | $O_{12}$ | | $+ O_{24}$ |

It cannot, of course, be positively asserted that sugar is really produced exactly in the manner here shown, but there are many facts which point to the probability of its occurring in a somewhat similar method. That water must be decomposed is evident from the fact established by analysis, that the hydrogen of the plant is generally larger than is required to form water with its oxygen, so that this excess at least must be produced by the decomposition of water. The hydrogen of the volatile oils, many of which contain no oxygen, and that of the fats, which contain only a small quantity of oxygen, must manifestly be obtained in a similar manner.

*Decomposition of Ammonia.*—The nitrogenous or albuminous compounds of vegetables must of necessity obtain their nitrogen from the decomposition of ammonia, experiment having distinctly shown that they are incapable of absorbing it in the free state from the atmosphere. It has been clearly ascertained, that the albuminous substances do not contain ammonia, and it is hence apparent that a complete decomposition of that substance must take place in the plant. In fact, carbonic acid, water, and ammonia, must simultaneously take part in these changes, which must of necessity be complicated; so much so, indeed, that in the present state of our knowledge we cannot attempt any distinct explanation of them.

It must be clearly understood, that while such changes as those described manifestly must take place, the explanations of them which have been attempted by various chemists are not to be accepted as determinately established *facts;* they are at present no more than hypothetical views which have been expressed chiefly with the view of presenting some definite idea to the mind, and are unsupported by absolute proof; they are only inferences drawn from the general bearings of known facts, and not facts themselves. Although, therefore, they are to be received with caution, they have advantages in so far as they present the matter to us in a somewhat more tangible form than the vague general statements which are all that could otherwise be made.

### THE INORGANIC CONSTITUENTS OF PLANTS.

The examination of the inorganic constituents or ash of plants has, of late years, formed the subject of a large number of laborious investigations which have served to give us pretty full information on this subject, and to refute several errors at one time prevalent. The proportion in which the inorganic constituents exist in many plants is so small that they were believed by the older chemists to be entirely fortuitous components, which were present merely because they had been dissolved along with the humus, which was then supposed to enter the roots in solution, and to form the chief food of the plant. This supposition which could only be sustained at a time when analysis was imperfect, has been long since disproved and abandoned, and it has been distinctly shown by repeated experiment that not only are these inorganic substances necessary to the plant, but that every one of them, however small its quantity, must be present if it is to grow luxuriantly and arrive at a healthy maturity. The experiments of Prince Salm Horstmar, before alluded to, have established beyond a doubt, that while a seed may germinate, and even grow, to a certain extent, in absence of one or more of the constituents of its ash, it remains sickly and stunted, and is incapable of producing either flower or seed.

While the necessity for a certain quantity of mineral matters is thus certain, it nevertheless appears that their relative and absolute quantities may vary within very wide limits. The total quantity of ash in different plants and parts of plants is extremely different, and the extent of this difference may be best seen from the table given below, which gives the quantity of ash in 100 parts of the different substances in a *dry* state.

*Table showing the quantity of inorganic matters in* 100 *parts of different plants dried at* 212 *degrees:—*

| | |
|---|---|
| SEEDS. | |
| Wheat | 1·97 |
| Barley | 2·48 |
| Oats (with husk) | 3·80 |
| Oats (without husk) | 2·06 |
| Rye | 2·00 |
| Millet | 3·60 |
| Rice | 0·37 |
| Maize | 1·20 |
| Pease | 2·88 |
| Beans | 3·22 |
| Kidney Beans | 4·09 |
| Lentils | 2·51 |
| Tares | 2·60 |
| Buckwheat | 2·13 |
| Linseed | 4·40 |
| Hemp seed | 5·60 |
| Rape seed | 4·35 |
| Sunflower | 2·95 |
| Guinea Corn | 1·99 |
| Gold of Pleasure | 4·10 |
| White Mustard | 4·15 |
| Black Mustard | 4·31 |
| Poppy | 6·56 |
| Horse-chesnut | 2·81 |
| Grape | 2·76 |
| Clover | 6·19 |
| Turnip | 3·98 |
| Carrot | 10·03 |
| Sainfoin | 5·27 |
| Italian Ryegrass | 6·91 |
| Mangold-Wurzel | 6·58 |
| STRAWS AND STEMS. | |
| Wheat | 4·54 |
| Barley | 4·99 |
| Oat | 7·24 |
| Winter Rye | 5·15 |
| Summer Rye | 5·78 |
| Millet | 8·32 |
| Maize | 3·60 |
| Pea | 4·81 |
| Bean | 6·59 |
| Tares | 6·00 |
| Lentil | 5·38 |
| Buckwheat | 4·50 |
| Hops | 4·42 |
| Flax straw | 4·25 |
| Hemp | 4·14 |
| Gold of Pleasure | 6·05 |
| Rape | 4·41 |
| Potato | 14·90 |
| Jerusalem Artichoke | 4·40 |
| ENTIRE PLANT. | |
| Potato | 17·70 |
| Spurry | 10·06 |
| Red Clover | 8·79 |
| White Clover | 8·72 |
| Yellow Clover | 8·56 |
| Crimson Clover (*T. incarnatum*) | 10·81 |
| Cow Grass (*T. medium*) | 11·31 |
| Sainfoin | 6·51 |
| Ryegrass | 6·42 |
| Meadow Foxtail (*Alopecurus pratensis*) | 7·81 |
| Sweet-scented Vernal Grass (*Anthoxanthum odoratum* | 6·32 |
| Downy Oat Grass (*Avena pubescens*) | 5·22 |
| Bromus erectus | 5·21 |
| Bromus mollis | 5·82 |
| Cynosurus cristatus | 6·38 |
| Dactylis glomeratis | 5·31 |
| Festucæ duriuscula | 5·42 |
| Holcus lanatus | 6·37 |
| Hordeum pratense | 5·67 |
| Lolium perenne | 7·54 |
| Poa annua | 2·83 |
| Poa pratensis | 5·94 |
| Poa trivialis | 8·33 |
| Phleum pratense | 5·29 |
| Plantago lanceolata | 8·68 |
| Poterium Sanguisorba | 7·97 |
| Yarrow | 13·45 |
| Rape Kale | 8·00 |
| Cow Cabbage | 10·00 |
| Asparagus | 6·40 |
| Parsley | 1·10 |
| Furze | 3·11 |
| Chamomile (*Anthemis arvensis*) | 9·66 |
| Wild Chamomile (*Matricaria Chamomilla*) | 9·10 |

| | |
|---|---|
| Corn Cockle (*Agrostemma Githago*) | 13·20 |
| Corn Blue Bottle (*Centaurea Cyanus*) | 7·32 |
| Foxglove | 10·89 |
| Hemlock (*Conium maculatum*) | 12·80 |
| Sweet Rush (*Acorus Calamus*) | 6·90 |
| Common Reed (*Arundo Phragmites*) | 1·44 |
| Celandine (*Chelidonium majus*) | 6·85 |
| Equisetum fluviatile | 23·60 |
| hyemale | 11·80 |
| arvense | 13·80 |
| linosum | 15·50 |
| LEAVES. | |
| Turnip | 9·37 |
| Beet | 20·30 |
| Kohl-rabi | 18·54 |
| Carrot | 10·95 |
| Jerusalem Artichoke | 28·30 |
| Hemp | 22·00 |
| Hop | 17·25 |
| Tobacco | 22·62 |
| Spinach | 19·76 |
| Poplar | 23·00 |
| Red Beech | 6·00 |
| White Beech | 10·51 |
| Oak | 9·80 |
| Elm | 16·33 |
| Horse-chesnut | 9·08 |
| Maple | 28·05 |
| Ash | 14·76 |
| Acacia | 18·20 |
| Olive | 6·45 |
| Orange | 13·73 |
| Potato | 15·10 |
| Tussac Grass | 7·15 |
| ROOTS AND TUBERS. | |
| Potato | 4·16 |
| Jerusalem Artichoke | 5·38 |
| Turnip | 13·64 |
| Beet | 8·27 |
| Kohl-rabi | 6·08 |
| Rutabaga | 7·34 |
| Carrot | 5·80 |
| Belgian White Carrot | 6·22 |
| Mangold-Wurzel | 8·78 |
| Parsnip | 5·52 |
| Radish | 7·35 |
| Chicory | |
| Madder | 8·33 |
| WOODS. | |
| Beech | 0·38 |
| Apple | 1·29 |
| Cherry | 0·28 |
| Birch | 1·00 |
| Oak | 2·50 |
| Walnut | 1·57 |
| Lime | 5·00 |
| Horse-chesnut | 1·05 |
| Olive | 0·58 |
| Vine | 2·57 |
| Larch | 0·32 |
| Fir | 0·14 |
| Filbert | 0·50 |
| Chesnut | 3·50 |
| Poplar | 0·80 |
| Hazel | 0·50 |
| Orange | 2·74 |
| Vine | 2·57 |
| BARKS. | |
| Beech | 6·62 |
| Cherry | 10·37 |
| Oak | 6·00 |
| Horse-chesnut | 7·85 |
| Filbert | 6·20 |
| FRUITS. | |
| Plum | 0·40 |
| Cherry | 0·43 |
| Strawberry | 0·41 |
| Pear | 0·41 |
| Apple | 0·27 |
| Chesnut | 0·99 |
| Cucumber | 0·63 |
| Vegetable Marrow | 5·10 |

An examination of this table indicates, that though great differences exist in the proportion of ash in different plants, some general relations may be traced. It appears that the grains of the cerealia of all other seeds contain the smallest quantity of ash, and that the proportion is nearly the same in all, and may be stated in round numbers at two per cent. In the leguminous plants (pease, beans, &c.), the quantity is larger, amounting to about three per cent., while in rape-seed, linseed, and the other oily seeds, it reaches four per cent. In the stems and straws less uniformity exists, but if we except a few extreme cases, the quantity of ash in most of them approaches pretty closely to five per cent. Still more diversified are the results obtained from the entire plants; but this diversity is probably much more apparent than real, and must be, in part at least, dependent on the proportion existing between the stem and leaves; for, the leaves, as we observe under the next head, are peculiarly rich in ash, and a leafy plant must, of course, indicate a higher total per-centage of ash, although, if stems and leaves were separately examined, they might not show so conspicuous a difference.

The leaves of all parts of plants are richest in ash; the table shows that in some instances, as in the maple, the inorganic constituents exceed one-fourth of the whole of the weight of the dry matter. In other instances, and particularly in the coniferous plants, the quantity is much smaller. The average proportion of ash in the leaves amounts to about thirteen per cent., but where such variations exist, little value is to be attached to an average such as this, except as an indication of their general abundance.

Roots and tubers likewise show some variety, but, with the exception of the turnip and potato, all approach pretty closely to seven per cent.

The wood is that part of the plant which contains the smallest quantity of ash. In one case only does it reach five per cent., while the average scarcely exceeds one per cent., and in the fir the quantity amounts to no more than one six-hundredth of the dry matter. In the bark the quantity is much larger, and may be stated at seven per cent.

We have thus, in round numbers, the following proportions of ash in different parts of plants:—

| | |
|---|---|
| Wood | 1 |
| Seeds | 3 |
| Stems and straws | 5 |
| Roots and tubers | 7 |
| Bark | 7 |
| Leaves | 13 |

The differences which exist in the proportion of ash, are much more strikingly seen when we examine different parts of the same plant. In few instances, however, have analyses been sufficiently multiplied to give much information on this point. The oat, the orange tree, and the horse-chesnut, are the only plants in which it has been done. The results obtained with the oat are given in the following table:—

| | Hopetoun Oats, Northumberland. | Hopetoun Oats, Fifeshire. | Potato Oats, Northumberland. | Black Oats, Edinburgh. | Sandy Oats, Fifeshire. | Mean. |
|---|---|---|---|---|---|---|
| Grain | 2·14 | 1·81 | 2·22 | 2·11 | 1·76 | 2·00 |
| Husk | 6·47 | 6·03 | 6·99 | 8·24 | 6·03 | 6·75 |
| Chaff | 16·53 | 17·23 | 15·59 | 19·19 | 18·97 | 16 06 |
| Leaves | 8·44 | 7·19 | 14·59 | 10·29 | 15·92 | 10·88 |
| Upper part of straw | 4·95 | 5·44 | 9·22 | 8·25 | 11·0 | 7·77 |
| Middle part of straw | 6·11 | 5·23 | 7·41 | 6·53 | 9·01 | 6·66 |
| Lower part of straw | 5·33 | 5·18 | 9·76 | 7·11 | 7·30 | 6·93 |

from which it will be seen that though considerable variations occur, the relative proportions of ash in different parts of the plant are pretty constant.

The proportion of ash which a plant contains varies greatly at different periods of its growth, but the changes which it undergoes seem, so far as we at present know, to be governed by no general laws. It appears, however, generally, that during the period of active growth the quantity of ash is largest. Thus, it has been found that in early spring the wood of the young shoots of the horse-chesnut contains 9·9 per cent. of ash. In autumn this has diminished to 3·4, and the last year's twigs contain only 1·1 per cent., while in the old wood the quantity does not exceed 0·5. Saussure has also observed that the quantity of ash diminishes in certain plants when the seed has ripened. Thus, he found that the per-centages of ash, before flowering, and after seeding, were as follows:—

| | Before flowering. | With ripe seed. |
|---|---|---|
| Sunflower | 14·7 | 9·3 |
| Wheat | 7·9 | 3·3 |
| Maize | 12·2 | 4·6 |

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On the other hand, the quantity of ash in the leaves of trees increases considerably in autumn, as shown by this table:—

| | Per-centage of ash in May. | September. |
|---|---|---|
| Oak leaves | 5·3 | 5·5 |
| Poplar | 6·6 | 9·3 |
| Hazel | 6·1 | 7·0 |
| Horse-chesnut | 7·2 | 8·6 |

In other cases, the proportion of ash appears to increase as the plant reaches maturity, and this is particularly seen in the oat, of which we have very complete analyses, at different periods of its growth:—

*Proportion of Ash in different parts of the Oat at different periods of its growth.*

| Date. | Stalks. | Leaves. | Chaff. | Grain with husk |
|---|---|---|---|---|
| 2d July | 7·83 | 11·35 | | 4·91 |
| 9th July | 7·80 | 12·20 | | 4·36 |
| 16th July | 7·94 | 12·61 | 6·00 | 3·38 |
| 23d July | 7·99 | 16·45 | 9·11 | 3·62 |
| 30th July | 7·45 | 16·44 | 12·28 | 4·22 |
| 5th August | 7·63 | 16·05 | 13·75 | 4·31 |
| 13th August | 6·62 | 20·47 | 18·68 | 4·07 |
| 20th August | 6·66 | 21·14 | 21·07 | 3·64 |
| 27th August | 7·71 | 22·13 | 22·46 | 3·51 |
| 3d September | 8·35 | 20·90 | 27·47 | 3·65 |

Here a rapid increase takes place in the quantity of ash in the leaves and chaff. In the stalks it remains nearly uniform at all periods of the growth. In the grain, again, there is a decided diminution; but this diminution is apparent, not real, and is due to the determination of the ash being made on the grain, with its husk, and the rapid increase in weight of the grain, which is poor in ash, while the husk remains nearly unchanged, causes an apparent diminution in its proportion.

The quantity of ash contained in a plant is also dependent upon the nature of the soil on which it grows. Of this an interesting illustration is given in the following table of the quantities found in the grain and straw of the same variety of the pea grown on fourteen different soils:—

| | Seed. | Straw. | | Seed. | Straw. |
|---|---|---|---|---|---|
| 1 | 2·30 | | 8 | 2·27 | 6·59 |
| 2 | 3·25 | 3·43 | 9 | 2·69 | 3·49 |
| 3 | 4·27 | 3·62 | 10 | 1·61 | 3·91 |
| 4 | 3·40 | 3·39 | 11 | 3·11 | 5·28 |
| 5 | 2·99 | 3·90 | 12 | 3·34 | 7·57 |
| 6 | 3·19 | 6·80 | 13 | 2·78 | 3·76 |
| 7 | 2·53 | 3·90 | 14 | 3·01 | 3·38 |

The differences, especially in the straw, are here very remarkable, but we are unable to connect them with the peculiarities in composition of the soils on which they grow; indeed it is obvious that they must be dependent on most complicated questions, which we cannot at present solve, for we see that the increase in the ash of the straw is not generally connected with any corresponding increase in that of the grain. Theoretically, we should anticipate the proportion to be greatest in those soils which contain the largest quantities of the substances which enter into the composition of the ash; but this is by no means invariably the case. In some instances, the variations certainly can be traced to this source, as in the following analysis of the fruit of the horse-chesnut, grown on a common fruit soil, and on a rich porphyry soil:—

| | Kernel of seed. | Green husk. | Brown husk. |
|---|---|---|---|
| Forest soil | 2·26 | 4·53 | 1·70 |
| Porphyry soil | 3·36 | 7·29 | 2·20 |

in which a very marked increase has occurred, in that grown on the rich soil. This, however, is only an isolated case, and in many instances no satisfactory connexion can be traced between the nature of the soil and the quantity of ash contained in the plants grown on it.

While it thus appears that the quantity of ash differs greatly in different plants, the proportion in which the individual components enter into these ashes is also variable. Within very wide limits this will be at once apparent, from the following table, in which are gathered together analyses of the ash of most of our common cultivated, and a few uncultivated plants:—

*Table of the Composition of the Ash of different Plants in* 100 *parts.*

*Note.*—Alumina and oxide of manganese are of so rare occurrence that separate columns have not been introduced for them, but when they occur their quantity is stated in a note at the end of the table.

| | Potash. | Soda. | Chloride of Potassium. | Chloride of Sodium. | Lime. | Magnesia. | Oxide of Iron. | Phosphoric Acid. | Sulphuric Acid. | Carbonic Acid. | Silica. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat, grain | 30·02 | 3·82 | ... | ... | 1·15 | 13·39 | 0·91 | 46·79 | ... | ... | 3·89 |
| straw | 17·98 | 2·47 | ... | ... | 7·42 | 1·94 | 0·45 | 2·75 | 3·09 | ... | 63·89 |
| chaff | 9·14 | 1·79 | ... | ... | 1·88 | 1·27 | 0·37 | 4·31 | ... | ... | 81·22 |
| Barley, grain | 21.14 | ... | 5·65 | 1·01 | 1·65 | 7·26 | 2 13 | 28·53 | 1·91 | ... | 30·68 |
| straw | 11·22 | ... | ... | 2 14 | 5·79 | 2·70 | 1·36 | 7·20 | 1·09 | ... | 68·50 |
| Oats, grain[1] | 20·63 | ... | 1·03 | ... | 10·28 | 7·82 | 3·85 | 50·44 | ... | ... | 4·40 |
| straw | 19·46 | 1·93 | 2·71 | 4·27 | 7·01 | 3·79 | 1·49 | 5·07 | 3·35 | 1·36 | 49·56 |
| chaff[2] | 6·33 | 3·93 | ... | 0·24 | 1·95 | 0·38 | 1·58 | 1·04 | 9·61 | ... | 72·85 |
| Rye, grain | 33·83 | 0·39 | ... | ... | 2·61 | 12·81 | 1·04 | 39·92 | 0·17 | ... | 9·22 |
| straw | 17·20 | ... | 0·30 | 0·60 | 9·10 | 2·40 | 1·40 | 3·80 | 0·80 | ... | 64·50 |
| Maize, grain | 28·37 | 1·74 | ... | trace | 0·57 | 13·60 | 0·47 | 53·69 | ... | ... | 1·55 |
| stalks and leaves | 35·26 | ... | ... | 2·29 | 10·53 | 5·52 | 2·28 | 8·09 | 5·16 | 2·87 | 27·98 |
| Rice, grain | 20·21 | 2·49 | ... | ... | 7·18 | 4·26 | 2·12 | 62·23 | ... | ... | 1·37 |
| Pease (gray), seed | 41·70 | ... | 3·82 | 1·24 | 4·78 | 5·78 | 0·18 | 36·50 | 4·47 | 0·82 | 0·68 |
| straw | 21·30 | 4·22 | ... | ... | 37·17 | 7·17 | 1·07 | 4·65 | 8·68 | 12·48 | 3·23 |
| Beans (common field), grain | 51·72 | 0·54 | ... | ... | 5·20 | 6·90 | ... | 28·72 | 3·05 | 3·42 | 0·42 |
| straw | 32·85 | 2·77 | ... | 11·54 | 19·85 | 2·53 | 0·61 | 0·49 | 1·40 | 25·32 | 2·61 |
| Tare, straw | 32·82 | ... | 3·27 | 4·03 | 20·78 | 5·31 | 0·65 | 10·59 | 2·52 | 18·73 | 1·28 |
| straw | 31·72 | ... | 7·41 | 4·55 | 15·71 | 1·66 | ... | 10·34 | 4·67 | 20·37 | 3·57 |

[1] Oxide of Manganese, 0·42.

[2] Oxide of Manganese, 0·92.

| | Potash. | Soda. | Chloride of Potassium. | Chloride of Sodium. | Lime. | Magnesia. | Oxide of Iron. | Phosphoric Acid. | Sulphuric Acid. | Carbonic Acid. | Silica. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flax, seed | 34·17 | 1·69 | ... | 0·36 | 8·40 | 13·11 | 0·50 | 38·54 | 1·56 | 0·22 | 1·45 |
| straw | 21·53 | 3·68 | ... | 9·21 | 21·20 | 4·20 | 5·58 | 7·53 | 3·39 | 15·75 | 7·92 |
| Rape, seed[1] | 16·33 | 0·34 | ... | 0·96 | 8·30 | 8·80 | 1·79 | 31·90 | 5·38 | 5·44 | 19·98 |
| straw[2] | 16·63 | 10·57 | ... | 2·53 | 21·51 | 2·92 | 1·30 | 4·68 | 3·90 | 23·04 | 11·80 |
| Spurry | 26·12 | 1·14 | ... | 8·90 | 14·46 | 8·88 | ... | 10·20 | 1·79 | 27·38 | 1·14 |
| Red clover | 25·60 | ... | 9·08 | 6·02 | 21·57 | 8·47 | 1·26 | 4·09 | 2·96 | 18·05 | 1·95 |
| Cow grass, *Trifolium medium* | 22·78 | ... | 12·39 | 1·86 | 24·42 | 8·86 | 1·09 | 4·94 | 2·66 | 20·16 | 1·12 |
| Yellow clover | 27·48 | ... | 11·72 | 8·16 | 17·26 | 8·39 | 1·40 | ... | 4·82 | 4·31 | 1·76 |
| Alsike clover | 29·72 | ... | 6·29 | 1·05 | 26·83 | 4·01 | 0·71 | 5·64 | 3·25 | 20·74 | 1·73 |
| Lucerne | 27·56 | ... | 11·64 | 1·91 | 20·60 | 5·22 | 2·23 | 6·47 | 4·80 | 15·94 | 2·63 |
| Anthoxanthum odoratum | 32·03 | ... | 7·03 | 4·90 | 9·21 | 2·53 | 1·18 | 10·09 | 3·39 | 1·26 | 28·35 |
| Alopecurus pratensis | 37·03 | ... | 9·50 | ... | 3·90 | 1·28 | 0·47 | 6·25 | 2·16 | 0·65 | 38·75 |
| Avena pubescens | 31·21 | ... | 4·05 | 5·66 | 4·72 | 3·17 | 0·72 | 10·82 | 3·37 | ... | 36·28 |
| Bromus erectus | 20·33 | ... | 10·63 | 1·38 | 10·38 | 4·99 | 0·26 | 7·53 | 5·46 | 0·55 | 38·48 |
| Bromus mollis | 30·09 | 0·33 | ... | 3·11 | 6·64 | 2·60 | 0·28 | 9·62 | 4·91 | 9·07 | 33·34 |
| Cynosurus cristatus | 24·99 | ... | 11·60 | ... | 10·16 | 2·43 | 0·18 | 7·24 | 3·20 | ... | 40·11 |
| Dactylis glomerata | 29·52 | ... | 17·86 | 3·09 | 5·82 | 2·22 | 0·59 | 8·60 | 3·52 | 2·09 | 26·65 |
| Festuca duriuscula | 31·84 | ... | 8·17 | 0·62 | 10·31 | 2·83 | 0·78 | 12·07 | 3·45 | 1·38 | 28·53 |
| Holcus lanatus | 34·83 | ... | 3·91 | 6·66 | 8·31 | 3·41 | 0·31 | 8·02 | 4·41 | 1·82 | 28·31 |
| Lolium perenne | 24·67 | ... | 13·80 | 7·25 | 9·64 | 2·85 | 0·21 | 8·73 | 5·20 | 0·49 | 27·13 |
| Annual ryegrass | 28·99 | 0·87 | ... | 5·11 | 6·82 | 2·59 | 0·28 | 10·07 | 3·45 | ... | 41·79 |
| Poa annua | 41·86 | ... | 0·47 | 3·35 | 11·69 | 2·44 | 1·57 | 9·11 | 10·18 | 3·29 | 16·03 |
| Poa pratensis | 31·17 | ... | 11·25 | 1·31 | 5·63 | 2·71 | 0·28 | 10·02 | 4·26 | 0·40 | 32·93 |
| Poa trivialis | 29·40 | ... | 6·90 | ... | 8·80 | 3·22 | 0·29 | 9·13 | 4·47 | 0·29 | 37·50 |
| Phleum pratense | 31·09 | ... | 0·70 | 3·24 | 14·94 | 5·30 | 0·27 | 11·29 | 4·86 | 4·02 | 31·09 |
| Plantago lanceolata | 33·26 | ... | 4·53 | 8·80 | 19·01 | 3·51 | 0·90 | 7·08 | 6·11 | 14·40 | 2·37 |
| Poterium Sanguisorba | 30·26 | ... | 3·27 | 1·35 | 24·82 | 4·21 | 0·86 | 7·81 | 4·84 | 21·72 | 0·83 |
| Achillea Millefolia | 30·37 | ... | 20·49 | 3·63 | 13·40 | 3·01 | 0·21 | 7·13 | 2·44 | 9·36 | 9·92 |
| Potato, tuber | 43·18 | 0·09 | ... | 7·92 | 1·80 | 3·17 | 0·44 | 8·61 | 15·24 | 18·29 | 1·94 |
| stem | 39·53 | 3·95 | ... | 20·43 | 14·85 | 4·10 | 1·34 | 6·68 | 6·56 | ... | 2·56 |
| leaves | 17·27 | ... | 4·95 | 11·37 | 27·69 | 7·78 | 4·50 | 13·60 | 6·37 | ... | 6·47 |
| Jerusalem Artichoke | 55·89 | ... | 4·88 | ... | 3·34 | 1·30 | 0·45 | 16·99 | 3·77 | 11·80 | 1·52 |
| stem | 38·40 | 0·69 | ... | 4·68 | 20·31 | 1·91 | 0·88 | 2·97 | 3·23 | 25·40 | 1·51 |
| leaves | 6·81 | 3·72 | ... | 1·82 | 40·15 | 1·95 | 1·14 | 6·61 | 2·21 | 24·31 | 17·25 |
| Turnip, seed | 21·91 | 1·23 | ... | ... | 17·40 | 8·74 | 1·95 | 40·17 | 7·10 | 0·82 | 0·67 |
| bulb | 23·70 | 14·75 | ... | 7·05 | 11·82 | 3·28 | 0·47 | 9·31 | 16·13 | 10·74 | 2·69 |
| leaves | 11·56 | 12·43 | ... | 12·41 | 28·49 | 2·62 | 3·02 | 4·85 | 10·36 | 6·18 | 8·04 |
| Mangold-Wurzel, root | 21·68 | 3·13 | ... | 49·51 | 1·90 | 1·79 | 0·52 | 1·65 | 3·14 | 15·23 | 1·40 |
| leaves | 8·34 | 12·21 | ... | 37·66 | 8·72 | 9·84 | 1·46 | 5·89 | 6·54 | 6·92 | 2·35 |
| Carrot, root | 42·73 | 12·11 | ... | ... | 5·64 | 2·29 | 0·51 | 12·31 | 4·26 | 18·00 | 1·11 |
| leaves | 17·10 | 4·85 | ... | 3·62 | 24·05 | 0·89 | 3·43 | 6·21 | 5·08 | 23·15 | 11·61 |
| Kohl-rabi, bulb | 36·27 | 2·84 | ... | 11·90 | 10·20 | 2·36 | 0·38 | 13·45 | 11·43 | 10·24 | 0·83 |
| leaves | 9·31 | ... | 5·99 | 6·66 | 30·31 | 3·62 | 5·50 | 9·43 | 10·63 | 8·97 | 9·57 |
| Cow cabbage, head | 40·86 | 2·43 | ... | ... | 15·01 | 2·39 | 0·77 | 12·53 | 7·27 | 16·68 | 1·66 |
| stalk | 40·93 | 4·05 | ... | 2·08 | 10·61 | 3·85 | 0·41 | 19·57 | 11·11 | 6·33 | 1·04 |
| Poppy seed | 9·10 | ... | 7·15 | 1·94 | 35·36 | 9·49 | 0·41 | 31·38 | 1·92 | ... | 3·24 |
| leaves | 36·37 | ... | 2·50 | 2·51 | 30·24 | 6·47 | 2·14 | 3·28 | 5·09 | ... | 11·40 |
| Mustard seed (white) | 25·78 | 0·33 | ... | ... | 19·10 | 5·90 | 0·39 | 44·97 | 2·19 | ... | 1·31 |
| Radish root | 21·16 | ... | 1·29 | 7·07 | 8·78 | 3·53 | 1·19 | 41·09 | 7·71 | ... | 8·17 |

A simple inspection of this table leads to various interesting conclusions. It is to be observed that two at least of the constituents of the ash, viz. alumina, and oxide of manganese, occur rarely, and in small quantity, and must be of very little importance. They have indeed been altogether excluded by some chemists from the list of the true constituents of the ashes of plants, and their presence considered as purely fortuitous. Oxide of iron, of which the proportion is also very small, has sometimes been classed along with these substances as a fortuitous component; but it is invariably present, and the experiments of Prince Salm Horstmar leave no doubt that it is essential to the plant. Its function is unknown, but it is an important constituent of the blood of herbivorous animals, and may be present in the plant, less for its own benefit than for that of the animal of which it is destined to become the food.

*Soda* would appear also to be a comparatively unimportant constituent, being absent in some cases, and found in most plants in but small quantity. It is only in the cruciferous plants (turnip, rape, &c.) that it is found abundantly, and in them it appears to be an indispensable element; but in most other plants it admits of replacement by potash, and this replacement is probably in some instances the result of cultivation. It has at least been found that the proportions of the two alkalies vary greatly in cultivated and uncultivated specimens of the same plant, the proportion of soda being greatest in the uncultivated. This is conspicuously seen in the asparagus plant, which gave the following quantities of alkalies and chlorine:—

| | Wild. | Cultivated. |
|---|---|---|
| Potash | 18·8 | 50·5 |
| Soda | 16·2 | traced |
| Chlorine | 16·5 | 8·3 |

[1] Alumina, 1·02.

[2] Alumina. 0·63.

The soda having almost entirely disappeared in the cultivated plant, while a corresponding increase had taken place in the quantity of potash.

*Potash* is a most important constituent of plants, and generally forms a considerable proportion of their ash. It is most abundant in the roots and tubers, and sometimes forms more than half of their mineral constituents. It is also abundant in the seeds, while its proportion is small in the straws and stems, and particularly in the chaff, of our common grains. In general, it may be said to constitute a third part of the ash of most plants.

The proportions of *lime* and *magnesia* are liable to very great variations. As a general rule, the proportion of the former greatly exceeds that of the latter. An exception to this is found in the cereals, the grains of which are remarkably rich in magnesia; but, generally speaking, the quantity of magnesia is small, and rarely exceeds 4 per cent. Lime is most abundant in the leguminous plants, exceeding, in some instances, 30 per cent. of the ash. In the cereals it is remarkably small.

*Chlorine* is by no means an invariable constituent of the ash, although it is most commonly met with, and sometimes in considerable quantity. It appears to have some relation to the quantity of soda, and is always largest when that element is most abundant. A reference to the analyses of the wild and cultivated asparagus will render this obvious, and the same conclusions may be drawn from the table of the composition of ashes, where it will be seen that the chlorine exists to a great extent, as chloride of sodium, and conspicuously so in the ash of mangold-wurzel, where it amounts to almost exactly half of the mineral matter.

*Sulphuric Acid* is an essential constituent of the ash. But it is to be observed that it is in some instances entirely, and in all partially, a product of the combustion to which the plant has been submitted in order to obtain the ash. It is partially derived from the albuminous compounds, which all contain a certain quantity of sulphur, and which, being oxidised to sulphuric acid during the burning, remains in the ash. It is certain, however, that we thus obtain an imperfect estimate of the whole quantity of sulphur which the plant contains in its natural state; and for this reason experiments have been made, by treating the plants with nitric acid, so as effectually to oxidise the whole of their sulphur, and admit of its being accurately determined. From such experiments, the following table, showing the *total* amount of sulphur contained in 100 parts of different DRY plants, has been constructed.

| | | | |
|---|---|---|---|
| Poa palustris | 0·165 | Drumhead Cabbage | 0·431 |
| Lolium perenne | 0·310 | Wheat, grain | 0·068 |
| Italian Ryegrass | 0·329 | straw | 0·245 |
| Trifolium pratense | 0·107 | Barley, grain | 0·053 |
| repens | 0·099 | straw | 0·191 |
| Lucerne | 0·336 | Oats, grain | 0·103 |
| Vetch | 0·178 | straw | 0·289 |
| Potato tuber | 0·082 | Rye, grain | 0·051 |
| tops | 0·206 | Beans | 0·056 |
| Carrot, root | 0·092 | Pease | 0·127 |
| tops | 0·745 | Lentils | 0·110 |
| Mangold-Wurzel, root | 0·058 | Hops | 1·063 |
| tops | 0·502 | Gold of Pleasure | 0·253 |
| Swede, root | 0·435 | Black Mustard | 1·170 |
| tops | 0·458 | White Mustard | 1·050 |
| Rape | 0·448 | | |

*Phosphoric Acid* is found principally in the seeds of plants in which it amounts to from 30 to 50 per cent. The straws of the cereal plants contain it only in very small proportion, and the stems and leaves of other plants afford intermediate proportions.

*Silica* is an invariable constituent of the ash. It is only, however, in the grasses that it is abundant, and that principally in their stems. It there contributes to the strength of the straw, and by giving it additional rigidity prevents its being broken or injured by the weight of the ear.

The knowledge of the composition of the ash of plants leads to many important practical deductions. It enables us to explain why some plants will not grow upon particular soils on which others flourish. Thus, for instance, a plant which contains a large quantity of lime, such as the bean or turnip, will not grow in a soil in which that element is deficient, although wheat or barley, which require but little lime, may yield excellent crops. Again, if the soil be deficient in phosphoric acid, those plants only will grow luxuriantly which require but a small quantity of that element. An extension of this principle leads us to the conclusion that even where a soil contains a proper quantity of all its ingredients, the repeated cultivation of a plant which removes a large quantity of any one substance, may, in the course of time, so far reduce its amount, that the soil becomes incapable of any longer producing that plant, but if it be replaced by another which requires but little of the element thus removed, it may again produce an abundant crop. On this principle the rotation of crops is founded, and its success is dependent on the cultivation in successive years of plants which remove preponderating quantities of different substances.

It may be observed by a minute inspection of the table of ashes, that some plants are peculiarly rich in alkalies, others in lime, and others again in silica; and it would, of course, be the object of the farmer to employ, in succession, crops containing these elements in different proportions. Practical experience in this matter has led to conclusions in all respects identical with those of science, and the successive crops of a good rotation always belong to these different classes. It has been attempted to classify different plants under the heads of silica plants, lime plants, and potash plants, and the following table, extracted from Liebig's *Agricultural Chemistry*, in which the constituents of the ash are grouped under the three heads of salts of potash and soda, lime and magnesia, and silica, gives such a classification as far as it can be done:—

| | | Salts of Potash and Soda. | Salts of Lime and Magnesia. | Silica. |
|---|---|---|---|---|
| Silica Plants. | Oat straw with seeds | 34·00 | 4·00 | 62·00 |
| | Wheat straw | 22·50 | 7·20 | 61·50 |
| | Barley straw with seeds | 19·00 | 25·70 | 55·30 |
| | Rye straw | 18·65 | 16·52 | 63·89 |
| | Good hay | 6·00 | 34·00 | 60·00 |
| Lime Plants. | Tobacco | 24·34 | 67·44 | 8·30 |
| | Pea straw | 27·82 | 63·74 | 7·81 |
| | Potato plant | 4·20 | 59·40 | 36·40 |
| | Meadow Clover | 39·20 | 56·00 | 4·90 |
| Potash Plants. | Maize straw | 72·45 | 6·50 | 18·00 |
| | Turnips | 81·60 | 18·40 | — |
| | Beet root | 88·00 | 12·00 | — |
| | Potatoes | 85·81 | 14·19 | — |
| | Jerusalem Artichoke | 84·30 | 15·70 | — |

The special application of these facts must be left till we come to treat of the subject of the rotation of crops in full, for which a knowledge of the composition of soils is required.

It must be manifest that, as the crops which we remove from the soil contain a greater or less amount of inorganic matters, the quantity of these must, under any circumstances, be undergoing diminution. In many cases the soil contains an almost inexhaustible supply of those substances, but in other instances, where the quantity is small, a system of reckless cropping may reduce a soil to a state of absolute sterility. A remarkable illustration of this fact is found in the virgin soils of certain parts of America. The early settlers there reaped from these soils almost unheard-of crops, but, by repeated cultivation, they were soon exhausted and abandoned, new tracts being brought in and cultivated only to be in their turn exhausted and abandoned. The knowledge of the composition of the ash of plants shows us how this exhaustion may be avoided, and indicates the mode in which such soils may be preserved in a fertile state.

THE SOIL—ITS CHEMICAL AND PHYSICAL CHARACTERS.

No department of agricultural chemistry is surrounded with such difficulties and uncertainties as that relating to the properties of the soil. When chemistry began to be applied to agriculture it was from the determination of the composition of the soil that its principal advantages were anticipated, and it was certainly from it that the most striking results were at first obtained; for when analysis revealed, as it occasionally did, the absence of one or more of the essential constituents of the plant in a barren soil, it indicated at once the cause and the cure of the defect. The expectations naturally formed from the facts then observed have been but very partially fulfilled; for, as our knowledge has advanced, it has become apparent that it is only in rare instances that it is possible satisfactorily to connect together the composition and the properties of a soil, and with each advancement in the accuracy and minuteness of our analysis the difficulties have been rather increased than diminished. It has become more and more obvious that the question of the composition of a soil is one of extreme complexity, and we are now convinced that it will be necessary to commence again almost *de novo*, and, discarding many of the observations hitherto made, endeavour to determine the fundamental principles on which the fertility of a soil depends. It has been found that while in some instances it is possible to predicate with certainty that a particular soil is barren, in numerous others a barren and a fertile soil may approach so closely in composition that it is scarcely possible to distinguish them from one another; and so much is this the case that the analysis of a soil must, at the present moment, be considered as in many instances of comparatively little practical value. No doubt practical deductions of importance may occasionally be drawn from the careful analysis of a soil, but the great majority of those hitherto made fail to give the desired information. This may be partly owing to the imperfect analyses which have too often been made, but it is certainly mainly due to imperfect knowledge of the chemical conditions requisite for fertility; and until these are clearly known we cannot expect to derive from the analysis of a soil the important conclusions which it ought to, and at some future period certainly will, yield. Under the present circumstances, therefore, we can only detail such limited facts as are at present known, and of these we shall endeavour to give as clear and succinct an account as possible.

*Origin of Soils.*—The constituents of the soil, like those of the plant, may be divided into the great classes of organic and inorganic. The origin of the former of these we have already discussed. We have pointed out that they are derived from the decay of plants which have already grown upon the soil, and which, in various stages of decomposition, form the numerous class of substances grouped together under the name of humus. The organic substances may therefore be considered as in a manner secondary constituents of the soil, which have been accumulated in it as the consequence of the growth and decay of successive generations of plants, while the primeval soil consisted of inorganic substances only.

The inorganic constituents of the soil are obtained as the result of a succession of chemical changes going on in the rocks which protrude through the surface of the earth. We have only to examine one of these rocks to observe that it is constantly undergoing a series of important changes. Under the influence of air and moisture it is seen to become soft, to disintegrate, and to fall to powder, and is finally washed away by the rains. These actions, minute and trifling as they may at first sight appear, acting throughout many thousand years, are the source of the inorganic matters of all our soils. Geology points to a period at which the earth's surface must have been altogether devoid of soil, and have consisted entirely of hard crystalline rocks, such as granite and trap, by the disintegration of which, slowly proceeding from the creation down to the present time, all the soils which now cover the surface have been produced. But they have been produced as the result of very complicated processes; for these disintegrated rocks being washed away in the form of fine mud, or at least of minute particles, and being deposited at the bottom of the primeval seas, have there hardened into what are called sedimentary rocks, which being raised above the surface by volcanic action or other great geological forces have been again disintegrated to yield different soils. Thus, then, all soils are directly or indirectly derived from the crystalline rocks, those soils which overlie them being formed immediately by their decomposition, while those which overlie the sedimentary rocks may be traced back through them to the crystalline rocks from which they were originally formed. Such being the case, the composition of a soil must manifestly be dependent on the crystalline rocks from which it is derived. When we inquire into the matter, we find that these crystalline rocks are by no means numerous, and that they are made up of but a small number of different minerals. The great mass of our different rocks is made up of mixtures, in variable proportions, of quartz, felspar, mica, hornblende, augite, and zeolites. With the exception of quartz and augite, these names are, however, representatives of different classes of minerals. There are, for instance, not less than four different sorts of felspar, which have been distinguished by mineralogists by the names of orthoclase, albite oligoclase, and Labrador felspar; and there are, at least, two sorts of mica and hornblende, and many varieties of zeolites. The composition of those different minerals, with the exception of quartz, which is pure silica, is as follows, Thomsonite being given as a general illustration of the zeolites, which is a very numerous family:—

| | Felspars. | | | |
|---|---|---|---|---|
| | Potash. Orthoclase. | Soda. Albite. | Lime and Soda. Oligoclase. | Lime. Labrador. |
| Silica | 65·72 | 67·99 | 62·70 | 54·66 |
| Alumina | 18·57 | 19·61 | 23·80 | 27·87 |
| Peroxide of iron | traces | 0·70 | 0·62 | — |
| Oxide of manganese | traces | — | — | — |
| Lime | 0·34 | 0·66 | 4·60 | 12·01 |
| Magnesia | 0·10 | — | 0·02 | — |
| Potash | 14·02 | — | 1·05 | — |
| Soda | 1·25 | 11·12 | 8·00 | 5·46 |
| | 100·00 | 100·08 | 100·79 | 100·00 |

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| | Mica. | | Hornblende. | | | |
|---|---|---|---|---|---|---|
| | Potash. | Magnesia. | Common. | Basaltic. | Augite. | Thomsonite. |
| Silica | 46·36 | 42·65 | 41·50 | 42·24 | 50·12 | 38·73 |
| Alumina | 36·80 | 12·96 | 15·75 | 13·92 | 4·20 | 30·84 |
| Peroxide of iron | 4·53 | — | — | — | — | — |
| Protoxide of iron | — | 7·11 | 7·75 | 14·59 | 11·60 | — |
| Oxide of manganese | 0·02 | 1·06 | 0·25 | 0·33 | — | — |
| Lime | — | — | 14·09 | 12·24 | 20·05 | 13·43 |
| Magnesia | — | 25·75 | 19·40 | 13·74 | 13·70 | — |
| Potash | 9·22 | 6·03 | — | — | — | 0·54 |
| Soda | — | — | — | — | — | 3·85 |
| Hydrofluoric acid | 0·70 | 0·62 | — | — | — | — |
| Water | 1·84 | 3·17 | 0·50 | — | — | 13·09 |
| | 99·47 | 99·35 | 99·24 | 97·06 | 99·67 | 100·48 |

It is very obvious that soils produced from the disintegration of those minerals must be very different in their composition and fertility. Potash felspar, for instance, must yield a soil of much greater value than albite or Labrador, as it contains abundance of potash which, in the foregoing section, we have seen to be so important a constituent of the ash of plants; in the same way mica ought to produce a valuable soil. On the other hand, Labrador, hornblende, and augite supply lime and magnesia, and in this respect may be said to surpass the other felspars. But the value of these different minerals is not dependent on their chemical constitution alone; the facility with which they disintegrate, and undergo decomposition so as to liberate their constituents in a state in which they may become available to the plant, is an important element of their value, and in this respect very marked differences are observable. The disintegration of these minerals occurs in two different ways: in those rich in the alkalies it depends on their gradual separation into a silicate of alumina, and an alkaline silicate; in those which contain little alkali, and much protoxide of iron it depends on the gradual absorption of oxygen by that substance, which causes the breaking up of the mineral into new compounds. These changes take place with very different degrees of rapidity. In potash and soda felspar they proceed apace, but in Labrador, owing to the absence of alkalies, they are extremely slow.

The changes which take place in felspar may be easily traced through all their stages. We observe, in the first place, that after a certain time the mineral loses its peculiar lustre, acquires a dull and earthy appearance, absorbs water, becomes gradually soft, and at length falls into a more or less white and soft powder, presenting the characters of common clay. The nature of this change will be best seen by the following analysis of the clay produced by the decomposition of felspar, which is employed in the manufacture of porcelain under the name of kaolin,—

| | |
|---|---|
| Silica | 46·80 |
| Alumina | 36·83 |
| Peroxide of Iron | 3·11 |
| Carbonate of Lime | 0·55 |
| Potash | 0·27 |
| Water | 12·44 |
| | 100·00 |

In this instance the decomposition of the felspar had reached its limit, a mere trace of potash being left, but if taken at different stages of the process, variable proportions of that alkali are met with. This decomposition of felspar is the source of the great deposits of clay which are so abundantly distributed over the globe; and it takes place with nearly equal rapidity with potash and soda felspar. It is only in rare instances complete, and the soils produced from it frequently contain a considerable proportion of undecomposed felspar, which continues for a long period to yield a supply of alkalies to the plants which grow on them.

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Mica undergoes decomposition with extreme slowness, as is at once illustrated by the fact that its shining scales may frequently be met with entirely unchanged in the soil. Its persistence is dependent on the small quantity of alkaline constituents which it contains; and for this reason it is observed that the magnesian micas undergo decomposition less rapidly than those containing the larger quantity of potash. Eventually, however, both varieties become converted into clay, their magnesia and potash passing gradually into soluble forms. Hornblende and augite, as already mentioned, owe their decomposition to another cause, oxygen is absorbed, the protoxide of iron being converted into peroxide; lime and magnesia being separated, and a ferruginous clay produced. The zeolites are all rapidly decomposable minerals; like the felspars they yield a clay, while lime and alkalies are separated.

It is obvious from what has just been stated that all of these minerals may yield soils, but most of them would be devoid of many essential ingredients, while not one of them would yield either phosphoric acid, sulphuric acid, or chlorine. It has, however, been recently ascertained that certain of these minerals, or at least the rocks formed from them, contain minute, but distinctly appreciable traces of phosphoric acid, although in too small quantity to be detected by ordinary analysis; and small quantities of chlorine and sulphuric acid may also in most instances be found. Still it will be observed that most of these minerals would yield a soil containing only two or three of those substances, which, as we have already learned, are essential to the plant. Thus potash felspar, while it would give abundance of potash, would be but an inefficient source of lime and magnesia; and Labrador, which contains abundance of lime, is altogether deficient in magnesia and potash.

Nature has, however, provided against this difficulty, for she has so arranged it that these minerals rarely occur alone, the rocks which form our great mountain masses being composed of intimate mixtures of two or more of them, and that in such a manner that the deficiencies of the one compensate those of the other. We shall shortly mention the composition of these rocks.

Granite is a mixture of quartz, felspar, and mica in variable proportions. The quality of the soil it yields is dependent on the variety of felspar present, for both orthoclase and albite occur in it. When the former is the constituent, granite yields soils of tolerable fertility provided their climatic conditions be favourable; but it frequently occurs in high and exposed situations which are unfavourable to the growth of plants. Gneiss is a similar mixture, but characterised by the predominance of mica, and by its banded structure. Owing to the small quantity of felspar which it contains, and the abundance of the difficultly decomposable mica, the soils formed by its disintegration are generally inferior. Mica slate is also a mixture of quartz, felspar, and mica, but consisting almost entirely of the latter ingredient, and consequently presenting an extreme infertility. The position of the granite gneiss and mica slate soils in this country is such that very few of them are of much value; but in warm climates they not unfrequently produce abundant crops of grain. Syenite is a rock similar in composition to granite, but having the mica replaced by hornblende, which by its decomposition yields supplies of lime and magnesia more readily than they can be obtained from the less easily disintegrated mica. For this reason soils produced from the syenitic rocks are frequently possessed of considerable fertility.

The series of rocks of which *greenstone* is the type, and which are among the most widely distributed, are very different in composition from those already mentioned. They are divisible into two great classes, which have received the names of diorite and dolerite, the former a mixture of albite and hornblende, the latter of augite and Labrador, sometimes with considerable quantities of a sort of oligoclase containing both soda and lime, and of different kinds of zeolitic minerals. Generally speaking, the soils produced from diorite are superior to those from dolerite. The albite which the former contains undergoes a rapid decomposition, and yields abundance of soda along with some potash, which is seldom altogether wanting, while the hornblende supplies both lime and magnesia. Dolerite, when composed entirely of augite and labrador, produces rather inferior soils; but when it contains oligoclase and zeolites, and comes under the head of basalt, its disintegration is the source of soils remarkable for their fertility; for these latter substances undergoing rapid decomposition furnish the plants with abundant supplies of alkalies and lime, while the more slowly decomposing hornblende affords the necessary quantity of magnesia. In addition to these the basaltic rocks are found to contain appreciable quantities of phosphoric acid, so that they are in a condition to yield to the plant almost all its necessary constituents.

The different rocks now mentioned, with a few others of less general distribution, constitute the whole of our great mountain masses; and while their general composition is such as I have stated, they frequently contain disseminated through them quantities of other minerals which, though in trifling quantity, nevertheless add their quota of valuable constituents to the soils. Moreover, the exact composition of the minerals of which the great masses of rocks are composed is liable to some variety. Those which we have taken as illustrations have been selected as typical of the minerals; but it is not uncommon to find albite containing 2 or 3 per cent. of potash, Labrador with but 2 per cent., the remainder being replaced by magnesia, and zeolitic minerals containing several per cent. of potash, the presence of which must of course considerably modify the properties of the soils produced from them. The properties of the soils are also greatly altered by the mechanical influences to which the rocks are exposed. Situated for the most part in elevated positions, they are no sooner disintegrated than they are washed down by the rains. A granite, for instance, as the result of disintegration, has its felspar reduced to an impalpable powder, while its quartz and mica remain, the former entirely, the latter in great part, in the crystalline grains which existed originally in the granite. If such a disintegrated granite remains on the spot, it is easy to see what its composition must be; but if exposed to the action of running water, by which it is washed away from its original site, a process of separation takes place, the heavy grains of quartz are first deposited, then the lighter mica, and lastly the felspar. Thus there may be produced from the same granite soils of very different nature and composition, from a pure and barren sand to a rich clay formed entirely of the debris of the felspar.

The sedimentary rocks are too numerous and too varied in their composition to admit of much detail being given regarding their relations to the soil. Being derived, however, from the crystalline rocks, the observations which we have already made regarding the latter will apply in some sort to the former. In fact, the sedimentary rocks may to all intents and purposes be classed under the head of clays (embracing the different sorts of clay slates, shales, &c.), and sandstone, the former derived from felspathic, the latter from quartzose minerals. To these must be added limestone, which in various forms is one of the most important of the stratified rocks. Each of these forms many subdivisions, partly dependent on chemical differences, and partly on their position in the geological series. The purest clays, such as the fire clay of the coal formation, have manifestly been produced by the thoroughly complete decomposition of felspar, and in them almost nothing but its silica and alumina have been left; such clays yield almost absolutely barren soils. But when the decomposition has not proceeded so far, different sorts of clay slates and shales are produced, which, though of considerable hardness, disintegrate sometimes with great rapidity, and often produce soils of much value. As an illustration of the general composition of such rocks the following analyses of the fire clay of the coal formation, and of transition clay slate are given.

| | Transition Clay Slate. | Fire Clay. |
|---|---|---|
| Silica | 60·03 | 54·77 |
| Alumina | 14·91 | 28·61 |
| Peroxide of iron | 8·94 | 4·92 |
| Lime | 2·08 | 0·58 |
| Magnesia | 4·22 | 1·14 |
| Potash | 3·87 | 1·00 |
| Soda | ... | 0·24 |
| Carbonic acid } Water } | 5·67 | 8·24 |
| | 99·72 | 99·50 |

The sandstones require little mention; many of them consist of nearly pure silica, and these produce mere sandy soils, incapable of supporting vegetable life; but in other instances silica is only the principal constituent, and is mixed with a certain proportion of clay, and such sandstones may yield soils of better quality, but they are always light and poor. Where such sandstones occur interstratified with clays, still better soils are produced, the mutual admixture of the disintegrated rocks producing a soil of intermediate properties, and in which the heaviness of the clay is tempered by the lightness of the sandstone.

Limestone is one of the most widely distributed of the stratified rocks, and in different localities occurs of very different composition. Limestones are divided into two classes, common and magnesian; the former a nearly pure carbonate of lime, the latter a mixture of that substance with carbonate of magnesia. But while these are the principal constituents, it is not uncommon to find small quantities of phosphate and sulphate of lime, which, however trifling their proportions, are not unimportant in an agricultural point of view. The following analyses will serve to illustrate the general composition of these two sorts of limestone:—

| | Common. | | Magnesian. | |
|---|---|---|---|---|
| | Mid-Lothian. | Sutherland. | Sutherland. | Dumfries. |
| Silica | 2·00 | 7·42 | 6·00 | 2·31 |
| Peroxide of iron and alumina | 0·45 | 0·76 | 1·57 | 2·00 |
| Carbonate of lime, | 93·61 | 84·11 | 50·21 | 58·81 |
| Carbonate of magnesia | 1·62 | 7·45 | 41·22 | 36·41 |
| Phosphate of lime | 0·56 | ... | ... | ... |
| Sulphate of lime | 0·92 | ... | ... | 0·10 |
| Organic matter | 0·20 | ... | ... | ... |
| Water | 0·50 | ... | 0·69 | ... |
| | 99·86 | 99·74 | 99·69 | 99·63 |

These are pure limestones; but there occurs yet another sort, which is a mixture of carbonate of lime with variable quantities of clay. Limestone and chalk, when disintegrated, produce light and open soils; but when mixed with clay, they give rise to soils of high fertility. This is particularly the case with chalk, on which are found some of the most valuable of all soils. But it is true only of the common limestones, for experience has shown that those which contain magnesia in large quantity are generally prejudicial to vegetation, and yield barren or at best very inferior soils.

Such are the general characters of the three great classes of stratified rocks; any attempt to particularise the numerous varieties of each would lead us far beyond the limits of the present article. It is necessary, however, to remark, that in many instances the one variety passes into the other, or, more correctly speaking, sedimentary rocks occur, which are, so to speak, mixtures of two or more of the three great classes. Thus we have sandstones which contain much clay, clay slates and shales, which are rich in lime, limestone rocks with a large intermixture of clay. Such mixtures usually produce better soils than either of their constituents separately, and accordingly, in those geological formations in which they are abundant, the soils are generally of excellent quality. The same effect is produced where numerous thin beds of members of the different classes are interstratified, the disintegrated portions being gradually intermixed, and valuable soils formed. It may be stated generally that the soils of the clay slates are for the most part cold, heavy, and very difficult and expensive to work; those of sandstone light and poor, and of limestone generally poor and thin. These statements must, however, be considered as very general; for individual cases occur in which some of these substances may produce good soils. Such is the case with the lower chalk and with some of the shales of the coal formation. Little is at present known regarding the peculiar nature of these rocks, or their composition; and the cause of the differences in the fertility of the soil produced from them is a subject worthy of minute investigation.

*Chemical Composition of the Soil.*—We have already referred to the division of the constituents of the soil into the two great classes of organic and inorganic. When treating of the sources of the organic constituents of plants, we entered with some degree of minuteness into the composition and relations of the different members of the former class, and expressed the opinion that they did not admit of being directly absorbed by the plant. As a direct source of these substances, humus is unimportant; but it has other functions to perform which render it an essential constituent of all fertile soils. These functions are dependent on the power which it has of absorbing and entering into chemical composition with ammonia, and with certain of the soluble inorganic substances of the soil. Its effects in this way are strikingly seen in the manner in which ammonia is absorbed by peat soils; it suffices merely to pour upon some dried peat a small quantity of a dilute solution of ammonia to find its smell immediately disappear. This peculiar absorptive power extends also to the fixed alkalies, potash and soda, as well as to lime and magnesia, and has an important effect in preventing these substances being washed out of the soil—a property which, as we shall afterwards see, is possessed also by the clay contained in greater or less quantity in most soils.

In examining into the inorganic constituents of the soil, we find that it is not sufficient merely to inquire into the nature of these substances, but that the states of combination in which they exist is of the very highest importance. Two soils may, for instance, be found on analysis to yield exactly the same results, and yet the one may prove in practice to be fertile, the other barren; and these differences may be entirely dependent on the conditions in which their individual elements exist. To pass into the plant, these substances must be soluble in water, and, unless they are so, it matters not in what quantity the soil contains them; if they are insoluble, they are locked up from use, and the soil is left to hopeless infertility. Accordingly, it must be at once apparent that the determination of the total amount of each of the elements of the soil is not sufficient to establish its value. If the analysis is to be of any use, it ought to indicate also the conditions in which they exist, so that we may ascertain the ease or difficulty with which they may be absorbed. For this purpose it is necessary to determine, 1*st*, The substances soluble in water; 2*d*, The substances insoluble in water, but soluble in acids; 3*d*, The substances insoluble both in water and acids. If to these we add the organic constituents, we have four separate heads, under which the components of a soil ought to be classified. This classification is accordingly adopted in the most careful and minute analyses; but the difficulty and labour attending such analyses has hitherto precluded the possibility of making them except in a few instances; and, generally speaking, chemists have been contented with treating the soil with an acid, and determining in the solution all that is dissolved. Such analyses are at times useful for practical purposes, as, for example, when they show the absence of lime, or any other individual substance, by the addition of which we may rectify the deficiency of the soil; but they are of comparatively little scientific value, and throw but little light on the true constitution of the soil, and the sources of its fertility. Nor is it likely that we shall arrive at much satisfactory information until the number of minute analyses is so far extended as to enable us to establish the fundamental principles on which the various properties of the soil depends.

The separation of the constituents of a soil into the four great groups already mentioned is effected in the following manner:—A given quantity of the soil is boiled with three of four successive quantities of water, which dissolves out all the soluble matters. These soluble matters generally amount to about one-half per cent. of the whole soil, and consist of nearly equal proportions of organic and inorganic substances. In very light and sandy soils, it occasionally happens that not more than one or two-tenths per cent. dissolve in water, and in peaty soils, on the other hand, the proportion is sometimes considerably increased, principally owing to the abundance of soluble organic matters.

When the residue of this operation is heated with dilute hydrochloric acid, the portion soluble in acids is obtained in the fluid. This portion of the soil is liable to very great variations. In some soils of excellent quality, and well adapted to the growth of wheat, it does not exceed three per cent., while in calcareous soils, such as those of the chalk formation, it may reach as high as 50 or 60 per cent. In general, however, it amounts to about 10 per cent. The organic constituents are also very variable in amount; ordinary soils of good quality containing from 2 to 10 per cent., while in peat soils it is no uncommon thing for them to exceed 30 per cent., and in some instances to reach as high as 50. Such soils, however, cannot be considered *fertile* soils. The insoluble constituents are likewise subject to great variations. In the ordinary clay and sandy soils of this country, they generally form from 80 to 90 per cent. of the whole, but they are occasionally as low as 30, especially in such soils as are very rich in lime.

The distribution of the constituents under these different heads will be best illustrated by a few analyses of soils of good quality. The following are the analyses of two noted for the excellent crops of wheat they produce, and for their general fertility. The analyses were made from the upper 10 inches, and a quantity of the 10 inches immediately subjacent was analysed as subsoil. The first is the ordinary wheat soil of the county of Mid-Lothian, the other the alluvial soil of the Carse of Gowrie in Perthshire, so celebrated for the abundance and luxuriance of the crops it produces.

| | Mid-Lothian. Soil. | Mid-Lothian. Subsoil. | Perthshire. Soil. | Perthshire. Subsoil. |
|---|---|---|---|---|
| *Substances soluble in water.* | | | | |
| Silica | 0·0149 | 0·0104 | 0·0072 | 0·0461 |
| Lime | 0·0300 | 0·0072 | 0·0184 | 0·0306 |
| Magnesia | 0·0097 | 0·0016 | 0·0040 | 0·0034 |
| Chlor. of magnesium | ... | ... | ... | 0·0033 |
| Potash | 0·0034 | 0·0037 | ... | ... |
| Soda | 0·0065 | 0·0049 | ... | ... |
| Chloride of potassium | ... | ... | 0·0088 | 0·0080 |
| Chloride of sodium | ... | ... | 0·0110 | 0·0166 |
| Sulphuric acid | 0·0193 | 0·0124 | 0·0089 | 0·0239 |
| Chlorine | trace | trace | ... | ... |
| Organic matters | 0·1481 | 0·2228 | 0·0608 | 0·1342 |
| | 0·2319 | 0·2630 | 0·1191 | 0·2661 |
| *Soluble in acids.* | | | | |
| Silica | 0·1490 | 0·0680 | 0·0482 | 0·1697 |
| Peroxide of iron | 5·1730 | 3·4820 | 4·8700 | 4·6633 |
| Alumina | 2·1540 | 1·8130 | 2·6900 | 3·9070 |
| Lime | 0·4470 | 0·3810 | 0·3616 | 0·5050 |
| Magnesia | 0·4120 | 0·2850 | 0·3960 | 0·9420 |
| Potash | 0·0650 | 0·1650 | 0·3445 | 0·1670 |
| Soda | 0·0050 | 0·0560 | 0·1242 | 0·1920 |
| Sulphuric acid | 0·0250 | 0·0850 | 0·0911 | 0·0160 |
| Phosphoric acid | 0·4300 | 0·1970 | 0·2400 | 0·2680 |
| Carbonic acid | ... | ... | 0·0500 | ... |
| | 8·8600 | 6·5320 | 9·2156 | 10·8300 |
| *Insoluble in acids.* | | | | |
| Silica | 71·3890 | 82·5090 | 63·1400 | 61·4200 |
| Alumina | 4·7810 | 3·5120 | 11·3500 | 10·3400 |
| Peroxide of iron | trace | trace | ... | 1·5670 |
| Lime | 0·7520 | 0·5500 | 0·4500 | 0·7400 |
| Magnesia | 0·6610 | 0·5500 | 0·6200 | 0·4450 |
| Potash | 0·2860 | ... | 2·4500 | 2·0030 |
| Soda | 0·4220 | ... | 1·3100 | 0·8440 |
| | 78·2910 | 87·1210 | 79·3200 | 77·3590 |
| *Organic matters.* | | | | |
| Insoluble organic matter | 8·8777 | 4·2370 | 7·7400 | 6·2910 |
| Humine | 0·8850 | 0·3450 | 0·0700 | 0·0840 |
| Humic acid | 0·1340 | 0·0310 | 0·6800 | 0·3600 |
| Apocrenic acid | 0·1533 | ... | ... | 0·0920 |
| Water | 2·6840 | 1·7670 | 2·7000 | 4·5750 |
| | 12·7340 | 6·3800 | 11·1900 | 11·4020 |
| Sum of all the constituents | 100·1169 | 100·2960 | 99·8447 | 99·8571 |

Amount of carbon, hydrogen, nitrogen, and oxygen contained in 100 parts of each soil.

| | | | | |
|---|---|---|---|---|
| Carbon | 4·510 | 1·3060 | 2·55 | 2·03 |
| Hydrogen | 0·550 | 0·3324 | 0·71 | 0·53 |
| Nitrogen | 0·220 | 0·0973 | 0·21 | 0·17 |
| Oxygen | 4·918 | 3·1001 | 5·08 | 4·09 |
| | 10·198 | 4·8358 | 8·55 | 6·82 |

From an examination of these analyses, it is apparent that certain of the inorganic constituents of the soil are met with in each of the three heads under which they are arranged, while others are confined to one or two. Silica and the alkalies occur generally, though not invariably in all three. Chlorine is met with only in the part soluble in water, phosphoric acid only in that soluble in acids, while sulphuric acid occurs in both the last-named divisions. The part soluble in water is composed entirely of salts of the alkalies, lime, and magnesia; the acids being sulphuric acid, silica, and chlorine, the latter in very small quantity. All the substances met with in solution are important constituents of the ash of plants. It is different, however, with those soluble in acids, of which the larger proportion consists of alumina and oxide of iron, both of which are comparatively unimportant to the plant, but very important, as we shall afterwards see, in relation to the physical properties of the soil. The remainder of the substances soluble in acids, amounting to from 1 to 2 per cent., is composed of some of the most essential constituents of plants. Lime, magnesia, potash, and soda, appear again in larger quantity than in the soluble part, and along with them we have the phosphoric acid to the amount of from 0·2 to 0·4 per cent. of the whole soil, and sulphuric acid in much smaller quantity. The insoluble matters show a striking difference in the two soils, in regard to the proportion of alkalies they contain, the Mid-Lothian soil showing only 0·28 per cent. of potash, the subsoil none, while the Perthshire contains 2·45 and 2·00 respectively.

As a contrast with these soils, we have the following analysis of a soil from the island of Antigua, from which very large crops of sugar-cane are obtained. The soil is of great depth, and analyses of the subsoil at the depth of 18 inches and 5 feet are given. These last analyses are not so minute as that of the soil itself, the soluble matters not having been separately determined, but included in that soluble in acids.

| | Surface soil. | 18 inches deep. | 5 feet deep. |
|---|---|---|---|
| *Soluble in water.* | | | |
| Lime | 0·07 | ... | ... |
| Magnesia | trace | ... | ... |
| Potash | 0·06 | ... | ... |
| Soda | 0·04 | ... | ... |
| Chlorine | 0·05 | ... | ... |
| Organic matter | 0·15 | ... | ... |
| | 0·37 | | |
| *Soluble in acids.* | | | |
| Silica | 0·74 | ... | ... |
| Peroxide of iron | 2·22 | 1·67 | 1·87 |
| Protoxide of iron | 0·77 | 9·05 | 3·10 |
| Alumina | 1·90 | 2·52 | 4·21 |
| Lime | 10·43 | 3·04 | 25·75 |
| Magnesia | 0·20 | 0·54 | 0·51 |
| Potash | 0·03 | 0·29 | 0·28 |
| Soda | 0·02 | 0·11 | 0·16 |
| Sulphuric acid | trace | 0·02 | 0·13 |
| Phosphoric acid | 0·14 | trace | 0·04 |
| Carbonic acid | 7·38 | 0·82 | 20·23 |
| | 23·83 | 18·06 | 56·28 |
| *Insoluble in acids.* | | | |
| Silica | 41·44 | 51·24 | 27·67 |
| Protoxide of iron | 3·24 | 0·26 | 1·40 |
| Alumina | 9·00 | 1·50 | 1·00 |
| Lime | 0·08 | 0·88 | trace |
| Magnesia | 0·80 | 0·54 | trace |
| Potash | ... | 0·74 | ... |
| Soda | ... | 0·25 | ... |
| | 54·56 | 55·41 | 30·07 |
| *Organic matters.* | | | |
| Humine | 1·58 | | |
| Humic acid | 1·15 | 12·05 | 7·49 |
| Insoluble organic matters | 7·66 | | |
| Water | 11·13 | 14·69 | 6·06 |
| | 21·52 | 26·74 | 13·55 |
| Sum of all the constituents | 100·28 | 100·21 | 99·90 |

In this soil there is a general resemblance in the composition of the portion soluble in water to those of the wheat soils. But the part soluble in acids is distinguished by the great abundance of carbonate of lime.

The soil of Holland from the neighbourhood of the Zuider Zee, which is an alluvial deposit from the waters of the Rhine, and produces large crops, gave the results which follow.

| | Surface. | 15 inches deep. | 30 inches deep. |
|---|---|---|---|
| Insoluble silica | 57·646 | 51·706 | 55·372 |
| Soluble silica | 2·340 | 2·496 | 2·286 |
| Alumina | 1·830 | 2·900 | 2·888 |
| Peroxide of iron | 9·039 | 10·305 | 11·864 |
| Protoxide of iron | 0·350 | 0·563 | 0·200 |
| Oxide of manganese | 0·288 | 0·354 | 0·284 |
| Lime | 4·092 | 5·096 | 2·480 |
| Magnesia | 0·130 | 0·140 | 0·128 |
| Potash | 1·026 | 1·430 | 1·521 |
| Soda | 1·972 | 2·069 | 1·937 |
| Ammonia | 0·060 | 0·078 | 0·075 |
| Phosphoric acid | 0·466 | 0·324 | 0·478 |
| Sulphuric acid | 0·896 | 1·104 | 0·576 |
| Carbonic acid | 6·085 | 6·940 | 4·775 |
| Chlorine | 1·240 | 1·302 | 1·418 |
| Humic acid | 2·798 | 3·991 | 3·428 |
| Crenic acid | 0.771 | 0·731 | 0·037 |
| Apocrenic acid | 0·107 | 0·160 | 0·152 |
| Other organic matters and Combined water | 8·324 | 7·700 | 9·348 |
| Loss | 0·540 | 0·611 | 0·753 |
| | 100·000 | 100·000 | 100·000 |

It is unnecessary to multiply analyses of fertile soils, those now given being sufficient to shew their general composition. They are all characterised by the presence in considerable quantity of all the essential constituents of plants, and by their presence in a state in which they may be readily absorbed. The absence of one or more of these substances immediately diminishes or altogether destroys the fertility of the soil; and the extent to which this occurs is illustrated by the following analysis of a soil from Pumpherston, Mid-Lothian, forming a small patch in the lower part of a field, and on which nothing would grow. Being naturally wet, it had been drained and sowed with oats, which died out about six weeks after sowing, and left a bare soil on which weeds did not show the slightest disposition to grow.

| | | |
|---|---|---|
| *Soluble in acids.* | | |
| Soluble silica | 0·173 | |
| Peroxide of iron | 6·775 | |
| Alumina | 1·150 | |
| Oxide of manganese | trace | |
| Carbonate of lime | 0·856 | |
| Magnesia | 0·099 | |
| Potash | 0·132 | |
| Soda | 0·123 | |
| Phosphoric acid | trace | |
| Chlorine | trace | |
| | | 9·308 |
| Silica | 73·096 | |
| Peroxide of iron | 1·371 | |
| Alumina | 4·263 | |
| Lime | 0·858 | |
| Magnesia | 0·520 | |
| | | 80·108 |
| Organic matter | 8·012 | |
| Water | 2·391 | |
| | | 10·403 |
| | | 99·819 |

In this instance the barrenness of the soil is distinctly traceable to the deficiency of phosphoric acid, sulphuric acid, and chlorine. There is also a remarkably large quantity of oxide of iron, which, when dissolved by the humic acid, is well known to be highly prejudicial to vegetation. That this took place was shown by the fact that the drains, a couple of months after being laid, were almost stopped up by humate of iron. Still more striking are the following analyses:—

| | Moorland soil near Aurich East Friesland. | Sandy soil near Wettingen. | Soil from near Muhlhausen. |
|---|---|---|---|
| Silica and sand | 70·576 | 96·000 | 77·780 |
| Alumina | 1·050 | 0·500 | 9·490 |
| Oxide of iron | 0·252 | 2·000 | 5·800 |
| Oxide of manganese | trace | trace | 0·105 |
| Lime | | 0·001 | 0·866 |
| Magnesia | 0·012 | | 0·728 |
| Potash | | | trace |
| Soda | trace | trace | |
| Phosphoric acid | | | 0·003 |
| Sulphuric acid | | | trace |
| Carbonic acid | ... | ... | 0·200 |
| Chlorine | trace | trace | trace |
| Humic acid | 11·910 | 0·200 | 0·732 |
| Insoluble humus | 16·200 | 1·299 | 0·200 |
| Water | ... | ... | 4·095 |
| | 100·000 | 100·000 | 100·000 |

The results contained in these analyses are peculiarly remarkable, indicating as they do the almost total absence of all those substances which the plant requires. These must, however, be considered as in a great measure exceptional cases, as it is no doubt but rarely that so large a number of constituents is absent, and far more frequent to find the deficiency restricted to one or two substances. They are illustrations of barrenness dependent on different circumstances. The first shows the unimportance of the organic matters of the soil, which are here unusually abundant, without in any way counteracting the unfertility dependent on the absence of the other constituents. The second is that of a nearly pure sand; and the third, though it contains a greater number of the essential ingredients of the ash, is still rendered unfruitful by the deficiency of alkalies, sulphuric acid, and chlorine.

An examination of the foregoing analyses indicates pretty clearly the conditions of fertility of the soil. It must obviously contain all the constituents of the plants which are to grow upon it, and in a soluble state, so that they may admit of absorption by the plant. It is clear, however, that the part directly soluble in water embraces only a certain number of the constituents of the plant, and that only in small quantity. This becomes still more apparent if we estimate the quantities contained in an acre of soil. It is calculated that the soil on an imperial acre of land 10 inches deep weighs in round numbers about 1000 tons; and calculating from this, we find that the quantity of potash soluble in water in the Mid-Lothian wheat soil amounts only to about 70 lb. per acre. But a crop of hay carries off from the soil about 38 lb. of potash, and one of turnips, including tops, not less than 200 lb. Manifestly, therefore, if only the matters soluble in water could be taken up by the plant, such soils could not possess the amount of fertility which they actually do. But the soil is not an inert unchangeable substance; it is the theatre of an important series of chemical changes effected by the action of air and moisture, and producing a continued liberation of its constituents. The oxygen of the air acts upon the organic matters of the soil, and produces a constant though slow evolution of carbonic acid, which is absorbed by the moisture contained in the soil, and exerts a solvent action on its constituents. In fact, though a very feeble acid, carbonic acid, by continuous action, is constantly effecting the solution of new quantities of the constituents of the soil; and this action goes on so slowly that at any one moment, the quantity in a soluble condition is not sufficient to supply the total amount required by the plant; but by a beautiful provision of nature, they are brought into the soluble state only in proportion as they are required for the plant, and thus the loss which would take place by the rain falling upon a soil charged with soluble matters and washing them out, is effectually prevented.

Carbonic acid is therefore a most important agent in producing the chemical changes in the soil, and the organic matters are valuable, as affording a supply of that substance within the soil itself; but the carbonic acid of the atmosphere will itself effect these changes, although with different degrees of rapidity according to the character of the soil. In light soils of open texture it will act easily, but in stiff clay soils its action is very slow. The solvent action of the carbonic acid is, no doubt, principally exerted on the substances soluble in acids, but not entirely, for we know that the part insoluble in acids is gradually being disintegrated and made soluble; and hence it is that the composition of that part of the soil which resists the action of acids, and which at first sight might appear of no moment, is really important. We observe, in fact, that this circumstance must at once confer on the soil of the Carse of Gowrie a great superiority over those of Mid-Lothian and most other districts; for it contains in its insoluble part a quantity of alkalies which must necessarily form a source of continual fertility. Accordingly, experience has all along shown the great superiority of that soil, and of alluvial soils generally, which are all more or less similar to it. The facility with which these matters are attackable by carbonic acid is also an important element of the fertility of a soil, and it is to the existence of compounds which are readily soluble that we attribute the high fertility of the trap soils.

By a further examination of the analyses of fertile soils, it is at once apparent that the most essential constituents of plants are by no means the most abundant in the soil. In fact, phosphoric and sulphuric acids, lime, magnesia, and the alkalies, which in most instances make up nine-tenths of the ash of plants, form but a small portion of even the most fertile soils; while silica, which except in the grasses occurs in small quantity, oxide of iron which is a limited, and alumina a rare, constituent of the ash, form by far their larger part. Thus the total amount of potash, soda, lime, magnesia, phosphoric and sulphuric acids and chlorine contained in the Mid-Lothian wheat soil amounts only to 3·5888 per cent., and in the Perthshire to 6·4385, the entire remainder being substances which enter into the plant for the most part in much smaller quantity. Now, as these small quantities of the more important substances are capable of supplying the wants of the plant, it must be obvious that a very small fraction of the silica, oxide of iron, and alumina, which the soils contain, would afford to it the whole quantity of these substances it requires, and that the rest of these constituents must have some other functions to perform in the soil. Hitherto we have looked upon a soil merely as the source of the inorganic food of plants, but it has to act also as a support for the plant while growing, and to retain a sufficient quantity of moisture to support its life; and unless it possess the properties which fit it for doing so, it may contain all the elements of the food of plants, and yet be nearly or altogether barren.

If a quantity of a soil be shaken up with water and allowed to stand for a few minutes, we find that it rapidly deposits a quantity of grains which we at once recognise as common sand. If the water be now poured off into another vessel and allowed to stand for a longer time, there is deposited a quantity of a fine soft powder, having the properties and composition of common clay, while the clear fluid now contains the soluble matter. By a more careful treatment we can likewise distinguish and separate humus, and in soils lying on chalk or limestone, calcareous matter or carbonate of lime. We perform in this way a sort of mechanical analysis, and classify the components of the soil into four groups, a mixture of two or more of which in variable proportions is found in all soils.

The relative proportions in which these substances exist in a soil are intimately connected with its mechanical and physical properties, which have as important an influence in its fertility as its chemical composition; for a soil may contain all the necessary elements of the crops, and yet, from some defect in its physical characters, be nearly or altogether barren. In fact, it is impossible to examine a large number of analyses of soils without seeing that though in many instances they may give tolerably satisfactory information as to their relative values, yet we sometimes see two soils one fertile and the other barren although there is no appreciable difference in their *chemical* composition. An illustration of this is found in the following analyses of two soils both fertile, but in one of which red clover grows luxuriantly, in the other it invariably fails.

| | Clover fails. | Clover succeeds. |
|---|---|---|
| Insoluble silicates | 83·90 | 81·34 |
| Soluble silica | 0·08 | 0·02 |
| Peroxide of iron | 4·45 | 6·68 |
| Alumina | 2·40 | 3·00 |
| Lime | 1·23 | 1·33 |
| Magnesia | 0·45 | 0·25 |
| Potash | 0·20 | 0·22 |
| Soda | 0·07 | 0·09 |
| Sulphuric acid | 0·05 | 0·08 |
| Phosphoric acid | 0·38 | 0·07 |
| Carbonic acid | 0·09 | 0·34 |
| Chlorine | trace | trace |
| Humic acid | 0·42 | 0·43 |
| Humine | ... | 0·10 |
| Insoluble organic matters | 3·70 | 3·61 |
| Water | 2·54 | 2·52 |
| | 99·96 | 100·08 |
| Nitrogen | 0·15 | 1·15 |

In default of any explanation deducible from the composition of the soil, we are induced to attribute the differences here observed to differences in their physical properties.

Now it appears that the mechanical constituents of the soil mentioned above possess certain properties, partly mechanical and partly chemical, which exert an important influence on its fertility. Sand and clay, the most important of the four, confer on the soil diametrically opposite properties; the former, when present in large quantity, producing what are designated as light, the latter stiff or heavy soils. Sand, being composed of hard indestructible grains of silicious matter, forms a soil of an open texture, through which water readily permeates; while clay, from its fine state of division, and peculiar adhesiveness or plasticity, gives a close-textured and retentive soil; and the proper intermixture of the two produces a light fertile soil, each tempering the peculiar properties of the other. Indeed, their mixture is manifestly essential, for sand alone contains none of the essential ingredients of the plant; and if present in large quantity, the openness of the soil is excessive, water flows through it with rapidity, manures are rapidly destroyed, and the accession of drought soon causes the plants which grow upon it to languish and die. Clay, on the other hand, is by itself equally objectionable; the closeness of its texture prevents the spreading of the roots of plants, and the access of carbonic acid, which, as we have already seen, is so important an agent in the changes occurring in the soil. In fact a pure clay, that is to say, a clay unmixed with sand, even though it may contain all the essential constituents of the plant is absolutely unfertile. Practically, of course, these extreme cases never occur; the heaviest clay soils are mixtures of true clay with sand, and the most sandy soils contain their proportion of clay; but frequently the preponderance of the one over the other is so great, as to produce soils greatly inferior to those in which the mixture is more uniform.

We have spoken of those substances merely as mechanically affecting the soil; but clay possesses also a very remarkable property, apparently of a chemical nature, although to what extent it is so is as yet unknown, and which gives it a high importance in the soil. It possesses a remarkable power of absorbing the soluble constituents of the soil, and preventing them, in part at least, from being washed out by the rains. This peculiar effect of clay has long been recognised by chemists; but its special importance in an agricultural point of view has been shown by Mr Thomson; and to the extended investigation of Way we owe the greater part of our definite information regarding it. It appears that all ordinary arable soils possess, in a more or less marked degree, the power of removing from their solution ammonia, potash, soda, and phosphoric acid, to a considerable extent, and lime and magnesia in smaller quantity. The amount of this absorption is easily seen by a simple experiment. It suffices to take a tall cylindrical vessel open at both ends, and filled with the soil to be operated upon, which is retained by a piece of rag tied over its lower end. A quantity of a dilute solution of ammonia being then poured upon the surface of the soil, and allowed to percolate, the first quantity which flows away is found to have entirely lost its peculiar smell and taste; and in a similar manner the removal of potash and soda may be illustrated. Mr Way has found, that not only is ammonia absorbed by the soil in the free state, but also when in combination with different acids. In the latter case the absorption is attended with a true chemical decomposition, for the fluid which flows from the soil contains the whole of the acid of the ammonia salt in combination with lime. Thus, if sulphate of ammonia be employed, we have sulphate of lime in the fluid, and if muriate of ammonia, we have muriate of lime escaping. Mr Way's experiments have shown, that an ordinary soil is capable of absorbing and bringing into an insoluble condition about 0·3 per cent. of ammonia, when either ammonia itself, its sulphate, or muriate, is employed. It thus appears, as far as absorption goes, to be immaterial whether the ammonia is free or combined. But it is different with potash, which is absorbed from the nitrate to the extent of about 0·6 per cent., and from a caustic solution of potash to double that amount. In these cases the *acid* of the substance employed appears to combine with lime, and the whole of it is obtained in the solution. From this it may be gathered, that lime is not readily absorbed from solutions of its salts; indeed, it would appear that the only salt of lime which comes under the absorbent power of the soil is the bicarbonate, from which lime is taken to the extent of 1·4 per cent. by the soil. The absorption of lime from this salt, and of phosphoric acid, which takes place to a considerable extent, probably occurs, however, quite independently of the clay present in the soil, and is occasioned by its *lime*, which forms an insoluble compound with phosphoric acid, and by removing half the carbonic acid of the bicarbonate of lime converts it also into an insoluble state.

Mr Way attributes the entire absorptive effects of the soil to the clay which they contain, but it may be questioned whether it is the exclusive agent at work. We have remarked, that the absorption of phosphoric acid and of lime from the bicarbonate is probably dependent on lime itself. But as regards alkalies and ammonia, there is another absorptive agent in the organic constituents of the soil. So powerful indeed is the affinity of these substances for ammonia, that chemists are at one as to the difficulty of obtaining the humic and other acids pure, owing to the obstinacy with which they retain it; and there cannot be a doubt that in many soils these substances are in this point of view of much importance. This is particularly the case in peat soils, which, though naturally barren, may be made to produce good crops by the application of sand or gravel; and as neither of these can cause any absorption of the valuable matters, we must attribute this effect to the organic matter. That peat does absorb ammonia may be shown by a simple experiment. If a quantity of dry peat be taken and ammonia poured on it, we find that its smell disappears; and this may be continued until upwards of 1·5 per cent. of dry ammonia has been absorbed, and this quantity is *retained* by the peat. There is another point worthy of inquiry at the present time, and which may prove of much importance. It is certain that the soil, when shaken up with ammonia, withdraws from its solution a quantity of that substance; but what is the effect of withdrawing the remaining solution, and agitating with more water? May it not happen that the ammonia at first absorbed may be again washed out of the soil. The analyses of the soils given in page 393 show at least that the whole of the potash and soda is not in an insoluble condition in the soil; and though the quantity extracted by water is small, it is unequivocal; we know also, that the water which flows from the drains always contains a variety of alkaline and other salts in solution, manifestly derived from the soils through which it has percolated. In short, it must not be supposed that the substances absorbed are rendered absolutely insoluble; they become only relatively so; and it is probable that, under particular circumstances, a considerable proportion of them may be again removed. This is obviously the case in regard to ammonia, as absorbed by peat, for we find that the alkaline reaction is removed by that substance from a considerable quantity of dilute ammonia, although only a *portion* of it is retained when the soil has become dry. Here the presence of moisture appears to be of consequence, and no doubt other conditions, not at present understood, may have the effect of greatly modifying the phenomena.

The peculiarities hitherto alluded to are perhaps in some respects more chemical than mechanical, or at least partake to some extent of both; but the more strictly physical characters, such for instance as the relations of the soil to heat and moisture, &c., are not less important. It needs, indeed, only a moment's consideration to see how great must be the influence exerted by their power of absorbing heat and moisture. We know that in these respects soils differ greatly, and the possession of these properties in a high degree may cause two soils chemically identical to differ widely in productiveness. Thus, for instance, two soils may be identical in composition, but one may be highly hygrometric, that is, may absorb moisture readily from the air, while the other may be very deficient in that property. Under ordinary circumstances no difference will be apparent between the produce of the two soils, but in a dry season the crop upon the former may be in a flourishing condition, while that on the latter may be languishing and enfeebled merely from its inability to absorb from the air, and supply to the plant the quantity of water required for its growth. In the same way, a soil which absorbs much heat from the sun's rays will surpass another which has not that property; and though in many cases this effect may be comparatively unimportant, it may make the difference between successful and unsuccessful cultivation in soils which lie in an unfavourable climate or exposure.

The investigation of the physical characters of soils has attracted little attention except on the part of Schübler, who published, nearly 30 years ago, a very elaborate series of researches on this subject, from which all our present information is derived. He determined, 1*st*, The specific gravity of the soils; 2*d*, The quantity of water which they are capable of imbibing; 3*d*, The rapidity with which they give off by evaporation the water they have imbibed; that is, their tendency to become dry; 4*th*, The extent to which they shrink in drying; 5*th*, Their hygrometric power; 6*th*, The extent to which they are heated by the sun's rays; 7*th*, The rapidity with which a heated soil cools down, which indicates its power of *retaining* heat; 8*th*, Their tenacity, or the resistance they offer to the passage of agricultural implements; 9*th*, Their power of absorbing oxygen from the air. Each of these experiments was performed on several different soils, and on their mechanical constituents. Schübler's experiments are undoubtedly important, and though the methods employed are some of them not altogether beyond cavil, they have apparently been performed with great care. It is nevertheless desirable that they should be carefully repeated, for such facts ought not to rest on the authority of one experimenter, however skilful and conscientious, nor on a single series of soils, which may not give a fair representation of their general physical properties. In fact Schübler appears to imagine that having once determined the extent to which the sand, clay, and other mechanical constituents of the soil possess these properties, we are in a condition to predicate with regard to soils produced from their mixture in variable proportions, although this is by no means probable.

In examining these properties, Schübler selected for experiment, pure silicious sand, calcareous sand (carbonate of lime in coarse grains), finely powdered carbonate of lime, pure clay, humus, and powdered gypsum. He used also a heavy clay consisting of 11 per cent. of sand and 89 of pure clay, a somewhat stiff clay containing 24 per cent. of sand and 76 of clay, a light clay, with 40 per cent. of sand and 60 of pure clay, a garden soil consisting of 52·4 per cent. of clay, 36·5 of silicious sand, 1·8 of calcareous sand, 2 per cent. of finely divided carbonate of lime, and 7·2 of humus, and two arable soils, one from Hoffwyl, and one from a valley in the Jura, the former a somewhat stiff, the latter a light soil.

| | Specific gravity. | Water absorbed by 100 parts. Per cent. | Of 100 parts of water absorbed, there evaporate in four hours at 66°. | Diminution during drying of 100 parts of moist soil. | Quantity of hydrometric water absorbed by 77·165 grains of the soil spread on a surface of 141·48 square inches. | | | | Power of retaining heat. Calcareous sand, 100. | Tenacity of the soils, pure clay, 100. | Quantity of oxygen absorbed by 77·165 grains of the moist soil in 30 days, from 15 cubic inches of atmospheric air. Expressed in cubic inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 12 hours. | 24 hours. | 48 hours. | 72 hours. | | | |
| Silicious sand, .... | 2·753 | 25 | 88·4 | 0·0 | 0 | 0 | 0 | 0 | 95·6 | 0 | 0·24 |
| Calcareous sand, | 2·822 | 29 | 75·9 | 0·0 | 0·154 | 0·231 | 0·231 | 0·231 | 100·0 | 0 | 0·84 |
| Light clay, ........ | 2·701 | 40 | 52·0 | 6·0 | 1·617 | 2·002 | 2·156 | 2·156 | 76·9 | 57·3 | 1·39 |
| Stiff clay,.......... | 2·652 | 50 | 45·7 | 8·9 | 1·925 | 2·310 | 2·618 | 2·695 | 71·1 | 68·8 | 1·65 |
| Heavy clay, ...... | 2·603 | 61 | 34·9 | 11·4 | 2·310 | 2·772 | 3·080 | 3·157 | 68·4 | 83·3 | 2·04 |
| Pure clay,......... | 2·591 | 70 | 31·3 | 18·3 | 2·849 | 3·234 | 3·696 | 3·773 | 66·7 | 100·0 | 2·29 |
| Carbonate of lime, | 2·468 | 85 | 28·0 | 5·0 | 2·002 | 2·387 | 2·695 | 2·695 | 61·8 | 5·0 | 1·62 |
| Humus,............ | 1·225 | 190 | 20·5 | 20·0 | 6·160 | 7·469 | 8·470 | 9·240 | 49·0 | 8·7 | 3·04 |
| Gypsum,........... | 2·358 | 27 | 71·7 | 0·0 | 0·077 | 0·077 | 0·077 | 0·077 | 73·2 | 7·3 | 0·40 |
| Garden soil, ...... | 2·332 | 96 | 24·5 | 14·9 | 2·695 | 3·465 | 3·850 | 4·004 | 64·8 | 7·6 | 2·60 |
| Soil from Hofwyl, | 2·401 | 52 | 32·0 | 12·0 | 1·232 | 1·771 | 1·771 | 1·771 | 70·1 | 33·0 | 2·43 |
| Soil from Jura,... | 2·526 | 47 | 40·1 | 9·5 | 1·078 | 1·463 | 1·540 | 1·540 | 74·3 | 22·0 | 2·25 |

The experiments detailed in the preceding table speak in a great measure for themselves, and scarcely require detailed comment. It must be remarked, however, that all the characters determined are not equally important. Those illustrating the relations of the soil to water are perhaps the most important. The superiority of a retentive over an open soil is sufficiently familiar in practice, and though this superiority is no doubt partly due to the former absorbing and retaining more completely the ammonia and other valuable constituents of the manures applied to it, it is also dependent to an equal if not greater extent upon the power it possesses of retaining moisture. A reference to the table makes it apparent that this power is presented under three different heads, which are certainly related to one another but are not identical. In the second column of the table we have the quantity of water absorbed by the soil, when thoroughly moistened as a sponge is, and it may be considered as representing the quantity of water which will be retained by these different soils when thoroughly saturated by long continued rains. The column immediately succeeding gives the quantity of that water which escapes by evaporation from the same soil after exposure for four hours to dry air at the temperature of 66°. The fifth, sixth, seventh, and eighth columns indicate the quantity of moisture absorbed, when the soil, previously artificially dried, is exposed to moist air for different periods. These characters are dependent principally, though not entirely, on the porosity of the soil. The last may also be in some measure due to the presence of deliquescent salts in the soil, but is partially occasioned by their peculiar structure. It is to be remarked that clay and humus are two of the most highly hygrometric substances known, and it is peculiarly interesting to observe, that by a beneficent provision of nature, they also form a principal part of all fertile soils. The quantity of water imbibed by the soil is important to its fertility, in so far as it prevents it becoming rapidly dry after having been moistened by the rains. It is valuable also in another point of view, because if the soil be incapable of absorbing much water, it becomes saturated by a moderate fall of rain, and when a larger quantity falls, the excess of necessity percolates through the soil and carries off with it a certain quantity of the soluble salts. Important as this property is, however, it must not be possessed in too high a degree, but must permit the *evaporation* of the water retained with a certain degree of rapidity. Soils which do not admit of this taking place, become the cause of much inconvenience and injury in practice. By becoming thoroughly saturated during winter, they remain for a long time in a wet and unworkable condition, in consequence of which they cannot be prepared and sown until late in the season, and though chemically unexceptionable, such soils are always disadvantageous, and may in certain seasons prove absolutely valueless. The extent to which the imbibition of water takes place is extremely variable, and the rapidity of evaporation equally so, but apparently in the inverse ratio of the former; for we observe that silicious sand absorbs only one-fourth of its weight of water, and again gives off in the course of four hours four-fifths of that it had taken up, while humus, which absorbs nearly twice its weight, retains nine-tenths of that quantity after four hours exposure. Long-continued and slow evaporation of the water absorbed by a soil is injurious in another way, for it makes the soil "cold," a term of practical origin, but which very correctly expresses the peculiarity in question, which is due to the quantity of heat absorbed during evaporation, which prevents the soil acquiring a sufficiently high temperature from the sun's rays. The soils which have absorbed a large quantity of moisture shrink more or less in the process of drying, and form cracks, which often break the delicate fibres of the roots of the plants and cause considerable injury: the extent of this shrinking is given in the fourth column.

The relation of the soils to heat divides itself into two considerations: the amount of heat absorbed by the soil, and the degree in which it is retained. Of these the latter only is illustrated in the table. The former is dependent on so many special considerations that the results cannot be tabulated in a satisfactory manner. It is independent of the chemical nature of the soil, but varies to a great extent according to its colour and the angle of incidence of the sun's rays, and its state of moisture. It is, however, an important character, and has been found by Girardin to modify to a considerable extent the rapidity of ripening of the crops. He found in a particular year, that on the 25th of August 26 varieties of potatoes were ripe on a very dark-coloured sandy vegetable mould, 20 on an ordinary sandy soil, 19 on a loamy soil, and only 16 on a nearly white calcareous soil.

The tenacity of the soil is very variable, and indicates the great differences in the amount of power which must be expended in working them. According to Schübler, a soil whose tenacity does not exceed 10 is easily worked, but when it reaches 40 it becomes sufficiently difficult and heavy to work.

In looking at the tables, we see manifestly that there is one constituent of the soil to which a high importance must be attached in relation to its *physical* properties, and it is the more interesting to observe, as it is that to which we have attributed a minor *chemical* importance. It is humus, which will be observed to confer on the soil a high power of absorbing and retaining water, to diminish its tenacity and permit its being more easily worked, to add to its hygrometric power and property of absorbing oxygen from the air, and finally, from its dark colour to cause the more rapid absorption of heat from the sun's rays. It will be thus understood, that while humus does not directly supply food to the plant, it ministers indirectly in a most important manner to its well-being, and that to so great an extent that it must be considered an indispensable constituent of a fertile soil. But it is important to observe that it must not be present in too large a quantity, for an excess of it does away with all the good effects of a smaller supply, and produces soils notorious for their infertility.

Such are the important physical properties of the soil, and it is greatly to be desired that they should be more extensively examined. The great labour which this involves has, however, hitherto prevented its being done, and will, in all probability, render it impossible ever to do so except in a limited number of cases. Some of these characters are, however, of minor importance, and for ordinary purposes it might be sufficient to determine the specific gravity of the soil in the dry and moist state, the power of imbibing and retaining water, its hygrometric power, its tenacity and its colour. With these data we should be in a condition to draw probable conclusions regarding the others; for we find that the higher the specific gravity in the dry state, the greater is the power of the soil to retain heat, and the darker its colour the more readily does it absorb it. The greater its tenacity, the more difficult is it to work, and the greater difficulty will the roots of the young plant find in pushing their way through it. The greater the power of imbibing water, the more it shrinks in drying; and the more slowly the water evaporates, the colder is the soil produced. The hygrometric power is so important a character that Davy and other chemists have even believed it possible to make it the measure of the fertility of a soil; but though this may be true within certain limits, it must not be too broadly assumed, the results of recent experiments by no means confirming the opinion in its integrity, but indicating only some relation between the two.

*The Subsoil.*—The term soil is strictly confined to that portion of the surface turned over by the plough working at ordinary depth; which, as a general rule, may be taken at 10 inches. The portion immediately subjacent we call the subsoil, and it has considerable agricultural importance, and requires a short notice. In many instances, soil and subsoil are separated by a purely imaginary line, and no striking difference can be observed either in their chemical or physical characters. In such cases it has been the practice with some persons not to limit the term soil to the upper portion, but to apply it to the whole depth, however great it may be, which agrees in characters with the upper part, and only to call that subsoil which manifestly differs from it. This principle is perhaps theoretically the more correct, but great practical advantages are derived from limiting the name of soil to the depth actually worked in common agricultural operations. The subsoil is always analogous in its general characters to a soil, but it may be either identical with that which overlies it or not. Of the former, striking illustrations are seen in the wheat subsoils, the analyses of which have been already given. In the latter case we find that great differences may exist. Thus we may have a heavy clay lying on an open and porous sand, or on peat, and *vice versa.* Even where the characters of the subsoil appear the same as those of the soil, appreciable chemical differences are generally observed, especially in the quantity of organic matter, which is increased in the soil by the decay of plants which have grown upon it, and by the manure added. In general, then, all that we have said regarding the characters of soils both chemically and physically, will apply to the subsoils, except that, from the difficulty with which the air reaches the latter, some minor peculiarities are observed. The most important is the effect of the decay of vegetable matter, without access of air, which is attended by the reduction of the peroxide of iron to the state of protoxide, or more commonly by the production of sulphuret of iron, compounds which are extremely prejudicial to vegetation, and occasionally give rise to some difficulties when the subsoil is brought to the surface, as we shall afterwards have to notice.

The physical characters of the subsoil are often of much importance to the soil itself. As, for instance, where a light soil lies on a clay subsoil, in which case the value of the soil is much higher than if it reposed on an open or sandy subsoil. And in many similar modes is an important influence exerted; but these belong more strictly to the practical department of agriculture, and need not be mentioned here.

*Classification of Soils.*—Numerous attempts have been made to form a classification of soils according to their characters and value, but they have not hitherto proved very successful; and the result of more recent chemical investigations has not been such as to encourage a farther attempt. We have not at present data sufficient for the purpose, nor if we had, would it be possible to arrange any soil in its class except after an elaborate chemical examination. The only classification at present possible must be founded on the general physical characters of the soil; and the ordinary mode followed in practice of dividing them into clays, loams, &c. &c., which we need not here particularise, fulfils all that can be done until we have more minute information regarding a large number of soils. Those of our readers who desire more full information on this point are referred to the works of Thaer, Schübler, and others, where the subject is minutely discussed.

### THE MECHANICAL IMPROVEMENT OF THE SOIL.

In order that it may have the highest degree of fertility, a soil must possess the necessary physical properties and chemical composition in perfection. In comparatively few instances does this actually occur; for the greater proportion of soils, either from mechanical or chemical defects, are incapable of producing an abundant vegetation. These defects, however, admit of diminution, or even entire removal, by certain methods of treatment, the adaptation of which to particular cases is necessarily one of the most important branches of agricultural practice, as the elucidation of their mode of action is of its theory. The observations already made with regard to the characters of fertile soils, will have prepared the reader for the statement that these defects may be removed in two ways, either mechanically or chemically. The former method of improvement may at first sight appear to fall more strictly under the head of practical agriculture, of which the mechanical treatment of the soil forms so important a part, and that their improvement by chemical means should form the sole subject of our consideration here. But the line of demarcation between the mechanical and the chemical, which seems so marked, disappears on more minute observation, and we find that the mechanical methods of improvement are frequently dependent on chemical principles; and those which, at first sight, appear to be entirely chemical, are also in reality partly mechanical. It will be necessary for us, therefore, to consider shortly the mechanical methods of improving the soil.

*Draining.*—By far the most important method of mechanically improving the soil is by draining,—a practice the beneficial action of which is dependent on a great variety of circumstances. Its most obvious effect is probably that which it produces on the temperature of the soil. We have already remarked that the germination of a seed is dependent on the soil in which it is sown acquiring a certain temperature, and the rapidity of the after-growth of the plant is, in part at least, dependent on the same circumstance. The necessary temperature is speedily attained by the heating action of the sun's rays, when the soil is dry; but when it is moist, the heat is expended in evaporating the moisture with which it is saturated; and it is only after this has been effected that it acquires a sufficiently high temperature to produce the rapid growth of the seeds committed to it. But when the soil is drained, the superfluous moisture is drawn off, and it is ready to take advantage of the heating effect of the sun's rays in early spring; and thus the period of germination, and by consequence also that of ripening, is advanced. The extent to which this takes place is necessarily variable, but it is generally considerable; and in some districts of Scotland the extensive introduction of draining has made the harvest on the average of years from 10 to 14 days earlier than it was before. It is unnecessary to insist on the importance of such a change, which in upland districts may make cultivation successful when it was previously almost impossible. The removal of moisture by drainage affects the physical characters of the soil in another manner: it makes it lighter, more friable, and more easily worked; and this change is occasioned by the downward flow of the water carrying with it to the lower part of the soil the finer argillaceous particles, leaving the coarser and sandy matters above, and in this way a marked improvement is produced on heavy clays. The abundant escape of water from the drains acts chemically by removing any noxious matters the soil may contain, and by diminishing the amount of soluble saline matters, which sometimes produce injurious effects. It thus prevents the saline incrustation, which is frequently seen in dry seasons on soils which are naturally wet, and which is produced by the water, which rises to the surface by capillary attraction, depositing, as it evaporates, the soluble substances it contained, and leaving a hard crust which prevents the access of air to the interior of the soil. The access of air to the soil, which is one of the most important elements of its fertility, is promoted in a high degree by draining, as, by removing the water which stagnates in the lower part of the soil, it permits the air to reach it. It provides also for the frequent change of the air which permeates the soil; for every shower that falls expels from it a quantity of the air it contains, and as the moisture flows off by the drains, a new supply of air enters to take its place, and thus the important changes which the atmospheric oxygen produces on the soil, are promoted in a high degree. The air which thus enters acts on the organic matters of the soil, and produces the carbonic acid, which we have already seen is so intimately connected with many of its chemical changes. In the absence of atmospheric air, the organic matters undergo different decompositions, they pass into states in which they are slowly acted on, and are incapable of supplying a sufficient quantity of carbonic acid to the soil. They also act upon the peroxide of iron, contained in all soils, reduce it to the state of protoxide, or, with the simultaneous reduction of the sulphuric acid, they produce sulphuret of iron, forms of combination which are well known to be most injurious to vegetation.

The removal of water from the lower part of the soil, and the admission of air, which is the consequence of draining, submits that part of it to the same changes which take place in its upper portion, and has the effect of practically deepening the soil to the extent to which it is thus laid dry. The roots of the plants growing on the soil, which stop as soon as they reach the moist part, now descend to a lower level, and derive from that part of it supplies of nourishment formerly unavailable. The deepening of the soil has further the effect of making the plants which grow upon it less liable to be burned up in seasons of drought, a somewhat unexpected result of making a soil drier, but which manifestly depends on its permitting the roots to penetrate to a greater depth, and so to get beyond the surface portion, which is rapidly dried up, and to which they were formerly confined.

It is thus obvious that the drainage of the soil modifies its properties both mechanically and chemically. It exerts also various other actions in particular cases which we cannot here stop to particularise. It ameliorates the climate of districts in which it is extensively carried out, and even affects the health of the population in a favourable manner. The sum of its effects must necessarily differ greatly in different soils, and in different districts; but a competent authority[1] has estimated, that, on the average, land which has been drained produces a quarter more grain per acre than that which is undrained. But this can scarcely be said to exhaust the benefits derived from it, for draining is merely the precursor of further improvement. It is only after it has been carried out that the farmer derives the full benefit of the manures which he applies. He gains also by the increased facility of working the soil, and by the rapidity with which it dries after continued rain, which enables him to get on at their proper season with agricultural operations, which would otherwise have to be postponed for a considerable time.

We can scarcely be expected here to say much regarding the mode in which draining ought to be carried out, but we may remark that much inconvenience and loss has occasionally been produced by too close adhesion to particular systems. No rules can be laid down as to the depth or distance between the drains which can be universally applicable, but the intelligent drainer will seek to modify his practice according to the circumstances of the case. As a general rule, the drains ought to be as deep as possible, but in numerous instances it may be more advantageous to curtail their depth and increase their number. If, for instance, a thick impervious pan resting on a clay were found at the depth of three feet below the surface, it would serve no good purpose to make the drains deeper; but if the pan were thin, and the subjacent layer readily permeable by water, it might be advantageous to go down to the depth of four feet, trusting to the possible action of the air which would thus be admitted, gradually to disintegrate the pan, and increase the depth of soil above it. It is a common opinion that if we reach, at a moderate depth, a tenacious and little permeable clay it is no use making the drains deeper than this; but this is an opinion which should be adopted with caution, both because no clay is absolutely impermeable, even the most tenacious admitting of the passage of water, and because the clay may have been brought down by water from the upper part of the soil, and may have stopped there merely for want of some deeper escape for the water, and which drains at a lower level might supply. It may even happen that it might be necessary to vary the depth of the drains in different parts of the same field, and the judicious drainer may sometimes save a considerable sum by a careful observation of the peculiarities of the different parts of the ground to be drained.

*Subsoil and Deep Ploughing.*—It frequently happens, when a soil is drained, that the subsoil is so stiff as to permit the passage of water imperfectly, and to prevent the tender roots of the plant from penetrating it, and reaching the new supplies of nourishment which are laid open to it. In such cases the benefits of subsoil ploughing and deep ploughing are conspicuous. The mode of action of these two methods of treatment is similar but not identical. The subsoil plough merely stirs and opens the subsoil, and permits the more ready passage of water and the access of air and of the roots of plants, the former to promote the necessary decompositions, the latter to avail themselves of the valuable matters set free. Deep ploughing again produces more extensive changes; it brings up new soil to the surface, mixes it with the original soil, and thus not only brings up new supplies of valuable matters to it, but frequently changes its chemical and mechanical characters, rendering a heavy soil lighter by the admixture of a light subsoil and *vice versa*. Both are operations which are useless unless they are combined with draining, for it must manifestly serve no good purpose to attempt to open up a soil unless the water which lies in it be previously removed. In fact, subsoiling is useless unless the subsoil has been made thoroughly dry, and it has been found by experience that no good effects are obtained if it be attempted immediately after draining, but that a sufficient time must elapse, in order to permit the escape of the accumulated moisture, which often takes place very slowly. Without this precaution, the subsoil, after being opened by the plough, soon sinks together, and the good effects anticipated are not realised. The necessity for allowing some time to elapse between draining and further operations is still more apparent in deep ploughing, when the soil is actually brought to the surface. In that case it requires to be left for a longer period after draining, in order that the air may produce the necessary changes on the subsoil; for if it be brought up after having been for a long time saturated with moisture, and containing its iron in the state of protoxide, and the organic matter in a state in which it is not readily acted upon by the air, the immediate effect of the operation is frequently injurious in place of being advantageous. One of the best methods of treating a soil in this way is to make the operation a gradual one, and by deepening an inch or two every year gradually to mix the soil and subsoil; as in this way from a small quantity being brought up at a time no injurious effects are produced. Deep ploughing may be said to act in two ways, *firstly*, by again bringing to the surface the manures which have a tendency to sink to the lower part of the soil, and, *secondly*, by bringing up a soil which has not been exhausted by previous cropping, in fact a virgin soil.

The success which attends the operation of subsoiling or deep ploughing must manifestly be greatly dependent on the character of the subsoil, and good effects can only be obtained when its chemical composition is such as to supply in increased quantity the essential constituents of the plant; and it is no doubt owing to this that the opinions entertained by practical men, each of whom speaks from the results of his own experience, are so varied. The effects produced by deep ploughing on the estates of the Marquis of Tweeddale, are familiarly known to most Scottish agriculturists, and they are at once explained by the analyses of the soil and subsoil here given, which show that the latter, though poor in some important constituents, contains more than twice as much potash as the soil.

| | Soil. | Subsoil. |
|---|---|---|
| Insoluble silicates | 87·623 | 82·72 |
| Soluble silica | 0·393 | 0·12 |
| Alumina and peroxide of iron | 4·129 | 8·60 |
| Lime | 0·341 | 0·18 |
| Magnesia | 0·290 | 0·24 |
| Sulphuric acid | 0·027 | 0·03 |
| Phosphoric acid | 0·240 | trace |
| Potash | 0·052 | 0·12 |
| Soda | 0·050 | 0·04 |
| Water | 1·956 | 3·26 |
| Organic matter | 5·220 | 4·02 |
| | 100·321 | 99·33 |

In addition to the difference in the amount of potash, something is probably due to the difference in the quantity of alumina and oxide of iron in the subsoil, which on this account must probably be more tenacious than the soil itself, which appears to be rather light. In many other instances, the use of the subsoil plough has occasioned much disappointment, and has led to its being decried by many practical men; but of late years its use having become better understood its merits are more generally admitted. We believe that, in all cases in which the soil is deep, more or less marked good effects must be produced by its use, but of course there must be cases in which, from the defective com-

[1] Mr Dudgeon of Spylaw. *Highland Society's Transactions*, vol. xii. p. 505.

position of the subsoil or other causes, it must fail. It may sometimes be possible *a priori* to detect these cases, but in a large majority of them we suspect our knowledge is much too limited to enable us to do so.

*Improving the Soil by Burning.*—It has long been familiarly known, that a decided improvement has been produced on some soils by burning. Its advantages have chiefly been observed on two sorts, heavy clays, and peat soils; and on these varieties it has been practised to a great extent. The action of heat on the heavy clays appears to be of a two-fold character, depending partly on the change effected in its physical properties, and partly on a chemical decomposition produced by the heat. The operation of burning is effected by mixing the clay with brushwood and vegetable refuse, and allowing it to smoulder for some time. It is an operation of some nicety, and its success depends on the temperature being kept as low as possible. It has been further found that its success is by no means equal in all clays, but that there are some which are rather injured than benefited by it. The cause of its beneficial action appears to depend on a change which takes place in the state in which the potash exists in the soil, as a consequence of which it becomes more soluble than it was before. It has been found, that after heating, a dilute acid will extract from clays improved by burning a much larger quantity of potash than it did before; and as we know that the substances not extractable by acids are in a state in which they are unavailable to the plant, or at least can only be slowly obtained by it, we can easily understand how such a soil should be improved by burning, and also how some clays which contain little or no potash should not be affected by the process. The necessity for preserving the temperature of the burning mass of clay as low as possible is also rendered obvious; for it has been found by direct experiment, that at high temperatures another change occurs, whereby the potash, which at lower temperatures becomes soluble, passes again into an insoluble state. A part of the beneficial effects is no doubt also due to the change produced in the physical characters of the clay by burning, which makes it lighter and more friable, and by mixture with the unburnt clay ameliorates the whole. This improvement in the physical characters of the clay also requires that it shall be burnt with as low a heat as possible; for if it rises too high, the clay coheres into hard masses which cannot again be reduced to powder, and the success of the operation of burning may always be judged of by the readiness with which it falls into a uniform friable powder.

The improvement of peat by burning has been practised to some extent in Scotland, though less frequently of late years than formerly; but it is still the principal method of reclaiming peat soils in many countries, and particularly in Finland, where large breadths of land have been brought into profitable cultivation by means of it. The *modus operandi* of burning peat is very simple; it acts by diminishing the superabundant quantity of humus or other organic matters, which, in the previous section we have seen to be so injurious to the fertility of the soil. It *may* act also in the same way as it does on clay, by making part of the inorganic constituents more really soluble, although it is not probable that its effect in this way can be very marked. Its chief action is certainly by destroying the organic matters, and by thus improving the physical character of the peat, and causing it to absorb and retain a smaller quantity of water than it naturally does. For this reason it is that it proves successful only on thin peat bogs, for if they be deep the inorganic matters soon sink into the lower part, and the surface relapses into its old state of infertility. It is probably for this reason that the practice has been so much abandoned in Scotland, the more especially as other and more economical modes of treating peat soils have come into use.

*Mixing of Soils.*—The mixing of soils is a very obvious method of improving those which are defective, and nothing but its expense limits its utility. It has been applied to the improvement of heavy soils and of peats, the former being mixed with sand or marl so as to diminish its tenacity; the latter with clay or gravel to add to its inorganic matters, and in both instances it has proved successful. The admixture of peat with open sandy soils and with heavy clays has also been tried, although to a small extent, and we are not aware of the results obtained. It is very probable that the practice of mixing soils might be judiciously extended if we had sufficiently accurate information regarding the chemical composition of those mixed. It must be manifest, indeed, that the admixture of a highly fertile soil, even in moderate quantity, with another of inferior quality, must of necessity be attended with some effect. We believe, indeed, that the rich trap soils of some parts of Scotland have been mixed with those of inferior quality, but the extent of the benefit derived from the practice has not been made public.

### MANURES.—THEIR CHEMICAL COMPOSITION AND MODE OF ACTION.

It is obvious from the statements we have made in a previous section, that even fertile soils contain many of the essential constituents of plants in limited and some of them in very small quantity; and the necessary consequence is, that the growth of successive generations of plants would soon exhaust the whole supply of these substances which they are capable of affording. In a state of nature, the plant which grows upon a soil dies there, or annually sheds its leaves, and returns to it the substances it had drawn into its system, in a state in which they are ready to afford nourishment to the next year's vegetation. But under the artificial circumstances of cultivation, when the crops produced are more or less completely removed from the soil, exhaustion would sooner or later take place if the substances removed from it were not again returned in the form of manure.

The action of a manure, however, is more complicated than this statement would lead us to suppose; for it is not confined to the mere addition to the soil of the substances required to sustain its fertility, but they exert an influence upon the soil itself, promote the changes which are continually in progress within it, and cause the liberation of a larger quantity of its valuable constituents than the atmosphere alone could do. It is clear that different manures may effect these objects in different ways and to different extents. Some may confine their influence to the mere addition of the necessary elements of the plants, others may exert a powerful influence on the changes occurring in the soil. Some again may supply all the constituents of the plants, others only one or two. The former of these is a very obscure and ill-understood branch of the action of manures; the latter is better known, and is an important element in our estimation of their value, those manures necessarily having the highest value which contain the greatest number of substances required by the plant, and those which afford only one or more having their value regulated by the difficulty which the plant has in obtaining the constituents these manures contain in abundance. There has thus arisen the distinction between general and special manures, a distinction which is important both in theory and practice, and which ought never to be lost sight of.

*General Manures.*—General manures, then, are those which are capable of supplying to the plant *all* or nearly all its constituents, and this is necessarily done in the most effectual manner by farm-yard manure, to which theory and practice concur in giving the highest rank.

*Farm-Yard Manure.*—Farm-yard manure is a mixture of the dung and urine of domestic animals with the straw which has been used as litter, and its composition and value will of course depend on that of these substances, which we must first consider. The dung of animals consists of that part of their food which passes through the intestinal canal without undergoing assimilation; the urine contains that portion which has been assimilated and is again excreted in consequence of the changes which are proceeding in the tissues of the animal. Their composition is naturally very different, and must be separately considered.

*Urine.*—Urine consists of a variety of earthy and alkaline salts, and of certain organic substances, generally rich in nitrogen, dissolved in a large quantity of water. The composition in the different domestic animals has been examined by different chemists; we quote the analyses of Fromberg, as giving the most complete view of the subject.

| | Horse. | Swine. | Ox. | Goat. | Sheep. |
|---|---|---|---|---|---|
| Extractive matter soluble in water | 2·132 | 0·142 | 2·248 | 0·100 | 0·340 |
| Extractive matter soluble in spirit | 2·550 | 0·387 | 1·421 | 0·454 | 3·330 |
| Salts soluble in water ............ | 2·340 | 0·909 | 2·442 | 0·850 | 1·957 |
| Salts insoluble in water ............ | 1·880 | 0·088 | 0·155 | 0·080 | 0·052 |
| Urea .................. | 1·244 | 0·273 | 1·976 | 0·378 | 1·262 |
| Hippuric acid ...... | 1·260 | ... | 0·550 | 0·125 | ... |
| Mucus .............. | 0·005 | 0·005 | 0·007 | 0·006 | 0·025 |
| Water .............. | 88·589 | 98·196 | 91·201 | 98·007 | 92·897 |
| | 100·000 | 100·000 | 100·000 | 100·000 | 99·863 |

*Composition of the ash of these Urines.*

| | Horse. | Swine. | Ox. | Goat. | Sheep. |
|---|---|---|---|---|---|
| Carbonate of lime ... | 12·50 | ... | 1·07 | trace. | 0·82 |
| Carbonate of magnesia.............. | 9·46 | ... | 6·93 | 7·3 | 0·46 |
| Carbonate of potash | 46·09 | 12·10 | 77·28 | trace. | ... |
| Carbonate of soda ... | 10·33 | ... | ... | 53·0 | 42·25 |
| Sulphate of potash... | ... | ... | 13·30 | ... | 2·98 |
| Sulphate of soda...... | 13·04 | 7·00 | ... | 25·0 | 7·72 |
| Phosphate of soda ... | ... | 19·00 | ... | ... | ... |
| Phosphate of lime<br>Phosphate of magnesia.............. | ... | 8·80 | ... | ... | 0·70 |
| Chloride of sodium... | 6·94 | 53·10 | 0·30 | 14·7 | 32·01 |
| Chloride of potassium .............. | ... | trace. | ... | ... | 12·00 |
| Silica ................. | 0·55 | ... | 0·35 | ... | 1·06 |
| Oxide of iron and loss | 1·09 | ... | 0·77 | ... | ... |
| | 100·00 | 100·00 | 100·00 | 100·0 | 100·00 |

Human urine has been accurately examined by Berzelius. His analysis gives the following numbers:—

| | Natural. | Dry Residue. |
|---|---|---|
| Urea ...................................... | 3·010 | 44·70 |
| Lactic acid, lactate of ammonia, and extractive matters......... | 1·714 | 25·58 |
| Uric acid ................................ | 0·100 | 1·49 |
| Mucus .................................... | 0·032 | 0·48 |
| Sulphate of potash.................... | 0·371 | 5·54 |
| Sulphate of soda....................... | 0·316 | 4·72 |
| Phosphate of soda .................... | 0·294 | 4·39 |
| Biphosphate of ammonia ............ | 0·165 | 2·46 |
| Chloride of sodium.................... | 0·445 | 6·64 |
| Muriate of ammonia ................. | 0·150 | 2·46 |
| Phosphates of magnesia and lime... | 0·100 | 1·49 |
| Silica ...................................... | 0·003 | 0·05 |
| Water ..................................... | 93·300 | ... |
| | 100·000 | 100·00 |

Among the special organic constituents of the urine are three substances of much importance, as they contain a large quantity of nitrogen, which they yield in the form of ammonia, as a consequence of certain changes to which they are liable. The composition of these substances is as follows:—

| | Urea. | Uric Acid. | Hippuric Acid. |
|---|---|---|---|
| Carbon .................. | 20·00 | 36·0 | 60·7 |
| Hydrogen ............... | 6·60 | 2·4 | 5·0 |
| Nitrogen ................ | 46·70 | 33·4 | 8·0 |
| Oxygen .................. | 26·70 | 28·2 | 26·3 |
| | 100·00 | 100·0 | 100·0 |

It is evident from these analyses that the urines of different animals must differ greatly in value, those of the ox, swine, and goat, containing a very much smaller quantity of solids than the others. They differ also in regard to their saline ingredients; and while salts of potash and soda form the principal part of the ash of the urine of the ox, sheep, goat, and horse, and phosphoric acid and phosphates are entirely absent, that of the pig contains a considerable quantity of the latter substances, and in this respect more nearly resembles the urine of man. Human urine is also much richer in urea and nitrogenous constituents generally, and has a higher value than any of the others.

*Dung.*—The solid excrement of animals is equally variable in composition. That of the domestic animals which had the ordinary winter food was found to have the following composition:—

| | Horse. | Cow. | Sheep. | Swine. |
|---|---|---|---|---|
| Per-centage of water in the fresh excrement.......... | 77·25 | 82·45 | 56·47 | 77·13 |
| Ash in the dry excrement......... | 13·36 | 15·23 | 13·49 | 37·17 |

100 parts of ash contained—

| | Horse. | Cow. | Sheep. | Swine. |
|---|---|---|---|---|
| Silica.................................. | 62·40 | 62·54 | 50·11 | 13·19 |
| Potash................................ | 11·30 | 2·91 | 8·32 | 3·60 |
| Soda .................................. | 1·98 | 0·98 | 3·28 | 3·44 |
| Chloride of sodium................. | 0·03 | 0·23 | 0·14 | 0·89 |
| Phosphate of iron ................. | 2·73 | 8·93 | 3·98 | 10·55 |
| Lime ................................ | 4·63 | 5·71 | 18·15 | 2·63 |
| Magnesia .......................... | 3·84 | 11·47 | 5·45 | 2·24 |
| Phosphoric acid ..................... | 8·93 | 4·75 | 7·52 | 0·41 |
| Sulphuric acid ...................... | 1·83 | 1·77 | 2·69 | 0·90 |
| Carbonic acid........................ | ... | trace | trace | 0·60 |
| Oxide of manganese ............... | 2·13 | ... | ... | ... |
| Sand ................................. | ... | ... | ... | 61·37 |
| | 99·80 | 99·29 | 99·64 | 99·82 |

Human fæces contain about 73 per cent. of water, and leave about 1 per cent. of ash, of which the composition is—

| | |
|---|---|
| Potash..................................... | 6·10 |
| Soda........................................ | 5·07 |
| Lime........................................ | 26·46 |
| Magnesia.................................. | 10·54 |
| Oxide of iron ............................ | 2·50 |
| Phosphoric acid.......................... | 36·03 |
| Sulphuric acid............................ | 3·13 |
| Carbonic acid............................. | 5·07 |
| Chloride of sodium...................... | 4·33 |
| | 99·23 |

It is to be observed that the urine and dung of animals differs conspicuously in the composition of the ash, the urine being characterised by the abundance of alkaline salts, the latter containing only a small proportion of these, but being rich in earthy matters, and especially in phosphoric acid. The difference in the quantity of nitrogen they contain is also very marked, and is distinctly shown by the following analyses by Boussingault, which give the quantity of carbon, hydrogen, nitrogen, and oxygen in the dung and urine of the horse and the cow.

| | Horse. | | | | Cow. | | | |
|---|---|---|---|---|---|---|---|---|
| | Natural. | | Dry. | | Natural. | | Dry. | |
| | Urine. | Dung. | Urine. | Dung. | Urine. | Dung. | Urine. | Dung. |
| Carbon | 4·46 | 9·56 | 36·0 | 38·7 | 3·18 | 4·02 | 27·2 | 42·8 |
| Hydrogen | 0·47 | 1·26 | 3·8 | 5·1 | 0·30 | 0·49 | 2·6 | 5·2 |
| Nitrogen | 1·55 | 0·54 | 12·5 | 2·2 | 0·44 | 0·22 | 3·8 | 2·3 |
| Oxygen | 1·40 | 9·31 | 11·3 | 37·7 | 3·09 | 3·54 | 26·4 | 37·7 |
| Ash | 4·51 | 4·02 | 36·4 | 16·3 | 4·68 | 1·13 | 40·0 | 12·0 |
| Water | 87·61 | 75·31 | 0·0 | 0·0 | 88·31 | 90·60 | 0·0 | 0·0 |
| | 100·00 | 100·00 | 100·0 | 100·0 | 100·00 | 100·00 | 100·0 | 100·0 |

It thus appears that the urine of the horse, in its natural state, contains three times as much nitrogen as its dung, and that of the cow twice as much; and the difference, especially in the horse, becomes still more conspicuous when they are dry.

Taking the facts just mentioned into account, it is obvious that the quality of farm-yard manure must depend, 1. On the kind of animal from which it is produced; 2. On the quantity of straw which has been used as litter; 3. On the nature of the food with which the animals have been supplied; and, 4. On the care which has been taken to prevent the escape of the urine, or of the ammonia produced by its decomposition. The extent to which these different circumstances modify the quality of farm-yard manure has not been very fully determined by analyses; nor is it probable that its composition varies very greatly, indeed, the analyses which we possess, although they are not very numerous, show a great degree of similarity in the farm-yard manure of different places, when prepared in the same manner. The results obtained by different analyses are contained in the following table, which, in addition to the ordinary farm-yard manure, gives also the composition of that produced by feeding cattle in boxes and of stable dung. The authority is given with each analysis.

| | Farm Yard Manure. | | | | | Box Manure. | Stable Dung. |
|---|---|---|---|---|---|---|---|
| | Nisbet. | | Liebig. | Boussingault. | Way. | Way. | Richardson. |
| Water | 70·0 | 70·0 | 65·0 | 79·3 | 71·4 | 71·0 | 65·2 |
| Organic matter | 20·8 | 20·4 | 24·0 | 14·0 | 28·6 | 29·0 | 24·7 |
| Ash | 9·2 | 9·6 | 11·0 | 6·7 | | | 10·1 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Nitrogen | ... | ... | ... | 0·4 | 0·4 | 0·6 | 0·6 |

The composition of the ash of farm-yard manure in 100 parts is:

| | Farm-Yard Manure. Nisbet. | | Liebig. | Stable Dung. Richardson. |
|---|---|---|---|---|
| Potash | 3·3 | 5·1 | 2·7 | 3·2 |
| Soda | 0·9 | 1·7 | 2·7 | 2·7 |
| Lime | 6·9 | 12·3 | 8·2 | 8·7 |
| Magnesia | 0·6 | 0·8 | 1·0 | 1·9 |
| Alumina | 0·5 | 0·8 | ... | ... |
| Oxide of iron | 1·0 | 1·0 | 1·8 | 2·4 |
| Chloride of sodium | 1·4 | 1·2 | 2·7 | ... |
| Chlorine | ... | ... | ... | 3·2 |
| Phosphoric acid | 3·6 | 3·6 | 6·4 | 7·8 |
| Sulphuric acid | 1·9 | 1·6 | 3·6 | 3·1 |
| Carbonic acid | ... | ... | 4·5 | 4·9 |
| Sand and silica | 79·9 | 71·9 | 66·4 | 59·0 |
| | 100·0 | 100·0 | 100·0 | 96·9 |

The value of farm-yard manure must manifestly depend on the quantity of all the constituents of the plant contained in it. If, however, we examine minutely into the action of the individual elements, it becomes obvious that two present a much higher value than the others, and may, in most cases, be taken as the measure of the value of any manure. These substances are nitrogen and phosphoric acid. Now, it is to be observed, that though both exist in the soil, they are present in but small quantity, even in those of the highest fertility. But this is not all, for the condition in which they are met with is far from being that in which they are readily available to the plant. The phosphoric acid of our soils is not only in an insoluble state, but in one in which it is not readily reached or dissolved by the roots of the plant, and, consequently can only become available as it is liberated by the continuous and slow decomposition constantly occurring in the soil. As regards nitrogen, we have already very distinctly referred to the fact that it can only be absorbed in the state of ammonia or of nitric acid, and most abundantly and readily in the former condition. But the soil contains its nitrogen in the form of vegetable debris, which do not contain that element in the form of ammonia, but only yield it as the result of decompositions, which, like all those occurring in the soil, proceed with extreme slowness. The importance of having the phosphoric acid in a soluble state, and the nitrogen in the form of ammonia, is conspicuously seen from the marked effects obtained from the use of superphosphate of lime (in which a large quantity of the phosphoric acid is soluble) and the salts of ammonia, to which we shall afterwards have to advert. By reference to the analyses of the urine and dung of our domestic animals in the previous page, we see that they do not contain ammonia as such, although they are rich in substances capable of yielding it, and that soluble phosphates are found only in the urine of man and the pig. The value of farm-yard manure is to be estimated by the abundance of these elements; but for all ordinary purposes, in considering the matter, we may put the phosphoric acid out of the question, and confine our attention to the nitrogen.

In the production of farm-yard manure of the highest quality, the object of the farmer must be, first, to produce a manure containing the largest possible amount of nitrogen; and secondly, to convert that nitrogen more or less completely into ammonia. In regard to the first of these points, it will be at once seen from what we have said of the comparative composition of the dung and urine, that the more effectually the latter is collected and its escape from the dung preserved, the higher will be the value of the manure; and it is for this reason that chemists have so anxiously impressed upon the agricultural public the great importance of preserving, and, if possible, retaining in the mass the fluid that drains from the dung heap, which must necessarily contain a considerable quantity of the nitrogenous constituents of the urine. This may be managed to a considerable extent, by arranging the manure heap in such a manner that the fluid which drains from it can be again pumped up over the solid matter, so that the latter may be saturated by it. A still more effectual plan is to mix the dung with some substance which may absorb the urine. For this purpose it is desirable that the absorbent substance shall be one which has an affinity for ammonia, so that it may not only retain the urine mechanically, but, by combining chemically with the ammonia produced by its decomposition, may prevent the escape of that substance into the air, which, from its volatility, it is of course very liable to do. Many substances, such as gypsum, sulphate of iron, chloride of manganese, sulphate of magnesia, and sulphuric acid, have been proposed for this purpose, and have occasionally been used, though not extensively. They all answer the purpose of *fixing* the ammonia, that is, of preventing its escaping into the air more or less effectually, but they do not add sufficiently to the porosity of the manure heap to enable it to absorb the fluid, which is a matter of some importance. For this purpose clay, or the vegetable refuse of the farm, may be employed. But by far the best substance, when it can be got, is dry peat, which not only absorbs the fluid, but will serve to fix the ammonia without the addition of any other substance. We have already referred to the absorbent power of peat in the section on soils, but we may mention here that accurate experiment has shown that a particular peat will absorb about 2 per cent.[1] of ammonia, and when dry will still retain from 1 to 1·5 per cent., or nearly three times as much as would be yielded by the whole nitrogen of an equal weight of farm-yard manure. Peat charcoal has been recommended for the same purpose, but careful experiment has shown that it *does not absorb ammonia*, although it removes putrid odour; and though it may be usefully employed when it is wished to deodorise the manure heap, it must not be trusted to as an absorbent of ammonia.

In addition to these methods of managing farm-yard manure, we have of late years had the introduction of box-feeding, one of the great advantages of which is said to be the production of a manure of superior quality to that obtained in the old way. In box-feeding none of the dung or urine is removed from under the animals, but is trampled down by their feet, and new quantities of litter being constantly added, the whole is consolidated into a compact mass, by which the urine is entirely retained. That, under these circumstances, the manure should be of high quality is certainly consistent with theory, and the analysis of box manure given above confirms the opinion. It is, however, a solitary analysis, and until confirmed by more extended analyses too much dependence must not be placed upon it. The value of box manure must mainly depend upon the solid retaining the whole of the liquid manure; but this is exactly the point on which practical men differ, the keen supporters of box-feeding asserting that it does, while others find that a certain quantity escapes. Should this prove to be frequently the case, the advantages of box-feeding, as a means of producing good manure, will be less than its supporters imagine.

Whether box manure is really superior to that prepared by the ordinary method is very questionable, but there is no doubt that it surpasses a large proportion of that actually produced. It is more than probable, however, that the more careful management of the manure heap may produce equally good effects. It is manifest that the same number of cattle, fed in the same way, and on the same food, and supplied with the same quantity of litter, must always excrete the same quantities of valuable matters, and the only question to be solved is, whether these valuable matters are more effectually preserved in the one way than the other. It will be readily seen that this cannot be done by the analysis of the manure alone, but we must conjoin with it a determination of the total weight of manure produced; for though, weight for weight, box manure may be better than ordinary farm-yard manure, the total quantity obtained from a given number of cattle may be so much greater that the deficiency in quality may be compensated for. At the present time our knowledge is too limited to admit of a definite opinion on this subject, but it is highly deserving of the combined investigation of the farmer and the chemist.

The value of the manure produced is also dependent on the nature of the food supplied to the cattle, and the period of the fattening process at which it is collected. When lean beasts are put up to fatten they at first exhaust the food much more completely then they do when they are nearly fattened, and the manure produced is very inferior at first, and goes on gradually improving in quality as the animal becomes fat. That the quality of the food affects the value of the manure is an opinion which has long been entertained by practical men, and it is no doubt correct, though not to the extent which some persons believe. It is held by some farmers, that while cattle are fed with oil-cake, the increased value of the manure is equal to from one-half to one-third that of the oil-cake. This is certainly an exaggeration, but there cannot be a doubt that some increase of value must take place; for when oil-cake is employed, the quantity of nutritive matters consumed by the animal is larger than when it is fed on turnip alone; but it is not possible at present to estimate the difference, for want of experiments especially directed to this point. From analyses made some time since, we have come to the conclusion that, weight for weight, the dung and urine of cattle fed with oil-cake are richer in valuable matters than those fed on turnips alone; but the experiments were not sufficiently extensive to enable us to draw a definite conclusion, and no determination of the total quantity excreted could be made.

Supposing the conditions which produce the manure containing the largest quantity of nitrogen to have been fulfilled, we have now to consider those which affect its evolution in the form of ammonia. This change is effected by *fermentation*. When a quantity of manure is left to itself for some time it is found to become hot, and gradually to diminish in bulk, and if it be now turned over it is found to evolve the smell of ammonia more or less distinctly. This ammonia is produced, in the first instance, from the urine, the nitrogenous constituents of which are rapidly decomposed, and the fermentation thus set up in the mass of manure extends to the solid dung, and finally to the straw of the litter, and gradually proceeds until a large quantity of ammonia is produced. The same change occurs in the manure if mixed with the soil, but in that case it is much slower, and experience has shown that much greater effects are produced if the manure has been fermented previous to being used. Science at once explains the necessity for the process, and shows that by its means the nitrogen is converted into a state in which the crop it is applied to can rapidly absorb it, and that the practice of applying well-fermented dung to the quickly growing crops, and fresh dung to those which come slowly to maturity, is consistent with theory. But it points out also that the method of doing this

[1] Report on the economic uses of peat. *Highland Society's Transactions*, N.S., vol. iv. p. 549.

by fermentation is, in so far, defective, that it cannot be effected without some loss of ammonia, however carefully it may be managed; and though up to the present time the fermentation of a manure has been deemed essential to its success, it may be questioned whether, now that we have other sources of ammonia, it might not be more economical to apply farm-yard manure in an unfermented state, so as to avoid the loss of ammonia which takes place during the process, and to supply the quantity required for the early growth of the plant by the use of some of the salts of ammonia or other ammoniacal manures. This is a speculative opinion, which must be submitted to experiment, and its value must depend on the amount of loss which takes place by fermentation in the manure heap, regarding which we have at present no information.

*Liquid Manure.*—This term is applied to the urine of the animals fed on the farm, and to the drainings from the manure-heap, which, in place of being returned to it, are in some instances allowed to drain away, and are collected in tanks, from which they are distributed according to the old plan by a watering-cart, or according to the method recently introduced in Ayrshire, by pipes laid under-ground in the fields, and through which the manure is either pumped by steam-power, or, where the necessary inclination can be obtained, is distributed by gravitation. That liquid manure must necessarily be valuable, is an inference which may be at once drawn from the analyses of the urine of different animals already given, and which, when it is collected apart from the solid matters, may be taken as representing the composition of liquid manure. It will be at once seen from these analyses, that liquid manure so obtained must be extremely rich in ammonia, but deficient in phosphates; and as the nitrogenous matters of urine pass with great rapidity into the form of ammonia, it must act quickly, and produce its best effects on those crops which admit of being rapidly forced on to maturity. The deficiency of phosphates in the urine of the common domestic animals is an objection to the use of that fluid alone. But where the drainings of the manure-heap are employed, this difficulty is done away with, for they generally contain a certain quantity of phosphates, either in solution, or more probably in suspension in the fluid. The following analyses by Professor Johnston give the composition, No. 1 of the drainings of the manure-heaps when exposed to rain; No. 2 of the drainings when moistened with cows' urine pumped over it. The numbers give the quantities in grains contained in a gallon of the fluid:—

| | No. 1. | No. 2. |
|---|---|---|
| Ammonia | 9·6 | 21·5 |
| Organic matter | 200·8 | 77·6 |
| Ash | 268·8 | 518·4 |
| Total solids in a gallon | 479·2 | 617·5 |
| The ash contained,— | | |
| Alkaline salts | 207·8 | 420·4 |
| Phosphates | 25·1 | 44·5 |
| Carbonate of lime | 18·2 | 31·1 |
| Carbonate of magnesia, and loss | 4·3 | 3·4 |
| Silica and alumina | 13·4 | 19·0 |
| | 268·8 | 518·4 |

The method of liquid manuring employed by Mr Kennedy at Myremill, the results of which have excited so much interest, is different from liquid manuring in its *strict* sense, for not only are the drainings of the manure-heap employed, but the whole solid excrements are mixed with water in a tank, and rape-dust and other substances occasionally added, and distributed through the pipes.

No system of manuring has produced more striking effects than liquid manuring; and especially on grass-lands, the rapidity of its action is such as to produce an extremely abundant vegetation, much greater, indeed, than could be produced by the application of the solid manure. The luxuriance of the growth of grass by its means is, however, apt to lead us to overrate its general effects; and it is by no means so certain that it can be advantageously applied to the general operations of the farm. Its effect on the cereals is certainly much less marked than that on ryegrass and root-crops, and we have not yet seen the effects of its continued use. Experience and theory concur in holding that a supply of solid matters capable of evolving carbonic acid, is essential to the fertility of the soil, so that, by acting on the mineral matters, it may cause their continuous decomposition. The objection to liquid manure is, that it does not supply these substances in sufficient quantity. This difficulty is no doubt got rid of, to some extent, in the Ayrshire plan, which, after all, is rather a new method of applying the *solid* manure of the farm than strictly *liquid* manuring; but still, as no litter is employed, the quantity of organic matters capable of evolving ammonia is greatly less than it is by the old method; and we must consider the Ayrshire mode of liquid manuring as a great experiment of which all will await the results with interest. Of course the pecuniary question is also of much importance in this method; but that is a matter which we only indicate here, as it is treated of in full in the article on Practical Agriculture.

*Vegetable Manures.*—Many vegetable substances are employed as manures, and their value is variable, and must be estimated in the same manner as that of farm-yard manure, the quantity of nitrogen and phosphoric acid greatly exceeding in importance that of the other constituents. Although like farm-yard manure they may be made to undergo fermentation so as to convert their nitrogen into ammonia, they are generally, indeed almost invariably, applied in the unfermented state, seldom alone, and most commonly conjoined with farm-yard manure.

*Rape-Dust, Castor-Cake, Poppy-Cake,* &c.—Rape-dust has long been employed as a manure, and the success which has attended its use has led to the introduction of the refuse cake from some other oil seeds, such as that of the castor-oil seed, which cannot be employed for feeding. Like the seeds of all plants, these substances are rich in nitrogen, and their ash, containing of course all the constituents of the plant, supplies the necessary inorganic elements. The following are analyses of these substances, which, in addition to the amount of nitrogen and phosphates, show also that of water and oil, to which we shall have occasion afterwards to refer in relation to the feeding value of some of them.

| | Rape-Cake. | Poppy-Cake. | Cotton-seed cake. | Castor-Cake. |
|---|---|---|---|---|
| Water | 10·68 | 11·63 | 11·19 | 12·31 |
| Oil | 11·10 | 5·95 | 9·08 | 24·32 |
| Albuminous compounds | 29·53 | 31·16 | 25·16 | 21·91 |
| Ash | 7·79 | 12·98 | 5·64 | 6·08 |
| Other constituents | 40·90 | 38·18 | 48·93 | 35·38 |
| | 100·00 | 100·00 | 100·00 | 100·00 |
| Nitrogen | 4·38 | 4·94 | 3·95 | 3·20 |
| Silica | 1·18 | 3·36 | 1·32 | 1·96 |
| Phosphates | 3·87 | 6·93 | 2·19 | 2·81 |
| Phosphoric acid in combination with alkaline | 0·39 | 3·27 | 0·15 | 0·64 |

A general similarity will be observed in the composition of all these substances; they are all rich in nitrogen, and contain as much of that element as is found in about ten times their weight of farm-yard manure, and a somewhat similar proportion exists in the amount of phosphates and probably of their other constituents. They have all been employed with success, but the most accurate experiments have been made with rape-dust, which has been longer and more extensively used than any of the others. It has been employed alone for turnips, or mixed with farm-yard manure, and also as a top-dressing to cereals. The most marked advantage is derived from it when applied in the latter way on land which has been much exhausted, on which its effects are often very striking. Several circumstances are essential to the production of its full effects. It requires moisture, and hence it often proves a failure in very dry seasons, and on dry soils. It must not be applied in too large a quantity, experience having shown that after a certain point has been reached, an increase in the quantity not only does not increase but positively diminishes the crop. The most advantageous application is found to be from five to seven cwt. per acre. The observations in regard to the use of rape-dust probably apply with equal force to the other substances of the same class; but their application being more recent and more limited, the results of their use have not been made public.

*Malt-Dust, Bran, Chaff,* &c.—All these substances have been applied as manures, and their value is principally dependent on the quantity of nitrogen they contain, which in malt-dust amounts to 4·5 per cent. of nitrogen, and in bran to about 3·2. They must therefore be made to rank with rape-dust in point of value.

*Straw* has been occasionally employed as a manure, and sometimes even as a top-dressing for grass land. It is generally admitted, however, that its application in the dry state, and especially as a top-dressing, is a practice not to be recommended, as it decomposes too slowly in the soil; and it is always desirable to ferment it in the manure heap, so as to facilitate the production of ammonia from its nitrogen. Still circumstances may occur in which it becomes necessary to employ it in the dry state, and it will generally prove most valuable on heavy soils, which it serves to keep open, and so promotes the access of air, and enables it to act on the soil. On light sandy soils it generally proves less advantageous, as its tendency of course is to increase the openness of the soil, and render it less able to retain the essential constituents of the plant. The manurial value of straw alone is low, as it contains only about 0·2 per cent. of nitrogen, or about half as much as farm-yard manure.

*Saw-Dust* has little value as a manure, as it undergoes decomposition with extreme slowness. It is a good *mechanical* addition to heavy soils, and diminishes their tenacity; and though its manurial effects are small, it sooner or later undergoes decomposition, and yields what valuable matters it contains. It is a useful absorbent of liquid manure, and may be advantageously added to farm-yard manure for that purpose.

*Manuring with Fresh Vegetable Matter.—Green Manuring.*—The term green manuring is applied to the ploughing in of green vegetable matter which has been grown on the soil for that purpose. The success which attends it, especially on soils poor in organic matter, is very marked. Its utility is manifestly dependent on its affording to the soil a supply of matter which by its decomposition may yield carbonic acid to act on the soil, as well as nitrogen and inorganic matters. The action is not, however, confined to this, for it serves also as a means of bringing up from the lower parts of the soil the valuable matters it contains, and of mixing them again with the surface part. Many of the plants found most useful for green manuring send down their roots to a considerable depth; and when they are ploughed in, all the substances which they have brought up are of course deposited in the upper few inches of the soil. Plants when ploughed in in the fresh state also decompose rapidly, and are therefore able immediately to improve the subsequent crop; and as this decomposition takes place in the soil without the loss of ammonia and other valuable matters, which infallibly occurs when they are fermented on the dung-heap, it will be obvious that in no other mode can equally good results be obtained by the use of these plants.



Many plants have been employed as green manure, and different opinions have been expressed as to their relative values. In the selection of any one for the purpose, that should of course be taken which grows most rapidly, and produces within a given time the largest quantity of valuable matters. No general rule can be given for the selection, as the plant which fulfils those conditions best will differ in different soils and climates. The plants most commonly employed in this country are spurry, white mustard, and turnips. Rye, clover, buck-wheat, white lupins, rape, borage, and some others, have been largely employed abroad. Some of these are obviously unfitted for the climate of the British Islands; and the others, although they have been tried occasionally, do not appear to have been very extensively employed. The turnip is sown broadcast at the end of harvest, and ploughed in after two months. White mustard and spurry are employed in the same way as a preparation for winter wheat, and with the best results. The latter is sometimes sown as a spring crop in March, ploughed in in May, and another crop sown which is ploughed in in June, and immediately followed by a third. The effect of this treatment is such that the worst sands may be made to bear a remunerative crop of rye.

*Sea-Weed.*—Sea-weeds are very extensively employed on the coasts of Scotland and England, in quantities varying from 10 to 20 tons per acre as a manure. Their action is necessarily similar to that of green manure ploughed in, as they contain all the ordinary constituents of land plants. Their nitrogen usually amounts to about 2·1 per cent. of the dry substances, and they are much richer in ash than ordinary land plants. The dry fucus saccharinus contains 28 per cent., and fucus vesiculosus about 20 per cent. The following are analyses of the ash of three species of sea-weeds from the Firth of Forth.

| | Laminaria digitata. | Fucus serratus. | Fucus nodosus. |
|---|---|---|---|
| Potash | 31·812 | 30·870 | 14·320 |
| Chloride of potassium | 19·764 | 6·148 | 29·885 |
| Iodide of potassium | 1·365 | ... | ... |
| Chloride of sodium | 23·986 | 25·859 | 15·557 |
| Lime | 5·351 | 7·927 | 7·647 |
| Magnesia | 3·454 | 6·368 | 5·636 |
| Peroxide of iron | 1·333 | 0·230 | 0·135 |
| Sulphuric acid | 9·598 | 17·870 | 24·812 |
| Phosphoric acid | 3·287 | 2·480 | 0·848 |
| Silica | 0·050 | 2·248 | 1·160 |
| | 100·000 | 100·000 | 100·000 |

The great value of sea-weed is dependent on the rapidity with which it decomposes. In fact, when spread on the land, it is seen to soften and disappear in a very short time. It is therefore a rapid manure, and its effects are almost entirely confined to the crop to which it is applied. It may be used as a top-dressing to grass land; but it is most beneficial when ploughed in green, or when made into a compost with lime and earth. On the western coast of Scotland and in the Hebrides sea-weed is the chief manure. It gives excellent crops of potatoes, but they are said to be of inferior quality, unless marl or shell sand is employed at the same time.

The observations which have been made regarding the manurial value of these substances, immediately lead to the inference that all vegetable matters possess a certain value, and that they ought to be carefully collected and preserved. In fact, the careful farmer adds every thing of the sort to his manure heap, where, by undergoing fermentation along with the manure, their nitrogen becomes immediately available to the plant; while during the fermentation the seeds of weeds are destroyed, and the risk of the land being rendered dirty by their springing up when the manure is used, is prevented.

*Animal Manures.*—Animal substances generally contain a much larger quantity of nitrogen than vegetables, and as they undergo decomposition and yield it in the form of ammonia more rapidly, their value is much higher.

*Flesh* is an important manure. That of horses is prepared and sold to some extent. The dead animal after being skinned is cut up and boiled in large cauldrons until the flesh separates from the bones. The latter are removed, and the flesh dried upon a flat stove. The flesh as sold has the following composition:—

| | |
|---|---|
| Water | 12·17 |
| Organic matter | 78·44 |
| Phosphate of lime, &c. | 3·82 |
| Alkaline salts | 3·64 |
| Sand | 1·93 |
| | 100·00 |
| Nitrogen | 9·22 |
| Ammonia to which the nitrogen is equivalent | 11·20 |

Another sort of "flesh manure" has been recently imported from South America. It is a mixture of the flesh and smaller bones of cattle which have been slaughtered for their tallow, and remains in the vats in which the separation of the tallow is effected by steaming. Owing to the variable proportion of bones and flesh, and to the mixture of sand, which takes place, owing to the careless way in which it has been preserved, it varies somewhat in composition. Its composition is,

| | |
|---|---|
| Water | 9·05 |
| Fat | 11·13 |
| Animal matter | 39·52 |
| Phosphate of lime | 28·74 |
| Carbonate of lime | 3·81 |
| Alkaline salts | 0·57 |
| Sand | 7·18 |
| | 100·00 |
| Nitrogen | 5·56 |
| Ammonia to which the nitrogen is equivalent | 6·67 |

Another sample contained 5·77 of nitrogen, 17·16 of phosphate of lime, and 18·78 of sand.

Considerable difference must necessarily exist in the effects of these two manures, owing to the difference of their composition. The first must owe its value entirely to nitrogen, the quantity of phosphate of lime and alkaline salts being too small to exert any influence of importance. In the South American manure, however, the quantity of bones raise that of phosphate of lime in the first instance to above a fourth, and in the second to nearly a fifth, of the whole weight, and must therefore cause it to act, to a great extent, in the same manner as bones, to the manurial value of which we shall presently refer.

*Fish* have been employed in considerable quantity as a manure. That most extensively employed in this country is the sprat, which is occasionally caught in enormous quantities on the Norfolk coast, and used as an application for turnips. They are sold at 8d. per bushel, and their composition is,—

| | |
|---|---|
| Water | 64·6 |
| Organic matter | 33·3 |
| Ash | 2·1 |
| | 100·0 |
| Nitrogen | 1·90 |
| Phosphoric acid | 0·91 |

The refuse of herring and other fish curing establishments, whales' blubber, and similar fish refuse are all useful as manure, and are employed whenever they can be obtained. They are not usually employed alone, but are more advantageously made into composts with their own weight of soil, and allowed to ferment thoroughly before being applied.

*Blood* is a most valuable manure, but it is not much employed in this country, at least in the neighbourhood of large towns, as there is a demand for it for other purposes, and it can rarely be obtained by the farmer in large quantity. In its natural state it contains about 3 per cent. of nitrogen, and after being dried up the residue contains about 15 per cent. It is best used in the form of a compost with peat or mould, and this forms an excellent manure for turnips, and is also advantageously applied as a top-dressing to wheat.

*Hair, Skin, and Horn.*—The refuse of manufactories in which these substances are employed, are frequently used as manures. They are all highly nitrogenous substances, and owe their entire value to the nitrogen they contain, their inorganic constituents being in too small quantity to be of any importance, wool and hair having only 2 per cent., and horn 0·7 per cent. of ash. In the pure and dry state, and after subtraction of the ash, their composition is,—

| | Skin. | Human Hair. | Wool. | Horn. |
|---|---|---|---|---|
| Carbon | 50·99 | 50·65 | 50·65 | 51·99 |
| Hydrogen | 7·07 | 6·36 | 7·03 | 6·72 |
| Nitrogen | 18·72 | 17·14 | 17·71 | 17·28 |
| Oxygen | 23·22 | 20·85 | 24·61 | 24·01 |
| Sulphur | ... | 5·00 | | |
| | 100·00 | 100·00 | 100·00 | 100·00 |

The refuse actually obtained is always moist and often mixed with foreign matters, and is consequently inferior to this. Refuse horse hair generally contains 11 or 12 per cent. of nitrogen. Wool contains very different quantities according to the kind of refuse. Woollen rags contain 12·7 per cent. of nitrogen; woollen cuttings about 14; and what is called shoddy only 5·5 per cent. Horn shavings are extremely variable in their amount of nitrogen. When pure they sometimes contain as much as 12·5 per cent., but a great deal of the horn shavings from comb manufactories, &c., contains much sand and bone dust, by which their percentage of nitrogen is greatly diminished, and it sometimes does not exceed 5 or 6 per cent.

All these substances are highly valuable as manures, but as they undergo decomposition more slowly than flesh or blood they are more applicable to slow growing crops, and to those which require a strong soil. Woollen rags have been largely employed as a manure for hops, and are believed to surpass every other substance for that crop. As a manure applicable to the ordinary purposes of the farm they have scarcely met with that attention which they deserve, probably because their first action is slow and the farmer is more accustomed to look to immediate than to future results; but they possess the important qualification of adding permanently to the fertility of the soil.

*Urate and Sulphated Urine.*—We have already discussed the urine of animals, in reference to farm-yard manure. But human urine, the composition of which was then stated, is of much higher value than that of the lower animals, and many attempts have been made to preserve and convert it into a dry manure. Urate is prepared by adding gypsum to urine, and collecting and drying the precipitate produced. It contains a considerable quantity of the phosphoric acid of the urine, but very little of its ammonia; and as the principal value of urine depends on the latter, it is necessarily a very inefficient method of turning it to account. A better method has been proposed by Dr Stenhouse, who adds lime-water to the urine, and collects the precipitate, which, when dried in the air, contains 1·91 per cent of nitrogen, and about 41 per cent. of phosphates. This method is subject to the same objection as that by which urate is made, namely, that the greater part of the ammonia is not precipitated. This might probably be got over to some extent by the addition of sulphate of magnesia, or, still better, of chloride of magnesium, which would throw down the phosphate of magnesia and ammonia. By much the best mode of employing urine is in the form of sulphated urine, which is made by adding to urine a sufficient quantity of sulphuric acid to neutralise its ammonia, and evaporating to dryness. In this form all the valuable constituents are retained, and excellent results are obtained from it. Its effects, though mainly attributable to its ammonia, are also in part dependent on the phosphates and alkaline salts which it contains; and it is therefore capable of supplying to the plant a larger number of its constituents than the animal matters already mentioned.

*Night-Soil and Poudrette.*—The value of night-soil as a manure is well known. It depends, of course, partly on the urine, and partly on the fæces of which it is formed. Its disagreeable odour has prevented its general use, and various methods have been contrived both for deodorising and converting it into a solid and portable form. The same difficulties which beset the conversion of urine into the solid form are found here, and in most of the methods employed the loss of ammonia is great. It is sometimes mixed with lime or gypsum, and dried with heat, and sometimes with animal charcoal or peat charcoal. By none of these methods, however, is it obtained of high quality; and a good method of making it portable at small expense is still a desideratum. It usually contains about 2 per cent. of nitrogen, and 6 of phosphoric acid.

*Guano* is the solid excrement of carnivorous sea-birds, which is accumulated in immense quantities on the coasts of South America and other tropical countries. It has been used as a manure in Peru from time immemorial, but the accounts given by the older travellers of its marvellous effects were considered to be fabulous, until Humboldt, from personal observation, confirmed all their statements. It was first imported into this country in 1840, in which year a few barrels of it were brought home; and from that time its importation rapidly increased. Soon after large deposits of it were found in Ichaboe; and it has since been brought from many other localities.

The value of guano differs greatly according to the locality from which it is obtained. That from the rainless districts of Peru contains the ingredients of the dung comparatively little changed, a considerable proportion of the uric acid and ammonia of the urine existing in some instances in its natural state, and a small quantity only having undergone decomposition. But that from other districts has suffered a more or less complete decomposition according to the moisture of the climate, which reduces the quantity of organic matters and ammonia, until, in some varieties, they are so small as to be of little importance. The following are minute analyses of three specimens of Peruvian guano, showing all the different constituents it contains, and the amount of difference which may exist:—

| | I. | II. | III. |
|---|---|---|---|
| Urate of ammonia | 10·70 | 9·0 | 3·24 |
| Oxalate of ammonia | 12·38 | 10·6 | 13·35 |
| Oxalate of lime | 5·44 | 7·0 | 16·36 |
| Phosphate of ammonia | 19·25 | 6·0 | 6·45 |
| Phosphate of magnesia and ammonia | ... | 2·6 | 4·20 |
| Sulphate of potash | 4·50 | 5·5 | 4·23 |
| Sulphate of soda | 1·95 | 3·8 | 1·12 |
| Sulphate of ammonia | 3·36 | ... | ... |
| Muriate of ammonia | 4·81 | 4·2 | 6·50 |
| Phosphate of soda | ... | ... | 5·29 |
| Chloride of sodium | ... | ... | 0·10 |
| Phosphate of lime | 15·56 | 14·3 | 9·94 |
| Carbonate of lime | 1·80 | ... | ... |
| Sand and alumina | 1·59 | 4·7 | 5·80 |
| Water | 9.14 | 32·3 | 23·42 |
| Undetermined humus-like organic matters | 10·00 | | |
| | 100·48 | 100·0 | 100·00 |

These analyses illustrate two points—*first*, that in different samples the decomposition may have advanced to different extents; for we observe that the quantity of uric acid, or rather of urate of ammonia, is greatly less in the last analysis than in the other two, and much smaller than in the fresh dung, which contains from 50 to 90 per cent. of uric acid; and *secondly*, that guano is rich in all the constituents of the plant, but especially in ammonia, the best form in which nitrogen can be supplied in uric acid, which, by decomposition, yields ammonia, and in phosphoric acid. But such analyses are too elaborate for ordinary purposes; and a less complete analysis is usually made, in which the total quantity of ammonia, with that which exists ready formed, and will be yielded by the uric acid. the quantity of water, the loss by ignition (that is, the total quantity of organic matter and ammoniacal salts), the water, sand, and alkaline salts, are determined. The subjoined tables give the average composition of different sorts of guano determined in this way. They are mostly averages deduced from a very large number of analyses, excepting those of recent Ichaboe, and of old Bolivian. In the second table are given the analyses of a number of other sorts of guano, but some of them only from a single analysis, so that they probably do not accurately represent the average, although they may give some idea of the composition of each sort. Two of the sorts—old Ichaboe and old Bolivian—are not now imported, the supplies being exhausted.

*Table showing the Average Composition of different varieties of Guano.*

| | Angamos. | Peruvian. | Ichaboe. | | Bolivian. | | | Latham Island. | Saldanha Bay. | Australian. | Patagonian. | Chilian. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Old. | New. | Old. | Government. | Inferior. | | | | | |
| Water | 12·36 | 13·73 | 24·21 | 18·89 | 12·55 | 16·44 | 14·15 | 24·96 | 21·03 | 13·20 | 20·61 | 14·89 |
| Organic matter & ammoniacal salts | 59·92 | 53·16 | 39·30 | 32·49 | 35·89 | 12·28 | 26·14 | 10·96 | 14·93 | 13·77 | 19·72 | 16·81 |
| Phosphates | 17·01 | 23·48 | 30·00 | 19·63 | 27·63 | 56·09 | 23·13 | 54·47 | 56·40 | 44·47 | 30·66 | 36·90 |
| Sulphate of lime | ... | ... | ... | ... | ... | ... | 9·65 | 2·82 | ... | 4·55 | 1·30 | ... |
| Carbonate of lime | ... | ... | ... | ... | ... | ... | 12·87 | 2·20 | ... | 8·82 | 3·06 | 10·28 |
| Alkaline salts | 7·20 | 7.97 | 4·19 | 8·82 | 15·29 | 11·33 | 5·97 | 4·06 | 6·10 | 7·34 | 7·01 | 6·84 |
| Sand | 3·51 | 1·66 | 2·30 | 6·72 | 8·64 | 2·81 | 8·09 | 0·51 | 1·54 | 7·85 | 17·04 | 14·26 |
| | 100·00 | 100.00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·0 | 100·00 |
| Ammonia | 21·10 | 17·50 | 8·50 | 10·42 | 8·99 | 2·57 | 3·26 | 1·26 | 1·62 | 1·01 | 2·69 | 1·42 |
| Phosphoric acid in alkaline salts | 1·20 | 2·50 | ... | ... | ... | 3·11 | ... | ... | ... | ... | 3·00 | ... |

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*Table showing the Composition of some of the less common varieties of Guano.*

*Note.*—The numbers in this Table are mostly derived only from a single analysis, and have no value as determining the *average* composition of these Guanos, but they serve to give a general idea of their value.

| | Sea Bear Bay. | Holmes's Bird Island. | Ascension Island. | Possession Island. | Algoa Bay. | New Island. | Bird's Island. |
|---|---|---|---|---|---|---|---|
| Water | 30·82 | 25·00 | 15·97 | 10·92 | 30·55 | 28·78 | 16·52 |
| Organic matter and ammoniacal salts | 31·78 | 32·10 | 23·15 | 15·42 | 6·85 | 13·78 | 14·84 |
| Phosphates | 24·33 | 27·36 | 32·54 | 46·41 | 21·24 | 22·46 | 25·21 |
| Sulphate of lime | 3·84 | ... | ... | 7·46 | 36·42 | ... | 40·47 |
| Carbonate of lime | 0·58 | ... | ... | ... | ... | 13·78 | ... |
| Alkaline salts | 7·38 | 8·82 | 15·92 | 6·15 | 3·32 | 12·62 | 1·16 |
| Sand | 1·27 | 6·72 | 12·42 | 13·64 | 1·62 | 11·58 | 1·80 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| Ammonia | 10·45 | 7·75 | 6·06 | 1·34 | 0·54 | 0·84 | 1·26 |
| Phosphoric acid in alkaline salts | ... | ... | 1·82 | ... | ... | ... | ... |

As with farm-yard manure, the value of guano is estimated by the quantity of nitrogen and phosphates which it is capable of yielding to the crop. As the nitrogen, however, exists in great part as ammonia, and the remainder in a state in which it readily passes into that substance, it is customary in the analysis to state the quantity of ammonia and not that of nitrogen, but it is easy to calculate the amount of the latter by bearing in mind that 17 parts of ammonia correspond to 14 of nitrogen.

By examining the tables given above, it is obvious that guanos may be divided into two classes, the one characterised by the abundance of ammonia, the other by that of phosphates; and which, for convenience sake, may be called ammoniacal and phosphatic guano. Peruvian and Angamos are characteristic of the former, and Saldanha Bay and Bolivian of the latter class. Of course the value of these varieties is very different; and as guano is an expensive manure, it is of much importance that some ready means of estimating the value of different samples should be known to the farmer. The principles that guide the chemist in making such an estimate are very simple. As the value of a guano depends on the quantity of ammonia and phosphates it contains, and as these are commercial articles, which have a definite value in the market, all that is necessary is to ascertain that value, and to calculate from it that of the guano. Now when sulphate of ammonia is bought, we find by calculation from its price, that the dry ammonia contained in it costs very nearly 6d. per pound, and in bones the cost of phosphate of lime is about ¾d. per pound.

In addition to this, we have also a certain quantity of phosphoric acid in the alkaline salts, which is equal in round numbers to double its weight of phosphate of lime. But this phosphoric acid being in a soluble state is worth more than twice as much as phosphate of lime. It is somewhat difficult to estimate its exact value, but we shall probably not be far wrong in assuming it at 3d. per lb. If we calculate the value of Peruvian guano upon this principle we obtain the following results per ton:—

| | L. | s. | d. |
|---|---|---|---|
| 17·5 per cent. of ammonia equal to 392 lb. per ton, value at 6d per lb., | L.9 | 16 | 0 |
| 23·48 per cent. of phosphates equal to 526 lb. at ¾d. per lb., | 1 | 13 | 0 |
| 2·5 per cent. of phosphoric acid equal to 56 lb. per ton at 3d. per lb. | | 14 | 0 |
| Total value per ton, | L.12 | 3 | 0 |

But the price of Peruvian guano is from L.9, 10s. to L.10 per ton; and this being the case, either it must be bought for its ammonia alone or else we buy ammonia in guano at a cheaper rate that we do in any other form. The latter is probably the most correct view of the case; and if so we find that the price paid for ammonia in Peruvian guano is rather less than 5d. per lb. Calculated on this principle, the value of a ton of average Peruvian guano is L.9, 13s. 8d., which is almost exactly the price at which it is sold. By calculating in this way, then, we can at once estimate the value of any sample of guano. A very simple method of effecting the calculation is the following:—If a pound of ammonia be worth 5d., a *ton* will be worth L.45; in the same way we find that a ton of phosphates is worth L.7, and of phosphoric acid in the alkaline salts L.28. If then we multiply the per-centage of ammonia by 45, that of phosphates by 7, and of phosphoric acid by 28, the sum of the products will give the price in pounds sterling of 100 tons of guano, and then dividing by 100 and doubling the first decimal, we have the price of a ton within a shilling or two. Applying this method of calculation to the Government Bolivian guano we find its value to be as follows:—

| | | |
|---|---|---|
| Phosphates | 56·09 × 7 = | 392·6 |
| Phosphoric acid | 3·11 × 28 = | 87·0 |
| Ammonia | 2·57 × 45 = | 115·6 |
| Value of 100 tons | | 593·2 |

The value of a ton will therefore be about L.5, 18s. But the usual selling price of Bolivian guano is about L.8 per ton, so that it actually sells at a much higher price than its value calculated in this way would warrant. By a similar calculation we find the value of Saldanha Bay would be L.4, 13s., its selling price at present being L.6, 10s.

This method of calculation, therefore, while it may be used with advantage for the comparison of different ammoniacal guanos, is not applicable to the phosphatic class, as it gives a lower value than that at which they are sold. It may be urged that these guanos are sold at a higher price than the value of their constituents warrants, but the question is not limited to this point. The two classes of guanos are bought for different purposes, the ammoniacal guanos for the sake of their ammonia principally, the phosphatic for their phosphates, and these prices would not be given for the latter sorts of guano unless the farmer found his advantage by it. We shall see afterwards that though Peruvian guano is generally the best, there are certain soils on which the phosphatic guanos nearly or altogether equal it; and on these soils, of course, Bolivian guano at L.8 is actually cheaper than Peruvian at L.9, 10s.; but this is only the case in particular instances, and taken as a whole it may be said that Peruvian, notwithstanding its high price, is the cheapest of all guanos.

In purchasing guano particular precautions are required on the part of the farmer, in order to avoid the risk of obtaining an adulterated article. He ought to attend to the following points in regard to *Peruvian* guano.

1*st*, The guano should be light coloured. If it is dark, the chances are that it has been damaged by sea-water.

2*d*, It should be dry, and when a handful is well squeezed together it should cohere very slightly.

3*d*, It should not have too powerful an ammoniacal odour.

4*th*, It should contain lumps which, when broken, appear of a paler colour than the powdery part of the sample.

5*th*, When rubbed between the fingers it should not be gritty.

These characters must not, however, be too implicitly relied on, for they are all imitated with wonderful ingenuity by the skilful adulterator, and they are applicable only to Peruvian guano; the others being so variable that no general rules can be given for determining whether they are genuine. With them as well as with Peruvian guano, the only safe mode of detecting adulteration is by analysis; and it is desirable even where there is no chance of adulteration having been practised, to determine in this way the value of the guano, as different cargos of the same sort differ materially in this respect. In the table above we have given the *average* composition of the different guanos, but in order to show how much individual cargos may differ from the mean, we give here analyses of samples of the highest and lowest quality of the genuine guanos of most importance.

| | Angamos. | | Peruvian. | | Bolivian. | |
|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| Water | 12·60 | 7·09 | 10·37 | 21·49 | 11·53 | 16·20 |
| Organic matter and ammoniacal salts | 65·62 | 50·83 | 55·73 | 46·26 | 11·17 | 12·86 |
| Phosphates | 10·83 | 8·70 | 25·20 | 18·93 | 62·99 | 52·95 |
| Alkaline salts | 7·50 | 16·30 | 7·50 | 10·64 | 9·93 | 13·83 |
| Sand | 3·45 | 17·08 | 1·20 | 2·68 | 4·38 | 4·16 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| Ammonia | 25·33 | 17·15 | 18·95 | 14·65 | 1·89 | 2·23 |

Calculating, in the manner before given, the value of these two samples of Peruvian guano, we find the highest to be worth L.10, 6s. per ton, the lowest no more than L.7, 18s. Something would have to be added for the phosphoric acid in the alkaline salts which have not been determined in these analyses, but this would not materially alter their *relative* values.

The adulteration of guano is carried on to a very large extent, and we are certainly within bounds in asserting that one-half of all the guano sold in this country is adulterated. The chief adulterations are a sort of yellow loam, very similar in appearance to guano, sand, gypsum, common salt, and apparently also ground coprolites. The extent to which it is adulterated may be estimated from the following analyses taken at random from those of a large number of guanos, all of which were sold as first-class Peruvian.

| | | | | | |
|---|---|---|---|---|---|
| Water | 12·85 | 15·19 | 12·06 | 27·86 | 6·32 |
| Organic matter and ammoniacal salts | 26·84 | 44·31 | 34·14 | 30·41 | 27·42 |
| Phosphates | 15·54 | 20·95 | 22·08 | 22·17 | 33·61 |
| Sulphate of lime | ... | ... | 11·08 | ... | 22·11 |
| Alkaline salts | 6·07 | 9·40 | 12·81 | 7·92 | 22·50 |
| Sand | 38·70 | 10·15 | 7·83 | 1·64 | 10·15 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| Ammonia | 9·34 | 13·90 | 9·77 | 8·64 | 9·76 |

In all these cases a very large depreciation in value has taken place; the first of them, by calculation, being worth only L.5, 5s. per ton. Large quantities of similarly adulterated guanos are annually sold at the price of the genuine article. The adulteration is principally carried on in London, but it is believed that it is also practised, though not so largely, in other places. In most instances these guanos are sold without analysis, and with the assurance on the part of the seller that they are genuine guano, which some farmers seem to consider all that is required. Others are sold with analysis, and sometimes it occurs that large quantities of adulterated and inferior guanos are sold by the analysis of a genuine sample, but of course this is the practice of the fraudulent dealer only. In order to insure obtaining a genuine guano, none should ever be purchased without an analysis, a comparison of which with the average composition of good guano, enables the buyer to ascertain its quality, and when the supply is obtained another sample should be selected of which an analysis should be obtained, in order to ascertain that the stock corresponds with the analysis by which it was sold—a very necessary precaution. It may be objected that this involves expense, but surely the cost of an analysis is a very trifling matter when a farmer buys perhaps L.100 or L.200 worth of a manure which adulteration may reduce to half its value.

The value and use of guano are now so well understood, that it will scarcely be necessary to enlarge on the mode of its application. Although owing its chief value to ammonia and phosphates, it contains also all the other ingredients of the plant, and everything required in a manure except the large quantity of organic matters capable of producing carbonic acid, on the importance of which to the soil we have already enlarged. It is capable of entirely replacing farm-yard manure, and excellent crops of turnips and potatoes have been raised by it alone, and at less cost than by farm-yard manure. But though this can be done, it is a practice not to be recommended, for the quantity of valuable matters in an ordinary application of guano is much smaller than in farm-yard manure, and not sufficient permanently to sustain the fertility of the soil. Five cwt. of Peruvian guano, which is a fair application to an acre, contains about 97 lb. of ammonia and 138 of phosphates, but 30 tons of farm-yard manure contain about 280 of ammonia and 360 of phosphates, and consequently the effects of the guano must be much more rapidly exhausted than those of the farm-yard manure. In fact guano is a rapidly acting manure, and its effects are principally observed on the crop to which it is applied. It is not of course to be denied that a certain effect will be experienced on the subsequent crops, but it must of necessity be small. The inference from these facts is, that, though guano may at an emergency be used as an entire substitute for farm-yard manure, the practice is one to be generally avoided. But the rapidity of action of guano makes it a most important auxiliary to farm-yard manure, and it is as an auxiliary that the greatest benefit has been derived from it. Experience has shown that one-half the farm-yard manure may be replaced by guano with the production of a larger crop than by the former alone in its full quantity. The proportion of guano usually employed is from three to five cwt., and it is said that a much larger quantity produces prejudicial effects on the subsequent crop, although it is not very easy to see on what it depends.

Guano has also been most advantageously employed as a top-dressing to grass land and to young corn.

In selecting the variety to be employed, several circumstances must be attended to. It will be found as a general rule that on strong soils, under good cultivation, the best effects are obtained from the ammoniacal guanos, but on light soils these guanos are less applicable, as the soluble ammoniacal compounds they contain are rapidly washed out, and much of their effects lost. On such soils the phosphatic guanos come up to, or even surpass, the others. No definite rules can be given for determining the soils on which these different varieties are most applicable, but each individual must determine by experiment that which best suits his own farm; and the inquiry is of much importance to him, as, of course, if the phosphatic guanos will answer as well as the ammoniacal, there is a large saving in the cost of the manure. A very excellent practice is to employ a mixture of equal parts of the two sorts of guano.

*Pigeons' Dung.*—The dung of all birds, which more or less closely resembles guano, may be employed with much advantage as a manure, but that of the pigeon and the common fowl are the only ones which can be got in quantity. Pigeons' dung, according to Boussingault, contains 8·3 per cent. of nitrogen, equivalent to 10·0 of ammonia. Its value, therefore, will be more than half that of guano, but it varies greatly, and a sample imported from Egypt into this country, and analysed by Professor Johnston, contained only 5·4 per cent. of ammonia. Hens' dung has not been accurately analysed, but its value must be about the same as pigeons'.

*Bones.*—Bones appear to have been employed agriculturally to a considerable extent in the last century as a dressing to old exhausted pasture lands in Cheshire; but it is only during the present century that they have been employed on arable land. The bones employed as a manure are always moist, and vary to some extent in quality. The following is an analysis of a very excellent sample, consisting, we believe, mostly of the bones of the horse:—

| | |
|---|---|
| Water | 6·20 |
| Organic matter | 39·13 |
| Phosphate of lime | 48·95 |
| Lime | 2·57 |
| Magnesia | 0·30 |
| Sulphuric acid | 3·15 |
| Silica | 0·30 |
| | 100·60 |
| Ammonia which the organic matter is capable of yielding, | 4·80 |

In general, bones may be said to contain about half their weight of phosphate of lime, and 10 or 12 per cent. of water. But besides these, bones are met with in other forms in commerce, in which their organic matter has been extracted either by boiling or burning. The latter is especially common in the form of the spent animal charcoal of the sugar refiners, which usually contains from 70 to 80 per cent. of phosphate of lime, but of course does not yield ammonia, the organic matters having been entirely destroyed by heat.

From the analysis given above, it is obvious that the manurial value of bones is dependent partly on their phosphates and partly on the ammonia they yield. It has been common to attribute their entire effects to the former, but this is manifestly erroneous. It is true that in some instances this may be the case, but there is no doubt that the ammonia must generally be of importance, and ought to be taken into account in estimating their value. When bones are applied for the sake of their phosphates alone, burnt bones or the spent animal charcoal of the sugar-refiners are to be preferred.

At the first introduction of bones they were applied in large fragments, and in quantities of from 20 to 30 cwt. per acre. As their use became more general they were gradually employed in smaller pieces, until at last they were reduced to dust, and it was found that, in a fine state of division, a few hundredweights produced as great an effect as the larger quantity of the unground bones. Even the most complete grinding which can be attained, however, leaves the bones in a much less minute state of division than guano, and they necessarily act more slowly than it does, the more especially as they contain no ready-formed ammonia. They may be still further reduced by fermentation, which acts by decomposing the organic matter, and causing the production of ammonia. Or by solution in sulphuric acid, which converts the insoluble phosphate of lime into a soluble state.

*Dissolved Bones.*—The method of dissolving bones in sulphuric acid has proved a very important boon to agriculture. It depends upon the fact that there exists a phosphate of lime containing half as much lime as that which is found naturally in the bones, and which is artificially produced by the sulphuric acid, which withdraws one-half of the lime, forming with it sulphate of lime, while the whole of the phosphoric acid of the bones remains in combination with the other half, and in a soluble form. By employing a sufficiently large quantity of sulphuric acid, the whole quantity of phosphoric acid in the bones may be thus brought into a soluble state, but in actual practice it is found preferable to leave part of it in both states; as where it is entirely soluble, its effect is too great during the early part of the season, and deficient at its end. In order to dissolve bones, we employ from one-half to one-fourth of their weight of strong sulphuric acid; but one-third will be found to be the quantity most generally applicable. The bones are put into a vessel of wood, stone, or lead (iron is to be avoided, as it is rapidly corroded by the acid), and mixed with one-third their weight of water, which may with some advantage be used hot. One-third their weight of sulphuric acid is then added, and mixed as uniformly as possible with the bones. Considerable effervescence takes place, and the mass becomes extremely hot. At the end of two or three days it is turned over with the spade, and after standing for some days longer, generally becomes pretty dry. Should it still be too moist to be sown, it must be again turned over, and mixed with some dry substance to absorb the moisture. For this purpose all substances containing lime or its carbonate must be carefully avoided, as they bring back the phosphates into the insoluble state, and undo what the sulphuric acid has done. Dry loam, peat, decaying leaves, or similar substances may be used. An excellent plan is to sift the bones before dissolving, and, applying the acid only to the coarser part, to mix in the finer dust which has passed through the sieve, to dry up the mass. Considerable trouble attends the manufacture of superphosphate on the small scale, and large manufactories have sprung up in which it is manufactured for sale, and is sold at about L.7 per ton. This probably exceeds the cost at which superphosphate can be prepared at the farm, but the saving of trouble induces many persons to purchase it. Since the introduction of coprolites, that substance has come into general use among manufacturers as a substitute for bones, owing to its cheapness and the large quantity of phosphates it contains. But as it is devoid of nitrogenous matters, and is consequently incapable of yielding ammonia, a certain quantity of bones is always employed along with it, or sulphate of ammonia, or some other ammoniacal salt is added to the mixture. The following are analyses of different samples of commercial superphosphate of fair quality. The first and second are made entirely from bones, the third apparently from coprolites alone. We have added also a single analysis of an inferior sort.

| | | | | Inferior. |
|---|---|---|---|---|
| Water | 10·50 | 23·97 | 10·43 | 7·37 |
| Organic matter | 26·47 | 16·18 | 3·61 | 13·99 |
| Phosphates | 34·29 | 27·18 | 37·59 | 20·96 |
| Sulphate of lime | 12·14 | 11·39 | 25·63 | 45·43 |
| Sulphuric acid | 14·40 | 12·93 | 4·69 | traces. |
| Alkaline salts | 0·72 | 2·54 | 7·71 | 2·67 |
| Sand | 1·48 | 5·81 | 10·34 | 9·58 |
| | 100·00 | 100·00 | 100·00 | |
| Ammonia | 3·17 | 1·32 | 0·54 | 0·44 |
| Soluble phosphates | 22·97 | 19·58 | 13·72 | |

These analyses give the total quantity of phosphates in the body of the analysis, and below the proportion of these phosphates which is rendered soluble by acids, as well as the quantity of ammonia contained in the organic matter. The two first of them are rather above the average quality, and it may be stated generally that the farmer must expect to find in a good superphosphate, about 30 per cent. of phosphates, of which from 12 to 15 ought to be in the soluble state; and about 1·5 per cent. of ammonia if the superphosphate is made from bones, a smaller quantity if from coprolites. Many superphosphates, however, are sold of greatly inferior quality, and containing little or no soluble phosphates; and these are generally made from coprolites and with a deficient quantity of sulphuric acid. Of this the last analysis is an example, but it is no uncommon thing to see samples which prove to contain *no* soluble phosphates, but even some per cent. of carbonate of lime, which is incompatible with their existence. The farmer should lay it down as a rule, never to purchase a superphosphate in the analysis of which carbonate of lime or of magnesia occurs.

The manurial value of bones depends principally, but not entirely, on their phosphates, and it is for these almost exclusively that they are employed. They were first made use of in Cheshire as an application to old pasture lands, on which their effects were truly marvellous. That here, at least, the phosphates alone were the cause of their beneficial effects is very clear. These lands had been from time immemorial pastured by milch cows; and in the milk and cheese removed, a large quantity of phosphoric acid is carried off, and so the pasture at length became deteriorated. The bones supplied this element, and hence their good effects. The principal use of bones at the present time is in the culture of the turnip, and it is on that crop that dissolved bones have proved so beneficial. They exert a remarkable influence in forcing on the plant through the early period of its growth, and so bringing it out of the stage during which it is most liable to suffer from the attacks of insects and other risks; and are best applied in conjunction with farm-yard manure or with guano; although the turnip can be raised with them alone. Dissolved bones are a rapid manure, and the greater part of their influence is exerted on the first crop. But undissolved bones are very permanent, and their effects have been observed many years subsequent to a liberal application.

Many other substances have been used as manures, but those to which we have referred are of much greater importance than any others. It is at once obvious from the remarks already made, that manures vary greatly in quality, and it is most desirable that some means should be contrived for estimating their comparative values. Considerable difficulties stand in the way of doing this effectually. Boussingault, who has paid much attention to this subject, is of opinion that the value of a manure may be determined solely from the quantity of nitrogen it contains, irrespective of its other constituents, and in his *Rural Economy* he has given a table constructed on this principle, of which the following is an abridgment.

| | Nitrogen in moist state, per cent. | Equivalent. |
|---|---|---|
| Farm-yard manure | 0·41 | 100 |
| Dung from inn-yard | 0·79 | 51 |
| Wheat straw | 0·24 | 167 |
| Rye straw | 0·17 | 235 |
| Oat straw | 0·28 | 143 |
| Pea straw | 1·79 | 22 |
| Potato tops | 0·37 | 108 |
| Withered beet-root leaves | 0·5 | 80 |
| Carrot leaves | 0·85 | 47 |
| Oak leaves | 1·18 | 34 |
| Fucus digitatus | 0·86 | 46 |
| Salt cod fish | 6·70 | 6 |
| White lupin seed | 3·49 | 11·5 |
| Malt grains | 4·51 | 9 |
| Hemp seed cake | 4·21 | 9·5 |
| Poppy cake | 5·36 | 7·5 |
| Cider apple refuse | 0·59 | 68 |
| Cow dung | 0·42 | 125 |
| Horse dung | 0·55 | 73 |
| Cows' urine | 0·44 | 91 |
| Horses' urine | 2·66 | 15·5 |
| Poudrette of Belloni | 3·85 | 10·3 |
| ... Montfaucon | 1·56 | 25·5 |
| Pigeons' dung | 8·30 | 5 |
| Guano (Peruvian) | 13·95 | 3·0 |
| Silkworm litter | 3·29 | 12 |
| Dried muscular flesh | 13·04 | 3 |
| Dried blood | 12·18 | 3·2 |
| Liquid blood | 2·95 | 13·3 |
| Bones (fresh) | 5·31 | 7·5 |
| Sugar-refiners' black | 13·75 | 2·9 |
| Animal black | 1·06 | 3·8 |
| Sugar scum | 0·54 | 7·5 |
| Feathers | 15·24 | 2·5 |
| Woollen rags | 17·98 | 2·0 |
| Horn shavings | 14·36 | 3·0 |
| Coal soot | 1·35 | 30·0 |
| Wood soot | 1·15 | 35 |

In this table the first column gives the quantity of nitrogen in 100 parts of the moist manure. The second gives the equivalent, that is, the quantity of any manure which may be substituted for another, farm-yard manure being taken at 100. Thus, to give an example of its use, suppose the farmer wished to employ a certain quantity of dried blood in place of farm-yard manure, he finds in the table that for every 100 lb. of the latter, he requires only 3·2 lb. of the former. It is evident, however, that this principle cannot be accurately carried out with all manures. In the comparison of farm-yard manure with straw and other analogous substances it probably approximates very closely to the truth; but with bones, guano, and other substances, much of the value of which is certainly dependent on their phosphates, it must manifestly give incorrect results, and with the phosphatic guanos especially we should obtain values much less than practical experience has shown them to possess. Moreover, no account is taken of the state in which the nitrogen exists, although we have already seen that this is far from unimportant. Still some value attaches to such a table, and except with those manures which contain phosphates or other substances in larger quantity, it may often prove useful.

### *Mineral Manures.*

All the substances to which we have hitherto alluded are capable of adding to the soil all, or the greater part of, the essential constituents of the plant. Even bones supply not merely ammonia and phosphates, but contain quantities of alkaline salts and other matters, which, though small, are not to be neglected. But many substances are also employed which contain only a single constituent, and their use is found to be followed by very remarkable results. We shall mention these substances in succession, commencing with those which yield nitrogen.

*Sulphate and Muriate of Ammonia.*—These and other salts of ammonia have been tried experimentally as manures, and it has been ascertained that they may all be used with equal success; and as the sulphate is by much cheaper, it is that which probably will always be employed to the exclusion of every other. It contains, when pure, 25·7 per cent. ammonia. That which is now manufactured for agricultural purposes is of very excellent quality, and when genuine, contains almost exactly the proper quantity of ammonia. Its purity may always be roughly estimated, by putting a small quantity on a shovel and heating it over a fire, when it ought to volatilise completely, or leave only a trifling residue. Some care, however, is necessary in applying this test, as in the hands of inexperienced persons it is sometimes fallacious. The salts of ammonia may be applied in the same way as guano; but they are most advantageously employed as a top-dressing, and principally to grass lands. In this way very remarkable effects are produced, and within a week after the application, the difference between the dressed and undressed portions of a field is already conspicuous. Experience has shown that success is best insured when the salt is applied during or immediately before rain, so that it may be at once incorporated with the soil; as when used in dry weather little or no benefit is derived from it. It seems also to exert a peculiarly beneficial effect upon clover; and hence it ought to be employed only on clover-hay, as where ryegrass or other grasses form the whole of the crop we have better manures.

*Ammoniacal Liquor of the Gas Works, and of the Ivory-Black Manufacturers.*—Both of these are excellent forms in which to apply ammonia, when they can be obtained. The ammoniacal liquor of the gas-works is very variable in quality, but contains generally from 4 to 8 ounces of dry ammonia per gallon, which corresponds in round numbers to from 1 to 2 lb. of sulphate of ammonia. It is best applied with the watering-cart, but must be diluted before use with three or four times its bulk of water, as if concentrated it burns up the grass. It is also well to use it during wet weather. The ammoniacal liquor of the ivory-black works contains above 12 per cent. of ammonia, or about four or five times as much as gas liquor. It has been used in some parts of England, made into a compost, and applied to the turnip and other crops, and, it is said, with good effect. *Bone oil,* which distils over along with it, has also been used in the form of a compost; it contains a large quantity of ammonia and of nitrogen in other forms of combination; the total quantity of nitrogen it contains being 9·04 per cent., which is equivalent to 10·98 of ammonia. Only part of this nitrogen is actually in the state of ammonia; and some circumstances connected with the chemical relations of the other nitrogenous compounds in this substance render it probable that they may pass very slowly into ammonia, and may therefore be of inferior value; but the substance is worth a trial, as it is very cheap. It must be carefully composted with peat, and turned over several times before being used.

*Nitrates of Potash and Soda.*—Nitrate of potash has been frequently employed as a manure, but its place is now entirely taken by nitrate of soda, which, from its superior cheapness, will always be preferred. Like the ammoniacal salts, it is a source of nitrogen, of which it yields about 16 per cent., and is therefore richer in that element than Peruvian guano. It is employed as a top-dressing to grass lands and to young corn, and with the most striking effects, even when the quantity employed has been extremely small. In a recent experiment, Mr Pusey found 42 lb. per acre to increase the produce of barley by 7 bushels per acre, and very favourable results have been obtained by other experimenters. The beneficial effects of nitrate of soda appear to be almost entirely confined to the grasses and cereals. At least experience here has shown that it produces little or no effect on clover; and one farmer has stated, that having recently adopted the practice of sowing clover with a very small proportion of ryegrass only, he has been led to abandon the use of nitrate of soda, which he formerly employed abundantly, when ryegrass formed a principal part of his crop. The action of nitrate of soda is very remarkable, not only in this respect, but also because a given quantity of nitrogen in it *appears* to produce a greater effect than the same quantity in sulphate of ammonia or guano. At the same time, this statement must be taken as very general, for our experiments are still too few to permit us to state it as a definite fact. Nitrate of soda is best conjoined with common salt, which checks its tendency to make the grain crops run to straw, and prevents their lodging, which, when it is employed alone, they are very apt to do. With hay this precaution is less necessary, and it is better to conjoin the nitrate with an equal quantity of sulphate of ammonia, the combination of the two giving better results than either separately.

*Salts of Potash and Soda.*—The substances just mentioned may be considered to owe all their value to their nitric acid, but other salts of the alkalies have been employed as manures, although, with the exception of common salt, to a limited extent. Sulphate of soda has been tried on clover and grass, but mixed with nitrate of soda, and with good effect, although we cannot tell how much may have been due to the nitrate.

*Chloride of Sodium, or Common Salt,* has at different times been employed as a manure, but its effects are so variable and uncertain, that its use, in place of increasing, has of late years rather diminished, it having frequently been found that on soils in all respects similar, or even on the same soil, in different years, it will sometimes prove advantageous, at others positively injurious. It appears, however, to be a valuable addition to other manures, especially to guano and nitrate of soda, as it prevents the tendency which crops manured with these substances have to lodge. The mode in which this effect is produced is obscure; and, so far as we know, no explanation has yet been given of it. It is supposed to cause the plant to absorb more silica from the soil; but this is a speculative explanation of its action, and has not been supported by definite experiment. Although little effect has been observed from salt, it deserves a more accurate investigation, as notwithstanding the extent to which it has been employed, we are singularly deficient in definite experiments with it.

*Silicates of Potash and Soda* have been employed with the view of supplying silica to the plant, but the results have been far from satisfactory. Good effects have been observed from the application of silicate of soda to the potato; but our experience of it is much too limited to enable us to form any estimate of its general value.

*Carbonates of Potash and Soda* have only been tried experimentally, and that to a small extent. The remarks we have made in the section of the ashes of plants regarding the subordinate value of soda, will enable the reader to see that greater effects are to be anticipated from the former than from the latter of these salts. They *may*, however, exert a chemical action in the soil, altogether independent of their absorption by the plant, but its nature and amount are still to determine.

*Sulphate of Magnesia* can be obtained at a low cost, and has been used as a manure in some instances with very marked success. It has been chiefly applied as a top-dressing to clover hay, but it seems probable that it might prove of use to the cereals, the ash of which is peculiarly rich in magnesia.

Many other saline substances have been tried as manures; but in most instances to too limited an extent to permit any definite conclusions as to their value. The experiments have also been too frequently performed without those precautions necessary to exclude fallacy, so that the results already arrived at must not be accepted as establishing facts, but rather as indications of the direction in which further experiments would be valuable. There is little doubt that many of these substances might be usefully employed, if the conditions necessary for their successful application were eliminated; and no subject is at present more deserving of elucidation by careful and well-devised field experiments.

Various mixtures of saline manures have been employed, and frequently with good effects. The most marked, however, have been from those of vegetable origin. Thus, wood ashes and peat ashes have been employed with more or less success, and their utility is clearly attributable to their affording a supply of all the inorganic constituents of the plant. Wood ashes, when they can be obtained, are a most valuable manure; coal and peat ashes appear to be inferior as a general rule; but in Belgium and Holland the use of peat ashes is common, and the effects are said to be excellent. They have at different times been imported into this country, but do not appear to have established a reputation as a manure.

It has been held by some chemists, and particularly by Liebig, that, provided we apply to the soil the mineral constituents of the plant, without adding either nitrogen or organic matters, we fulfil all the conditions necessary to the growth of the plant. This opinion has certainly not been confirmed by experiment in this country; the presence of ammonia, or at all events of nitrogen, in some form or other, having always been found necessary, and the application of the mineral matters, even when their proportions have been regulated by reference to the composition of the ash of the plant to which they have been applied, has proved a failure. Notwithstanding this, Liebig still holds to this view, which he has found supported by experiments of his own. It is extremely difficult to reconcile these discordant statements and facts; but we suspect strongly that something must depend on climate and soil; we know at least as regards one manure, superphosphate, that climate has its effect. In England dissolved coprolites have been successfully employed as a manure for the turnip, but in Scotland they have proved by no means so successful. An addition of ammonia is necessary in the moister and colder climate of Scotland; and this is so well known to some manufacturers that they avoid sending to our market any superphosphates made from coprolite alone, but take care to add a sufficient quantity of nitrogenous matters to satisfy the wants of the climate. It is not impossible that the different requirements of the climates may be the real cause of these differences of opinion and that Liebig may be right for the climate of Giessen, as our experimenters are for this country. Boussingault, who first insisted on the importance of ammonia or nitrogen in manures, has had his opinion fully confirmed by the valuable researches of Lawes, to which we must refer our readers for a very full discussion of the whole subject.

*Lime.*—Lime is by far the most important of the mineral manures, and is an almost indispensable agent in all agricultural improvement. It has been employed in the form of chalk, limestone, marl, shell-sand, and as quick and slaked lime. To the composition of limestones we have already referred when treating of the origin of soils, and have pointed out that they are divisible into two classes—one consisting of nearly pure carbonate of lime, the other of a mixture of carbonate of lime and magnesia. It will be unnecessary, therefore, to refer further to this subject. Chalk is a nearly pure carbonate of lime; marl is a pulverulent deposit of carbonate of lime, sometimes nearly pure, at others mixed with a variable proportion of clay and sand; and shell-sand is the debris of shells which has been cast up on the seashore, and which contain a greater or less admixture of sand.

Pure carbonate of lime contains exactly 56 per cent. of *lime*, and a good limestone ought to contain from 90 to 95 per cent. of the carbonate, equivalent to 50·40 per cent. of lime. It may therefore be said generally, that a good limestone should contain about half its weight of lime. When limestone is exposed to heat, its carbonic acid is driven off, and the lime is left in the quick state; and the quick lime, by exposure to the air, absorbs moisture from it and *slakes*; and if it be exposed for a longer time, it also absorbs carbonic acid, and passes back, more or less completely according to the length of time it is exposed, into the state of carbonate. While lime may be applied in the state of carbonate, either as chalk, marl, or pounded limestone, and with a certain amount of advantage, much greater effects are obtained from the use of the lime itself in the quick or slaked state. These advantages are dependent partly on the mechanical effect of the burning and slaking, which enable us to reduce the lime to a much more minute state of division, and consequently to incorporate it more uniformly and thoroughly with the soil, and partly on the more powerful chemical action of the quick or caustic lime, by which a greater effect is produced upon the soil. Other minor advantages are also secured, such as the production of a certain quantity of sulphate of lime, &c., which, though comparatively trifling, may, under particular circumstances and in some soils, be of considerable importance.

The action of lime is of a complicated character. Like all the inorganic constituents of plants, it may of course serve as food for those growing in the soil to which it is added. But this is manifestly a very subordinate part of its action,—1*st*, Because no soil exists which does not contain lime in sufficient quantity to supply that element to the plants. 2*d*, Because its effects are not restricted to those soils in which it exists naturally in small quantity; and, 3*d*, Because it is found that a small application, such as would suffice for the wants of the crops, is not sufficient to produce its best effects. In fact, by far the most important action of lime is that which it exerts on the chemical and mechanical properties of the soil; and it is this which necessitates its application in very large quantities.

The proportion of lime applied varies very greatly in different places. As much as ten tons per acre have frequently been applied, and in some instances much more. Of late years, however, we believe that these very large applications have become less common, because it is found that better effects are produced by a smaller quantity more frequently repeated. Its quantity depends greatly on the nature of the soil; on heavy clays, especially if undrained, very large applications are required; on light soils much smaller; even the depth of a soil must be considered, and a smaller quantity will suffice when it is shallow. The geological origin of the soil is also not without its influence; for we find that its beneficial effect is peculiarly seen on granite, porphyry, and gneiss soils, both because these are naturally deficient in lime, and because they undergo very slowly those decompositions which liberate their active constituents.

The greater part of the action of lime is indeed dependent on its exerting a chemical decomposition on the soil; and it acts equally on both the great divisions of its constituents, the inorganic and the organic. On the former, it acts by decomposing the silicates, which form the main part of the soil, and by liberating the alkalies they contain, it causes a larger supply of these substances to become available to the plant. On the organic constituents its effects are principally expended in promoting the decomposition which converts their nitrogen into ammonia; and thus a supply of food, which might remain for a long period locked up, is set free in a state in which the plant can at once absorb it. But these chemical decompositions are attended by a corresponding change in the mechanical characters of the soil. Heavy clays are observed to become lighter and more open in their texture; and those which are too rich in organic matter have it rapidly reduced in quantity, and the excessive lightness which it occasions diminished.

The effects of an application of lime are not generally observed immediately, but become apparent in the course of one or two years, when it has had time to exert its chemical influence on the soil; but from that time its effects are seen gradually to diminish and finally to cease entirely. The period within which this occurs necessarily varies with the amount of the application and the nature of the soil, but it may be said generally that lime will last from ten to fifteen years. The cessation of its effects is due to several circumstances, partly of course to the absorption of lime by the plants, partly to its being washed out of the soil by the rains, and partly to its tendency to sink to a lower level in the soil, a tendency which most practical men have had opportunities of observing. In the latter case, deep-ploughing often produces a marked effect, and sometimes makes it possible to postpone for a year or two the reapplication of lime. All these circumstances have their influence in bringing to an end its action, but the most important is, that after a time it has exhausted its decomposing effect on the soil, having destroyed all the organic matter, or liberated all the insoluble mineral substances which the quantity added is competent to do, and so the soil passes back to its old state. It does even more, for unless active measures are taken to sustain the fertility of the soil by other means, it is found that its fertility is apt to become less than it was before the use of lime. And that it should be so is manifest, if we consider that the lime added has liberated a quantity of inorganic matter, which, in the natural state of the soil, would have become slowly available to the plant, and that it must have acted chiefly in those very portions which, from having already undergone a partial decomposition, were ready to pass into a state fitted for absorption, and thus as it were, must have anticipated the supplies of future years. This effect has been frequently observed by farmers, and is indeed so common, that it has passed into a proverbial saying, that "lime enriches the fathers and impoverishes the sons." But this is true only when the soil is stinted of other manures, for when it is liberally treated the exhausting effect of lime is not observed, and it must be laid down as a practical rule that the use of lime necessitates a liberal treatment of the soil in all other respects. But when lime has been once employed, it becomes almost necessary to resort to it again; and generally so soon as its effects are exhausted a new quantity is applied, not so large as that which is used when the soil is first limed, but still considerable. When this is done very frequently, however, bad effects ensue; the soil gets into a particular state in which it is so open that the grain crops become uncertain, and such land is said, in practical language, to be overlimed. The explanation commonly assumed by those unacquainted with chemistry is, that the land has become too full of lime; but a moment's consideration of the very small fraction of the soil, which even the largest application of lime forms, will serve to show that this cannot be the cause. And analyses of overlimed soils have proved that the lime does not exceed the ordinary quantity found in fertile soils. The explanation of the phenomenon probably is, that the rapid decomposition of organic matter by the lime, and its escape as carbonic acid has so opened the pores of the soil as to give it the peculiar appearance so well known in practice. The cure for overliming is found to be the employment of such means as consolidate the soil, such as eating off with sheep, rolling, or laying down to permanent pasture.

The immediate effect of lime on the vegetation of the land to which it is applied is very striking. It immediately destroys all sorts of moss, makes a tender herbage spring up, and eradicates a number of weeds. It improves the quantity and quality of most crops, and causes them to arrive more rapidly at maturity. The extent to which it produces these effects is due to the form in which it is applied. In general they are produced more distinctly and more rapidly when it is applied in the quick state, more slowly if it be in the mild state, that is to say, quick lime which has been exposed for a long time to the air, and still more slowly as marl or chalk. The particular circumstances under which these different forms of lime are best employed is a very extensive subject, and would lead us beyond our limits; and for further information we must refer the reader to Professor Johnston's treatise on the use of lime in agriculture.

*Sulphate of Lime, or Gypsum.*—Gypsum has been applied in large quantity as a manure, and is found to exert a very remarkable influence upon clover, and leguminous crops generally. It is used in quantities varying from 2 cwt. per acre up to a very large quantity, and almost invariably with good results, in some instances even with the production of double crops. Much speculation has taken place as to the cause of this action which is so specific in its character, and from Sir Humphry Davy down to the present time, many chemists and agriculturists have considered the matter. Sir Humphry Davy attributed its action to its supplying sulphur to those plants which, according to him, contain a larger quantity of that element than other plants. That opinion has been since entertained by others, but it can scarcely be considered as well founded, for the more accurate experiments recently made do not point to any conspicuous differences between the quantities of sulphur contained in these and other plants. It is, moreover, to gypsum alone that these effects are due, and if it were merely as a source of sulphur that it was employed, there are other salts which could be equally, perhaps more advantageously, used; such, for instance, as sulphate of soda. It is more probable that the action of sulphate of lime may depend on its value as an absorbent of ammonia, and to its taking the atmospheric ammonia, and supplying it to the plants. Great difficulties unquestionably surround this explanation, and though supported by some persons, much may be said against it; as, for instance, why should its effect be so very marked on particular plants. In fact, while we have experiments which prove in the most unquestionable manner the utility of gypsum, we require others made with the express object of elucidating the cause of its action.

*Phosphate of Lime.*—In treating of bones we have alluded sufficiently to the value of phosphate of lime, but when conjoined with animal matters, ammonia, and other valuable substances. We have now simply to refer to the existence of certain varieties of mineral phosphates, some of which have been used, and others proposed, as manures. The apatite of Estremadura was some years since proposed as a manure, and a commission was sent by our Government to inquire into the extent of the supplies, and the possibility of its being imported, but it was found to be limited in extent and too inaccessible to be of much importance, and we believe no attempt has been made to import it. The same mineral is met with in New Jersey and other districts of America, and has been sent to this country, but its price was too high to admit of its being employed. Phosphate of lime also occurs in England, principally in Suffolk, in the form of what are called coprolites, although it is doubtful whether they really deserve that name, which was originally given by geologists to very different substances. The coprolites are now collected in very large quantities, and some thousand tons must be annually employed. They are extremely hard, and require very powerful machinery to reduce them to powder, and hence their price is considerable, we believe about L.3 per ton. From this hardness they are also less easily attacked by the plant, and are consequently best employed dissolved in sulphuric acid. Coprolites have the following composition:—

| | |
|---|---|
| Phosphate of lime | 57·33 |
| Carbonate of lime | 23·89 |
| Sulphate of lime | 2·03 |
| Sand | 12·70 |
| Organic matter | 2·23 |
| Water | 1·82 |
| | 100·00 |

They are therefore rich in phosphates, containing, in fact, more of these substances than guano; but as they are hard, and not easily dissolved by the plant, an inferior value must be attributed to them. Much coprolite of inferior quality, and containing a larger proportion of carbonate of lime, is sold; and the purchaser must ascertain by analysis that the article he buys is good.

### THE ROTATION OF CROPS.

It is a necessary consequence of the facts detailed in the previous sections, that a crop growing on any land must necessarily exhaust it more or less; that is, must remove from it a certain quantity of the elements which confer fertility upon it. That this is the case has been long admitted in practice, and it has also been established that the exhausting effects of different species of plants are very different; that while some rapidly impoverish the soil, others may be cultivated for a number of years without material injury, and others even *apparently* improve it. Thus, it is a notorious fact that white crops exhaust, while grass improves the soil; but the improvement in the latter case is really dependent on the fact, that when the land is laid down in pasture, nothing is removed from it, the cattle which feed on its produce returning again all that they had removed; so that, when we take into account the fact that the plants derive a part, and in some instances a very large part, of their nutriment from the air, the fertility of the soil must manifestly be improved, or at all events supported in its previous state.

When, however, the plant, or some of its parts, is removed from the soil, there must be a reduction in the amount of its fertility dependent on the quantity of its valuable constituents which each plant contains; and thus it occurs that when a plant has grown on any soil, and has removed from it a large quantity of nutritive matters, that it becomes incapable of producing an equally large crop of the same species; and if the attempt is made to grow it in successive years, the land becomes incapable of producing it at all, and is then said to be thoroughly exhausted. But if the exhausted land be allowed to lie for some time without a crop, it is found, more or less rapidly according to circumstances, to regain its fertility, and to produce again the same substance in remunerative crops. The observation of this fact led to the introduction of naked fallows, which, up to a comparatively recent period, were an essential feature in agriculture. But after a time it was observed that the land which had been exhausted by successive crops of one species was not absolutely barren, but was still capable of producing a luxuriant growth of other plants. Thus pease, beans, clover, or potatoes, might be cultivated with success on land which would no longer sustain a crop of grain, and these plants came into use in place of the naked fallow under the name of fallow crops. On this was founded the rotation of crops; for it was clear that a judicious interchange of the plants sown might enable the soil to regain its fertility for one crop at the time when it was producing another; and when exhausted for the second, it might be again ready to bear crops of the first.

The necessity for a rotation of crops has been explained in several ways. The oldest is that of Decandolle, who founded his theory on the fact that the plants excrete certain substances from their roots. He found that when a plant was grown in water, a substance was excreted from the roots; and he believed that this extrementitious substance was thrown out *because* it was injurious to the plant, and that, remaining in the soil, it acted as a poison to those of the same species, and so prevented the growth of another crop. But this excretion, though poisonous to the plants from which it was excreted, he believed to be nutritive to those of another species which thus grew luxuriantly where the others failed. Nothing can be more simple than this explanation, and it was readily embraced at the time it was propounded and considered fully satisfactory. But when more minutely examined, it becomes apparent that the facts on which it is founded are of a very uncertain character. Decandolle's observations regarding the radical excretions of plants have not been confirmed by subsequent observers. On the contrary, they have found that though some plants, when growing in water, do excrete a particular substance in small quantity, that nothing of the sort appears when they are grown in a silicious sand. And hence the inference is, that the peculiar excretion of plants growing in water is rather the result of disease than a natural product. But even admitting the existence of these matters, it would be impossible to accept the explanation founded upon them, because we know that, on individual soils, the repeated growth of particular crops is perfectly possible, as, for instance, on the virgin soils of America, from which many successive crops of wheat have been taken; and in these cases the alleged excretion must have taken place without producing any deleterious effect on the crop. Besides, it is in the last degree improbable that these excretions, consisting of soluble organic matters, should remain in the soil without undergoing decomposition, as all similar substances do; and even if they did, we cannot, with our present knowledge of the food of plants, admit the possibility of the direct absorption of any organic substance whatever. We believe, indeed, that the idea of radical excretions, as an explanation of the rotation of crops, must be considered as being entirely abandoned.

We now seek for its explanation in the different quantities of valuable matters which different plants remove from the soil, and more especially to their mineral constituents. To the great differences which exist in the composition of the ash of different plants we have referred in the section on that subject; and we have pointed out that a distinction has been made between lime, potash, and silica plants. This distinction has its origin in the explanation of the rotation of crops, to which we now refer. In fact, it is believed that if, to take a particular instance, a plant which requires a large quantity of potash be grown on a soil, it will, in a greater or less time, exhaust all, or nearly all, the potash which that soil contains in an *available* form, and will consequently cease to produce a luxuriant crop of it. But if we replace it by another plant which requires only a small quantity of potash and a large quantity of lime, it will flourish, because it finds what is necessary to its growth. In the meantime, the changes which are proceeding in the soil, are liberating new quantities of the inorganic matters from those forms of combination in which they are not immediately available, and when after a time the plant which requires potash is again sown on the soil, it finds a sufficient quantity to serve its purpose. We have already, in treating of the ashes of plants, pointed out the extent of the differences which exist; but these will be made more obvious by the annexed table, giving the quantity of the different mineral matters contained in the produce of an imperial acre of the different crops. We have omitted the oxide of iron and manganese as unimportant, and have added the quantity of nitrogen, which is of considerable interest, though of course not directly important as regards rotation.

*Table showing the number of Pounds of Mineral Matters and Nitrogen removed from an Acre of Land by average Crops of different Grains, &c.*

| | Silica. | Potash. | Soda. | Lime. | Magnesia. | Chloride of Potassium. | Chloride of Sodium. | Phosphoric Acid. | Sulphuric Acid. | Nitrogen. |
|---|---|---|---|---|---|---|---|---|---|---|
| Wheat, grain..... | 1·2 | 10·5 | 1·0 | 1·2 | 4·1 | ... | ... | 15·3 | 0·1 | 38·0 |
| straw......... | 96·8 | 27·2 | 3·7 | 11·1 | 3·0 | ... | ... | 4·0 | 4·6 | 16·0 |
| Barley, grain ... | 17·5 | 11·7 | 0·8 | 1·0 | 4·1 | 2·3 | 0·5 | 16·0 | 1·0 | 36·0 |
| straw......... | 129·7 | 6·0 | 1·6 | 18·4 | 2·7 | ... | ... | 5·4 | 4·0 | 8·0 |
| Oat, grain......... | 23·0 | 8·0 | 1·2 | 3·8 | 3·8 | 2·6 | ... | 17·2 | 3.3 | 60·0 |
| straw......... | 83·5 | 18·7 | 20·0 | 11·1 | 7·2 | ... | 3·8 | 3·0 | 3·0 | 14·0 |
| Beans, grain...... | 0·4 | 23·1 | 0·4 | 4·8 | 3·7 | 0·2 | 1·0 | 17·9 | 2·5 | 80·0 |
| straw......... | 5·9 | 32·1 | 7·0 | 32·1 | 7·4 | 1·3 | 13·8 | 11·1 | 4·9 | 35·0 |
| Pease, grain...... | 0·6 | 19·3 | 0·4 | 2·9 | 3·1 | 0·6 | 0·4 | 16·8 | 2·7 | 75·0 |
| straw......... | 9·7 | 30·7 | 4·5 | 67·5 | 11·8 | ... | 6·4 | 8·1 | 10·2 | 60·0 |
| Turnip, bulb...... | 4·0 | 112·0 | 26·0 | 32·0 | 8·0 | ... | 26·0 | 32·0 | 40·0 | 76·0 |
| tops .......... | ... | 50·0 | 1·0 | 70·0 | 2·0 | 11·0 | 14·0 | 11·0 | 29·0 | 50·0 |
| | | | | | | Chlorine. | | | | |
| Potato, tuber...... | 2·0 | 87·0 | 7·0 | 2·0 | 7·0 | 9·0 | | 18·0 | 29·0 | 81·0 |
| top............ | 60·0 | 4·0 | 2·0 | 58·0 | 9·0 | 4·0 | | 12·0 | 9·0 | 24·0 |
| Meadow hay...... | 68·0 | 48·0 | 5·0 | 39·0 | 16·0 | 6·0 | | 12·0 | 6·0 | 57·0 |
| Ryegrass .......... | 147·0 | 31·0 | 10·0 | 25·0 | 6·0 | ... | 6·0 | 16·0 | 7·0 | 68·0 |
| Red clover ........ | 10·0 | 44·0 | 5·0 | 103·0 | 32·0 | 9·0 | 7·0 | 18·0 | 12·0 | 74·0 |
| | | | | | | Chlorine. | | | | |
| Flax, straw........ | 90·7 | 14·1 | 14·1 | 17·8 | 11·4 | 3·3 | | 15·4 | 4·0 | 16·0 |
| seed........... | 0·6 | 13·4 | 0·6 | 3·4 | 5·2 | ... | 0·1 | 15·2 | 0·7 | 44·0 |

From an inspection of this table, we at once perceive the difference of effects which different crops must produce on the soil. Thus, a wheat crop (grain and straw) removes from the soil 98 lb. of silica; and as we know that that substance exists in small quantity in an available state in most soils, we understand how a succession of wheat or other grain crops (some containing even a larger quantity of silica than wheat) should fail to flourish, unless a sufficient quantity of that element be annually set free to supply the loss; while a crop of turnips removing only 4 lb. of silica may be produced, and at the same time permit the accumulation of a quantity of soluble silica ready for another crop of grain. The turnip again, which carries off no less than 112 lb. of potash, soon exhausts the soil of that element; and when a grain crop, removing only from 17 to 37 lb. according to circumstances, replaces it, we have the conditions necessary for the restoration of that which the turnip had removed. So with the other elements we find that the turnip removes 40 lb. of sulphuric acid, wheat only 4·7; and clover requires above 135 lb. of lime and magnesia, and wheat only 19 of the two. And thus the small quantity of individual substances removed by one plant, compensates for the large quantity withdrawn by another; and by a judicious interchange we have the soil always in a condition to supply a sufficient quantity of the elements necessary for any crop which grows on it.

Viewed in this light, we see that there are several important practical deductions to be drawn from these observations regarding the principles of rotation. We observe that the quantities of mineral matters withdrawn by the plants of the same class are generally similar, and thus we infer that we ought as much as possible to cause crops of the most opposite class to alternate with one another, and to repeat each plant as seldom as possible, so that even when we are obliged to return to the same class we should, if circumstances permit, employ a different member of it. Thus, for instance, in place of immediately repeating wheat, when we wish another grain crop, it would theoretically be preferable to employ oats or barley, and to replace the turnip by mangold-wurzel or some other root. It is obvious, however, that this system cannot be carried out in practice to its full extent; for the superior value of individual crops causes their repetition more frequently than that of those which make a less return. But experience has so far concurred with theory, that it has taught the farmer the advantage of long rotations; and we have had the successive introduction of the three, four, five, and six course shift, and even of longer periods in some instances.

In all this the farmer only imitates the practice of nature; for it has been long observed that when one generation of plants dies out, it is immediately replaced by another. In the forests of Sweden we have a remarkable illustration of this, for when a pine forest is felled and the land left to itself, there spring up not pines but birch trees; and every one is familiar with the fact that when a gap occurs in a thorn-hedge it is useless to attempt to fill it up by putting in a young thorn, but that some other plant must be used.

Such is the theory of rotation; but is it absolutely necessary that it should be rigidly adhered to? We think not. Because in the art of agriculture we place the plants in artificial circumstances, and instead of allowing them to depend entirely on the soil we supply them with a quantity of manure containing all the elements of the plant, and if it be used in sufficiently large quantity we may grow year after year the same crop. And accordingly the order of rotation which is theoretically the best may be, and every day is, violated in practice. This must necessarily be done at the expense of a certain quantity of the valuable matters of the manure added, and is so far a practice which ought theoretically to be avoided. But in actual practice the matter is to be decided on other grounds. The object then is, not to produce the largest crops, but those which make the largest money return, and thus it may be practically economical to grow a crop of high commercial value more frequently than is theoretically advantageous. The farmer must therefore seek to do away as far as possible with the disadvantages which such a course entails, and this he will endeavour to do by a liberal treatment of the soil, and by as careful a management of the other crops of this nature as possible.

But while the farmer may do this to some extent, he must bear in mind that the frequent repetition of some crops cannot be practised with impunity, for they are liable to certain diseases, which have been attributed more or less correctly to this cause. Such is the case with clover, which, when frequently repeated on light soils, fails entirely; and the potato and turnip disease have also, though with less foundation, been attributed to the same cause. Whether this is the sole origin of these diseases is questionable, but there is no doubt that they are aggravated by frequent repetition, and hence a strong argument in favour of rotation. We have been told by great authorities in high farming, that with the command of manures we now have, rotations may be done away with; but this is an opinion to which science gives no countenance, and he would be a rash man who attempted to carry it out in practice.

### THE FEEDING OF THE ANIMALS ON THE FARM.

The feeding of cattle, once a subordinate part of the operations of the farm, has now become one of its most important departments, and the principles of its most successful and economical practice have been elucidated by the recent investigations of chemists and physiologists, by which much light has been thrown on many matters which would otherwise have remained obscure.

It scarcely requires to be stated at the outset, that the food must contain all the different elements which enter into the composition of the animal body. When we examine what these are, we find them identical with those of plants; their organic part consisting of carbon, hydrogen, nitrogen, and oxygen, and their ash of the same ingredients as that of plants. The organic elements are not only the same, but they are united together in a similar manner, and we have them existing, on the one hand, as nitrogenous matters, in the form of fibrine, albumen, and caseine, which, as we have pointed out when treating of the proximate constituents of plants, are identical in chemical composition and properties with the substances extracted from plants, and described under the same names; and, on the other hand, as fatty matters, which correspond in all respects with those found in plants. It has hence been inferred, and is supported by many other facts which our limits will not permit us to detail, that the animals simply absorb the substances which have been formed by the plant, and deposit them in their tissues. It has been distinctly ascertained that the whole nutriment of animals is derived from their food, and that neither nitrogen nor any other element is derived from the air. Now, of the food consumed, a part only is absorbed; the remainder passes through the intestinal canal and is excreted in the form of fæces, while the absorbed portion goes to fulfil two different functions; one quantity being deposited in the tissues to supply that waste which we learn from physiological facts is constantly occurring; the other being employed in supporting the process of respiration, combining with the oxygen of the air inspired, and converting it partly into carbonic acid. If the supply of food be properly apportioned to the animal, the loss occasioned by the waste of the tissues and the process of respiration is exactly sufficient to counterbalance the gain of food, and the animal remains with its weight unchanged; but if it be larger than is required for this purpose, an increase of weight takes place, and a quantity of fat and flesh is laid up as a sort of reserve against future deficiencies of supply. In a state of nature an equilibrium subsists between the supply and the waste, which prevents the animal ever increasing greatly in weight; and it is the object of the feeder, by placing the animal in artificial circumstances, and increasing the supply of food, to raise this reserve to the greatest extent compatible with the health of the animal. In order to this, he must consult nature, and endeavour to imitate her processes as closely as possible, to give food consonant with her principles, and to fulfil all those conditions which are likely to diminish the waste of the tissues.

*The Food of Animals.*—In examining the conditions which must be attended to in the food of animals, we may with advantage take an example from that which nature has provided for the sustenance of their young. The milk may, in fact, be considered as a typical food, and necessarily the best fitted to fulfil the purposes for which it is intended. Now, we find it, exclusive of its inorganic constituents, to contain three different classes of nutritious matters. 1st, Nitrogenous or albuminous substances; 2d, Fatty matters; 3d, Sugar; the first adapted to the production of flesh, the second to the formation of the fat of the body, and the third going partly to supply the respiratory process, and partly to be converted into fat. Now, to sustain the animal in its usual state, a sufficient quantity of those substances must be given to supply the waste of the tissues, and the process of respiration, along with a quantity which is never absorbed, but passes through the alimentary canal. In round numbers this latter quantity amounts to not less than half the whole nutritive matters. The quantity of albuminous substances absorbed and used to supply the waste of the tissues varies very greatly according to circumstances shortly to be mentioned, but in an experiment of Boussingault's on a cow, amounted to about 18 ounces. The consumption of sugar, starch, and similar substances, to maintain respiration is much larger; for it has been ascertained that in the course of 24 hours an ox will convert into carbonic acid by respiration, from 4 to 5 lb. of carbon, to supply which from 10 to 12 lb. of sugar or starch are required. It is necessary, therefore, that the food to be supplied should contain these substances, and a sufficiency of them for the purpose; and what we have already said of the composition of vegetables shows that all do contain these substances, though their quantity is very variable. In comparing the value of different sorts of food, it is necessary to consider the quantity of nitrogenous and other matters which they contain. But we find by experience, that all these substances are not of equal importance, some being supplied in sufficient quantity for all purposes, others being found in many sorts of food in comparatively small quantity. It appears, indeed, that the nitrogenous constituents are by much the most important, and for many purposes the value of the food may be estimated almost entirely from them. But these substances are the flesh-forming element of the food only; the production of fat is dependent partly on the fatty matter, and partly on the starch and sugar of the plant. At one time it was believed that the presence of fatty matters in the food was essential to the production of fat in the animal; but careful experiments have entirely refuted this opinion, and have shown that the fat may be produced from sugar or starch alone, and hence some chemists and physiologists have even gone so far as to hold that the fat of the food does not go to form the fat of the animal. We apprehend, however, that this is an extreme view of the case, and it can scarcely be doubted that the fat must be of importance, though it may not be absolutely essential. Now, in comparing different sorts of food, we come to the conclusion, that those are most valuable which contain the largest quantity of albuminous substances, oil and saccharine matters; but there are few or no foods which do not contain these latter substances in sufficient quantity to supply the wants of any animals which feed upon them. We may therefore take the quantities of albuminous matters and oil as the measure of the nutritive value of any sort of food. That this is borne out by practice, we may see at once by selecting any two sorts of food: let us take the turnip and linseed-cake. Now the former of these is very poor in nutritive matters, and hence requires to be supplied in large quantity to the animal; the latter is rich both in albuminous and oily matters, and only a small quantity of it is required. The practical farmer, when he gives cattle linseed-cake,

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generally considers that he may replace 100 lb. weight of turnips by 5 lb. of cake; and that with this apparently trifling quantity the cattle fatten better than they did with the large quantity of turnip. Now, when we inquire into the relative quantities of nitrogenous and oily matters contained in these two substances, we have at once an explanation of the observed fact. Analysis shows us, that the quantities of albuminous matters and of oil contained in 100 parts of those two substances are as follows:—

| | Oil-Cake. | Turnip. |
|---|---|---|
| Albuminous matter | 27·69 | 1·27 |
| Oil | 12·79 | 0·20 |

If we calculate from these results, we find that 100 lb. of turnips contain the same quantity of albuminous matter as 4·5 lb. of oil-cake, and no more oil than is supplied by 1·5 lb. of oil-cake, so that the 5 lb. of oil-cake contain a larger quantity of nutritive matter than the large quantity of turnip for which they are a substitute.

The consideration of these facts is of much importance in the economic feeding of animals, for it is manifest that very great differences must exist in the nutritive value of different sorts of food; and now that the farmer finds it desirable to use other substances than those produced on the farm, it is of importance that he should possess some means of estimating the relative value of different sorts of food. We give here, as an assistance in doing so, a table showing the per-centage of albuminous and oily matters contained in 100 parts of different crops.

| | Albuminous Matters. | Oil. |
|---|---|---|
| Poppy cake | 31·46 | 5·75 |
| Rape cake | 29·53 | 11·10 |
| Crambolina cake | 28·79 | 9·50 |
| Common Scotch tares | 28·57 | 1·30 |
| Hopetoun tares | 28·32 | 1·49 |
| Linseed cake | 27·69 | 12·79 |
| Field beans | 27·05 | 1·58 |
| Winter tares (foreign) | 26·73 | 1·58 |
| Spring tares (foreign) | 26·54 | 1·26 |
| Cotton seed cake | 25·16 | 9·08 |
| Beans (65 lb. per bushel) | 24·70 | 1·59 |
| Linseed | 24·44 | 34·00 |
| Lentils (foreign) | 24·57 | 1·51 |
| Lentils (Scotch growth) | 24·25 | 1·79 |
| Gray pease | 24·25 | 3·30 |
| Foreign beans | 23·49 | 1·51 |
| Kidney beans | 20·06 | 1·22 |
| Maple pease | 19·43 | 1·72 |
| Clover hay, second crop | 13·52 | ... |
| Sunflower seed | 12·70 | 29·98 |
| Oats | 10·16 | 6·12 |
| Buckwheat | 9·84 | 2·69 |
| Guinea corn | 9·27 | 3·46 |
| Wheat | 9·01 | 1·99 |
| Common Scotch bean straw | 8·25 | ... |
| Barley | 7·74 | 1·88 |
| Hay (new) | 6·16 | ... |
| Winter bean straw | 5·71 | ... |
| Hay (old) | 4·00 | ... |
| Crimson clover | 3·30 | ... |
| Yellow clover | 3·26 | ... |
| Lucerne | 3·11 | ... |
| Cow grass | 2·75 | ... |
| Red clover | 2·59 | ... |
| Chevalier barley straw | 1·90 | ... |
| Early Angus oat straw | 1·50 | ... |
| Red wheat straw | 1·50 | ... |
| White wheat straw | 1·37 | ... |
| Turnip | 1·27 | 0·20 |

The blank spaces in the second column occur where the oil is in too small quantity to admit of accurate determination.

A simple inspection of this table gives a great deal of information; but by the use of the rule of three it is easy to calculate the quantity of one substance which corresponds in albuminous or in oily matters to another. It is to be observed, however, that the substances containing the former in large quantity, do not necessarily, or even frequently contain a proportionate amount of the other, so that, practically, in making the comparison, we must rely upon one only, and we commonly select the quantity of albuminous matters as the most important. It will be understood, that while these two constituents are the most important as regards the estimation of the value of any food, they are not the only substances *essential* to its nutritive value. On the contrary, the non-nitrogenous, or, as they are sometimes called, the respiratory elements, because they supply the carbon consumed in the process of respiration, and each individual inorganic substance is essential; but as these substances are met with in abundance in all sorts of food, they are unimportant in the estimation of their relative value.

The values as deduced from these numbers must be considered as an approximation only; but they are very close approximations when the substances are of analogous characters; as, for instance, in the case of different sorts of grain. They are, however, liable to modification, by a number of different circumstances: thus, for example, rape-cake has, according to the table, a higher value than linseed-cake, but it possesses a peculiar bitter flavour, which makes it unpalatable to the cattle; and it also frequently produces scouring, so that it may not always give as good effects as might be anticipated from it. Something also is to be attributed to the general nature of the substance, and to the condition in which its constituents exist; and it would appear that the presence of a large quantity of woody fibre reduces the value of food, by enveloping its nitrogenous and other matters, and preventing their absorption during their passage through the intestines of the animal; and it is probably on this account that straw, though richer in nitrogenous matters, has a much lower nutritive value than the turnip.

The nutritive effects obtained from the food, are also increased by mixing together different sorts. Indeed this is found to be an exceedingly important point; for as we have seen that the milk which nature supplies as the appropriate food of the young animal, contains a mixture of all the different classes of nutritive elements, so it appears the best effects are produced by an imitation of this also. But few of the substances which we employ contain all the necessary elements of the food in proper proportion; we find one deficient in fatty matters, another in albuminous, and so on, and in order to produce a food of the most suitable kind, we require to mix together several substances; and when this is judiciously done so as to insure a proper relation between the individual nutritive elements, a higher effect is obtained than could have been got by the use of these substances separately. Thus the farmer who is feeding with bean-meal in considerable quantity, will generally find that a better effect is obtained by replacing a part of it with some of the more oleaginous seeds or cakes. There is, however, another circumstance independent of chemical composition which modifies the nutritive value of the different sorts of food. It is necessary in order to its proper digestion, that the food shall have a certain bulk, for without it the peristaltic motions of the intestines are not properly performed, digestion is incomplete, and a quantity of nutritive matter is wasted. For this reason the highly nutritive foods must always be conjoined with those which occupy a large bulk in the stomach. But, on the other hand, the bulk of the food must not be excessive, for then the stomach is overloaded, digestion and absorption of the food are checked, and the health of the animal becomes impaired.

*The circumstances which diminish the waste of the Food.*—We have already remarked that there are three great purposes to which the food swallowed is appropriated; the increase of weight in the animal—the object the feeder has in view and desires to promote—the supplying the waste of the tissues, and the process of respiration, both of which are sources of waste of food, and which it must necessarily be his aim to diminish as much as possible. The circumstances which must be attended to in order to do this are sufficiently well understood. It has been clearly established that the natural heat of the animal is sustained by the consumption of a certain quantity of its food in the respiratory process, during which it undergoes exactly the same change as those which occur during combustion. In fact, a certain quantity of the food is no more than so much fuel intended to sustain the heat of the body. We observe, however, that the temperature of the body is always the same, whatever be that of the surrounding air. Now it is obvious that if the temperature of the animal is to remain the same in winter as in summer, a larger quantity of fuel (*i.e.*, food) must be consumed for this purpose, just as a room requires more fire to keep it warm in winter than in summer, and hence it naturally follows that if we keep the animal in a warm locality we economise the fuel. In order to do this, then the housing of the cattle is a matter of importance, and here practice has arrived at conclusions strictly concordant with science. The old feeders kept their cattle in large open courts, where they were exposed to every vicissitude of the weather. But as intelligence advanced, we find them substituting, first, what are called hammels and then stalls, in which the animals are kept, during the whole time of fattening, at an equable temperature. The effect of this is necessarily to introduce a considerable economy of the food required to sustain the animal heat; but it also effects a saving in another way, for it diminishes the waste of the tissues. It has been ascertained in the most conclusive manner, that this waste is dependent on the amount of muscular exertion. Thus if we sit still for an hour a certain amount of waste in our tissues takes place, but if we run or engage in any violent muscular exertion, we increase this waste, and consequently require a larger quantity of food to supply it. The confining the animals in stalls has the effect of diminishing the amount of muscular action, and introduces an important economy in the food. Even the making the houses dark, and thus preventing the attention of the animal being disturbed by various objects, has its effect in promoting this economy.

An extension of the same principle has led to the use of the food artificially heated, but it is doubtful whether the advantages derived from it are commensurate to the increased expenses of the process; at least opinions differ among the best informed practical men on this subject.

The rapidity of fattening is dependent on many other circumstances. One of the most important is the breed, and universal experience has shown that the short-horn manifests in this respect a marked superiority. This and many similar facts are, however, less chemical than physiological, and could not be considered here without entering upon many matters not connected with our subject.



### CONCLUDING REMARKS.

We have thus endeavoured to give our readers as full an account of the present state of agricultural chemistry as our limits permit. In a science so new, and embracing so many minute facts, the task is not without difficulty. It has been our object, however, as far as possible to avoid details, and to give rather such principles as have been established, and to illustrate them by what appeared to be the most satisfactory and best observed facts. In many branches of the subject these are but few, and the conclusions founded on them must necessarily be uncertain, and in some instances may possibly be proved erroneous by further observations. That a department of science cultivated for so short a period, and requiring for its proper pursuit the co-operation of two classes of men, the farmer and the chemist, who have hitherto had so little in common, should be imperfect, is not to be wondered at. On the contrary, we are of opinion that the progress made within the last few years, considering all the disadvantages under which it has been placed, from the rash and unweighed theories with which it has been overloaded, the excessive and imprudent zeal of its supporters, the opposition of another class, and the equally fatal lukewarmness of a third, a great deal has been done. Facts of much practical value have been elicited, and an immense stimulus has been given to careful observation and inquiry into principles on the part of the farmer. That this is already beginning to bear its fruit is unquestionable, and it is impossible to look at the opinions and practice of modern farmers of the best class, without observing how much they are influenced by science. That much, however, still remains to be done, is only too obvious from many of the statements we have made, and even in what we consider familiar matters, the chemist is frequently stopped by the want of field experiments sufficiently definite to support or refute his positions. Indeed there are few departments of scientific agriculture that would not be benefited by experiments of a more minute and careful nature than those which, in a less advanced state of the art, and for purely practical purposes, were sufficient. We doubt much, however, whether this can be carried out in detail until a regular professional education in the principles as well as the practice of agriculture is provided for the young farmer, a want which is every day becoming more felt, and the fulfilment of which cannot long be postponed.

AGRIGENTUM, in *Ancient Geography*, a city of Sicily, part of the site of which is now occupied by a town called *Girgenti*, from the old name. See GIRGENTI. According to ancient authors, Dædalus, the most famous mechanician of fabulous antiquity, fled to this spot for protection against Minos, and built many wonderful edifices for Cocalus, king of the island. Long after his flight, the people of Gela sent a colony hither 582 years before the birth of Christ, and, from the name of a neighbouring stream, called the new city *Acragas*, whence the Romans formed the word *Agrigentum*. These Greeks converted the ancient abode of the Siculi into a citadel to guard the magnificent city which they erected on the hillocks below. An advantageous situation, a free government, with all its happy effects, and an active commercial spirit, exalted their commonwealth to a degree of riches and power unknown to the other Greek settlements, Syracuse alone excepted. But the prosperity of Agrigentum appears to have been but of short duration, and tyranny soon destroyed its liberties. Phalaris was the first who reduced it to slavery. His name is familiar to most readers on account of the cruelty with which he tortured his enemies. See PHALARIS. Phalaris met with the common fate of tyrants, and after his death the Agrigentines enjoyed their liberty for sixty years; at the expiration of which term Thero usurped the sovereign authority. The moderation, justice, and valour of this prince preserved him from opposition while living, and have rescued his memory from the obloquy of posterity. He joined his son-in-law Gelo, king of Syracuse, in a war against the Carthaginians; in the course of which victory attended all his steps, and Sicily saw herself for a time delivered from her African oppressors. Soon after his decease, his son Thrasydeus was deprived of the diadem, and Agrigentum restored to her old democratical government, which she retained till the Carthaginian invasion in 406 B.C., a period of more than sixty years. During this interval of prosperity were executed most of those splendid public works which excited the admiration of succeeding ages, and caused their citizen Empedocles to remark, "that the Agrigentines built their dwellings as though they should exist for ever, and indulged in luxury as if they were to die on the morrow." The total number of the inhabitants at this period was estimated by Diodorus at 200,000. But their prosperity was not entirely without interruption; for the Agrigentines having engaged in hostilities with the mountain chief Ducetius, the conduct of the Syracusans towards that chieftain occasioned a war between these two rival states, which terminated in the signal defeat of the Agrigentines at the river Himera. But a more terrible reverse awaited them: they were attacked by the Carthaginians in 406 B.C., and by this enemy their armies were routed, their city taken, their race almost extirpated, and scarce a vestige of magnificence was left. It appears, however, that some of the fugitive inhabitants availed themselves of permission to return to the ruined city, and after a few years were even able to shake off the yoke of Carthage, and attach themselves to the cause of Dionysius. But the city was so far from having recovered its previous importance, that Timoleon, after his triumph over the Carthaginians B.C. 340, found it necessary to re-colonize it with citizens from Velia in Italy. This measure was crowned with astonishing success; for Agrigentum rose from its ashes with such a renewal of vigour, that in a very short time we find it engaged in the bold scheme of seizing a lucky moment, when Agathocles and Carthage had reduced Syracuse to the lowest ebb, and arrogating to itself supremacy over all the Sicilian republics. Xenodocus was appointed the leader of this arduous enterprise; and had his latter operations been as fortunate as his first campaign, Agrigentum would have acquired such a preponderance of reputation and power, that the rival states would not have even dared to attack it. But a few brilliant exploits were succeeded by a severe overthrow; the Agrigentines lost courage, disagreed in council, and humbly sued for peace to Agathocles. This commonwealth afterwards took a strong part with Pyrrhus; and, when he left Sicily to the mercy of her enemies, threw herself into the arms of Carthage. During the first Punic war Agrigentum was the headquarters of the Carthaginians, and was besieged by the Roman consuls, who, after eight months' blockade, took it by storm. It nevertheless changed masters several times during the contests between these rival states, and in every instance suffered most cruel outrages. After this period very little mention of it occurs in history, nor do we know the precise time of the destruction of the old city and the building of the new one.



The hospitality and parade for which the Agrigentines are celebrated in history were supported by an extensive commerce: by means of which, the commonwealth was able to resist many shocks of adversity, and always to rise again with fresh splendour. It was, however, crushed by the general fall of Grecian liberty: the feeble remnants of its population, which had survived so many calamities, were at length driven out of its walls by the Saracens, and obliged to lock themselves up for safety among the bleak and inaccessible rocks of the present city.

Agrigentum occupied a hill of considerable extent, but small elevation, rising between the small rivers Acragas and Hypsas, and was remarkable for its strength as a fortress. The whole space comprehended within the walls of the ancient city abounds with traces of antiquity, foundations, brick arches, and little channels for the conveyance of water. Of its many celebrated edifices, the most magnificent was the temple of Olympian Jupiter, which, according to Diodorus, was 340 feet long, 160 broad, and 120 in height, without including the basement; each fluting of the columns being of capacity sufficient to admit the body of a man. Of this vast structure nothing remains but the basement and a few fragments of the columns and entablature; but these, and many other monuments less ruinous, attest the ancient wealth and magnificence of the Agrigentines.

AGRIONIA, in *Grecian Antiquity*, festivals annually celebrated by the Bœotians in honour of Bacchus. At these festivals the women pretended to search after Bacchus as a fugitive, and, after some time, gave over their inquiry, saying that he had fled to the Muses, and was concealed among them.

AGRIOPHAGI (αγριος, and φαγω), in *Antiquity*, a name given to those who fed on wild beasts. The name is given, by ancient writers, to certain people, real or fabulous, said to have fed altogether on lions or panthers. Pliny and Solinus speak of *Agriophagi* in Ethiopia, and Ptolemy of others in India on this side the Ganges.

AGRIOPUS, a genus of Acanthopterygious fishes in the system of Cuvier. The best known, *A. Torvus*, is found at the Cape of Good Hope.

AGRIPPA, CORNELIUS, born at Cologne in 1486, a man of considerable learning, and by common report a great magician; for the monks at that time suspected every thing of heresy or sorcery which they did not understand. He composed his treatise of the *Excellence of Women* to insinuate himself into the favour of Margaret of Austria, governess of the Low Countries. He accepted of the charge of historiographer to the emperor, which that princess gave him. The treatise of the *Vanity of the Sciences*, which he published in 1530, enraged his enemies extremely; as did that of *Occult Philosophy*, which he printed soon after at Antwerp. He was imprisoned in France for having written something against the mother of Francis I. On being liberated, he went to Grenoble, where he died in 1535.

AGRIPPA, *Herod*, the son of Aristobulus and Berenice, and grandson to Herod the Great, was born A.M. 3994, ten years before the vulgar era. After the death of Aristobulus his father, Josephus informs us that Herod, his grandfather, took care of his education, and sent him to Rome to make his court to Tiberius. The emperor conceived a great affection for Agrippa, and placed him near his son Drusus. He very soon won the favour of Drusus, and of the empress Antonia. On the death of Drusus, Agrippa, who had indulged his inclination to liberality, was obliged to leave Rome, overwhelmed with debt, and retired to the castle of Malatha, where he lived rather like a private person than a prince. Herod the tetrarch, his uncle, who had married Herodias, his sister, assisted him for some time with great generosity. He made him principal magistrate of Tiberias, and presented him with a large sum of money; but growing weary of assisting him, and reproaching him with his bad economy, Agrippa left Judea, and some time afterwards returned to Rome. Upon his arrival he was received into the good graces of Tiberius, and commanded to attend Tiberius Nero, the son of Drusus. Agrippa, however, having more inclination for Caius, the son of Germanicus, and grandson of Antonia, chose rather to attach himself to him; as if foreseeing the future elevation of Caius, who, at that time, was universally beloved. The great assiduity and agreeable behaviour of Agrippa so far won upon this prince, that he kept him continually about him.

Agrippa being one day overheard by Eutyches, a slave whom he had made free, to express his wishes for Tiberius's death and the advancement of Caius, the slave betrayed him to the emperor; whereupon Agrippa was loaded with fetters, and committed to the custody of an officer. Tiberius soon after died, and Caius Caligula ascended the throne. The new emperor heaped wealth and favours upon Agrippa, changed his iron fetters into a chain of gold, set a royal diadem upon his head, and gave him the tetrarchy of Batanæa and Trachonitis, which Philip the son of Herod the Great had formerly possessed. To this he added that of Lysanias; and Agrippa returned very soon into Judea to take possession of his new kingdom.

On the assassination of Caligula, Agrippa, who was then at Rome, contributed much by his advice to maintain Claudius in possession of the imperial dignity, to which he had been advanced by the army; and while he made a show of being in the interest of the senate, he secretly advised Claudius to maintain his good fortune with firmness. The emperor, as an acknowledgment for his kind offices, gave him all Judea; and the kingdom of Chalcis, at his request, was given to his brother Herod. Thus Agrippa became of a sudden one of the greatest princes of the East, and was possessed of as much, if not more territory than had been held by Herod the Great, his grandfather. He returned to Judea, and governed it to the great satisfaction of the Jews. But the desire of pleasing them, and a mistaken zeal for their religion, impelled him to acts of cruelty, the memory of which is preserved in Scripture, Acts xii. 1, 2, &c.; for about the feast of the passover, in the year of Jesus Christ 44, St James major, the son of Zebedee, and brother of St John the Evangelist, was seized by his order and put to death. He proceeded also to lay hands on St Peter, and imprisoned him, delaying his execution till the close of the festival. But God having miraculously delivered St Peter from the place of his confinement, the designs of Agrippa were frustrated. After the passover, he went from Jerusalem to Cæsarea, and there had games performed in honour of Claudius. Here the inhabitants of Tyre and Sidon waited on him to sue for peace. Agrippa being come early in the morning to the theatre to give them audience, seated himself on his throne, dressed in a robe of silver tissue, which reflected the rays of the rising sun with such lustre as to dazzle the eyes of the spectators. When the king had delivered his address, the parasites around him shouted out that it was not the voice of a man but of a god. The vain Agrippa received the impious flattery with complacent satisfaction; but in the midst of his elation, looking upwards he saw, with superstitious alarm, an owl perched over his head. During his confinement by Tiberius, he had been startled by a like omen, which had been interpreted as portending his speedy release, with the warning, that whenever he should behold the same sight again, his death was to follow within the space of five days. Seized with terror, he took to his bed, and after a few days of excruciating torment, died, according to the Scripture expression, "eaten up by worms." Such was the death of Herod Agrippa, after a reign of seven years, in the year of Christ 44.



Agrippa II., son of the preceding, was made king of Chalcis; but three or four years after, he was deprived of that kingdom by Claudius, who gave him instead of it other provinces. In the war which Vespasian carried on against the Jews, Herod sent him a succour of 2000 men; by which it appears, that though a Jew by religion, he was yet entirely devoted to the Romans, whose assistance indeed he wanted to secure the peace of his own kingdom. He lived to the third year of Trajan, and died at Rome A.D. 100. He was the seventh and last king of the family of Herod the Great. It was before him and Berenice his sister that St Paul pleaded his cause at Cæsarea.

Agrippa, *Marcus Vipsanius*, according to Tacitus, was born of humble parents about 69 years B.C.; yet he could scarcely have been of very mean birth, as at the age of 18 he was the chosen companion at Apollonia of Octavius, the nephew and successor of Julius Cæsar; many of whose successes were mainly due to the courage and military talents of Agrippa. On the assassination of the dictator, Agrippa accompanied his friend to Italy, and rendered essential service in the conduct of the first war against M. Antonius, which terminated in the capture of Perusia, into which L. Antonius, the younger brother of the triumvir, had thrown himself. He appears to have had no part in the atrocious butcheries that followed the capture of that city, which cast such a deep stain on the character of Octavius. The event took place 40 years B.C. Three years after this Agrippa was made consul, and had the command in Gaul; when he defeated the Aquitani, and led the Roman eagles beyond the Rhine, to punish the aggressions of the Germans on the province of Gaul. But Agrippa was soon summoned to Italy by the critical state of the affairs of Octavius; where the whole coasts were commanded by the superior fleets of Sex. Pompeius. His first care was the formation of a secure harbour for the ships of Octavius; and this he accomplished by uniting the Lucrine lake with the sea by means of a fortified canal through a narrow slip of land called the Barrier of Hercules. He made an inner haven also by joining the lake Avernus to the Lucrine by another cut. In these secure ports the fleets were equipped, and 20,000 manumitted slaves were sedulously trained to rowing and naval manœuvres, until they were able to cope with the seamen of Pompeius. Agrippa was thus enabled in the following year to defeat S. Pompeius in the naval action of Mylæ, in which he captured 30 ships from his opponent; and soon after gave him a more signal defeat near Naulochus, sinking 28, and capturing or burning 250 of his ships. This victory gave Octavius the empire of the Mediterranean, and secured to him Sicily, the granary of Rome, after an easy triumph over his feeble colleague Lepidus; and it prepared the way for the overthrow of the power of M. Antonius the other triumvir. The whole merit of these successes is due to Agrippa; for Octavius scarcely exhibited common courage in any of these transactions.

In the year 33 B.C. Agrippa filled the useful office of ædile; and he signalized the tenure of his office by fresh proofs of the activity and perseverance of his character, by the great improvements in the city of Rome, in the repairs and construction of aqueducts and fountains neglected or injured during the civil wars, and in the reformation of the sewers of the capital, which he repaired and enlarged until they became what Pliny has described them,—"Operum omnium maximum, suffossis montibus, atque urbe pensili, subterque navigatâ." He appears also on this occasion to have introduced an effectual mode of *flushing* those sewers by conducting into them the united waters of several different streams.

From these useful labours he was again called away in the year 31 B.C. to command the Roman fleet, which by the victory at Actium fixed the empire of the world on the unworthy Octavius. The services of Agrippa made him a special favourite with the former, who gave him his niece Marcella in marriage, 27 B.C., when for a third time he was consul; and in the following year the servile senate bestowed on Octavius the imperial title of AUGUSTUS. In this same year Agrippa, in commemoration of the naval victory of Actium, dedicated to Jupiter and all the other gods the pantheon, now called *Rotunda*. The inscription on its portico still remains, M. AGRIPPA L. F. CONSUL TERTIUM FECIT. But it is probable that he only added the magnificent portico to a much more ancient building; as a minute examination of the architecture of the structure appears to indicate. In the year 25 B.C. we again find this eminent man employed in Spain; where he reduced the insurgent Cantabri, the ancestors of the present Biscayans.

The friendship of Augustus and Agrippa seems to have been clouded by the jealousy of Marcellus, who had married Julia the daughter of Augustus by Scribonia. This coolness was probably fomented by the intrigues of Livia, the second wife of Augustus, who probably dreaded his influence with her husband. The consequence was that Agrippa left Rome; and though, to cloak his retirement, he was appointed to the distant government of Syria, he repaired to Mytilene. But Marcellus dying within a year, Agrippa was recalled to Rome; and at the desire of Augustus was divorced from Marcella, and became the husband of the widowed Julia, who was no less distinguished by her beauty and abilities, than afterwards by her shameless profligacy.

In 19 B.C. we find Agrippa again at the head of an army in Spain, where he subdued the Cantabri, who had been for two years in insurrection against the Romans. After that he was a second time made governor of Syria; where by his justice and wise administration he obtained general commendation, especially from the Hebrew population of his province, of which Judea formed a part.

The last military employment of this great and good man was in Pannonia, where his character for equity alone sufficed to put down insurrection, without bloodshed. In fact he was the greatest military commander of Rome since the days of Julius Cæsar, and the most honest of Roman governors in any province. His character is well described by V. Paterculus, "Virtutis nobilissimæ, labore, vigiliâ, periculo invictus, parendique sed uni scientissimus, aliis sane imperandi cupidus, et per omnia extra dilationes positus, consultisque facta conjungens."

This great man returned to Italy, where he lived greatly honoured, and died two years before his imperial father-in-law.

Agrippa left several children; by his first wife—Pomponia Vipsania, who became the first wife of Tiberius, and was the mother of Drusus: he had no children by Marcella; but by Julia he was the father of Caius and Lucius Cæsar; of Julia, married to Lepidus; of Agrippina the elder, wife of Germanicus; and of Agrippa Posthumus.—See *Dio Cassius; Appianus; Suetonius; Velleius Paterculus;* Fergusson's *R. Rep.* (T. S. T.)



AGRIPPINA, THE ELDER, the virtuous, heroic, but unfortunate offspring of M. Agrippa by a very abandoned mother, and herself the parent of a still more profligate and guilty daughter of the same name. She was early married to Germanicus, the son of Drusus and Antonia the niece of Augustus. On the death of Augustus, she joined her husband in his German campaigns, where she had several opportunities of showing her intrepidity, sharing with Germanicus his toils and his triumphs. The love which the army showed for this leader was the cause of his recal from the Rhine by the suspicious Tiberius. He was soon afterwards sent into Syria, where he died at Antioch, from the effects, as was believed, of poison administered to him by Piso, the governor of Phœnice.

On his deathbed, Germanicus implored his wife for heaven's sake, and that of their numerous children, to submit with resignation to the evil times on which they were fallen, and not to provoke the vengeance of the tyrant Tiberius. But unhappily this prudent advice was not followed by this high-spirited woman; who, on landing at Brundusium, went straight to Rome, and entered the city bearing the urn of her deceased husband in her arms, and was received amid the tears of the citizens and the soldiery, to whom Germanicus was dear. She boldly accused Piso of the murder of her husband; and that bad man, to avoid public infamy, committed suicide. She continued to reside at Rome, watched and suspected by Tiberius, who for some time dreaded to glut his vengeance on the widow and family of so popular a prince as Germanicus. She soon had the temerity to upbraid the tyrant with his hypocrisy in pretending to worship at the tomb of Augustus. He began by putting to death both men and women who had shown attachment to the family of Germanicus; and finally he arrested Agrippina and her two eldest sons, Nero and Drusus, and deported them to the isle of Pandataria, where her mother Julia had perished; and there she was starved to death. Tiberius also ordered the execution of her two eldest sons. Yet it is remarkable that, by his will, the emperor left her youngest son Caius, better known by the name of *Caligula*, as one of the heirs of the empire. Agrippina was murdered in the 33d year of our era. (T. S. T.)

AGRIPPINA, daughter of Germanicus, sister of Caligula, and mother of Nero; a woman of wit, but licentious and cruel. She was thrice married, the last time to Claudius, her own uncle, whom she poisoned to make way for Nero, her son. Nero afterwards caused her to be murdered in her chamber, when she bid the executioner stab her first in the belly, that had brought forth such a monster.

AGRIPPINA COLONIA UBIORUM, in *Ancient Geography*, now *Cologne;* so called from Agrippina, the daughter of Germanicus and mother of Nero, who had a colony sent thither at her request by the Emperor Claudius, to honour the place of her birth. See COLOGNE.

AGRONOMI, *in Antiquity*, rural police, frequently mentioned by Plato.

AGROSTIS, a genus of grasses. See BOTANY.

AGROTERAS THUSIA, an annual festival at Athens, in honour of Artemis or Diana, in consequence of a vow made before the battle of Marathon to offer in sacrifice as many goats as there should be slain of the enemy. The number was afterwards restricted to 500.

AGUAS CALIENTES, a well-built town of Mexico, in the province of Guadalaxara, containing about 500 families of Spanish descent, besides numerous others of mixed races. It takes its name from the hot-springs in its vicinity. The climate is fine, and the extensive and beautiful gardens

Agudo || Aguesseau.

surrounding the town produce abundance of olives, figs, grapes, &c. Much maize also is raised. It has a great cloth manufactory, and the general trade is considerable. Lat. 22. N. Long. 101. 50. W.

AGUDO, a well-built town of La Mancha, in Spain, with a population of 1240, chiefly engaged in agriculture and cattle-breeding.

AGUE. See Medicine.

AGUEDA, the *Æminium Flumen* of the Romans (Pliny), a river of Spain in the province of Salamanca. It rises in the Sierra de Gata, and passing by Ciudad Rodrigo, falls into the Douro, on the Portuguese frontier, after a northward course of 70 miles.

Agueda, *Santa*, a small village in the province of Guipúzcoa, in Spain, celebrated for its sulphurous baths, which for 300 years have been esteemed for their efficacy in the cure of cutaneous and other diseases.

AGUESSEAU, Henri Francois d', Chancellor of France, illustrious for his virtues, learning, and talents, was born at Limoges on the 27th of November 1668. His father, at that time intendant of Languedoc, and afterwards a counsellor of state, was a man of great worth and abilities. He seems to have taken the sole charge of his son's education; and having destined him for the bar, he took uncommon pains to exercise him in every branch of knowledge which could contribute to his success in that profession. His care was rewarded with the happiest success. Young D'Aguesseau gave early indications of uncommon abilities; and such was his thirst for knowledge, and his habits of application, that he soon acquired the reputation of an almost universal scholar. He had a particular relish for poetry, which, he used to say, "was the only passion of his youth;" but this passion was so far from withdrawing him from severer studies, that it was allied in his mind with a nearly equal taste for mathematics. He studied law with the zeal of an antiquary, and the spirit of a philosopher; and, in order to form his taste as a pleader, he employed a whole year in repeated perusals of the most esteemed productions of ancient eloquence. After this thorough course of preparation, he became an advocate in 1690; and by the interest of his father, who then resided in Paris, he was soon furnished with opportunities of distinguishing himself, and of rising to the highest honours of the profession. When little more than 21 years of age, he was appointed one of the three *Advocates-General*,—an office which imposed the duty of assisting in those causes where the king, the church, or the public was concerned. The king, Louis XIV., in appointing him, yet untried, to this situation, acted solely upon the recommendation of the elder D'Aguesseau, "who was incapable," said Louis, "of deceiving him, even to advance his own son." D'Aguesseau's first appearances as an advocate-general were such as amply to fulfil the expectations of his father, and to warrant the appointment which he had obtained from the king. Denis Talon, an old lawyer, who had long officiated with great reputation in the same capacity, was heard to say, that "he should have been glad to have finished his career as that young man had begun."

D'Aguesseau held this office for ten years, during which period he greatly distinguished himself, both for learning in his profession, and for a superior style of forensic eloquence. The society which he chiefly frequented was well adapted to improve his taste; for the chosen companions of his leisure hours were Racine and Boileau, the latter of whom has frequently mentioned him with praise in his writings.

It was D'Aguesseau's opinion, that no one could rise to distinguished eminence as an orator, who did not labour to enlarge his mind, and to improve his taste, by the study of philosophy, and by exercises of literature; and he accordingly employed several of those stated discourses which the usages of France required from the advocates-general at the opening of the Sessions, to impress these views upon the minds of the younger members of the bar.

Aguesseau.

In the year 1700 he was appointed *Procurator-General;* an office of higher dignity, and of more various and extensive duties, than that of advocate-general. He filled this office for seventeen years with the most splendid reputation; adding, by his lenity in criminal cases, and by his care of the public hospitals, the praise of humanity and benevolence to his other claims to the respect and admiration of his countrymen.

It had been early predicted of D'Aguesseau, that he would one day fill the place of Chancellor; and this prediction was at length realised in 1717, upon the death of Voisin, who then held the seals. Though he was yet only forty-eight years of age, his nomination to this high dignity gave general satisfaction, and was, indeed, intended as a popular measure by the Duke of Orleans, who had lately assumed the regency. D'Aguesseau soon began to experience the difficulties and perils attendant upon his elevation; for he had not been installed above a year, when he was deprived of the seals, and exiled to his estate. His steady opposition to the delusive projects of the famous John Law, with which the regent and his ministers were wholly intoxicated, was the honourable cause of this first reverse of fortune. In 1720, when the ruinous consequences of these schemes had filled the nation with distress and alarm, the chancellor was recalled from banishment; and he contributed not a little, by the firmness and sagacity of his counsels, to calm the public discontents, and repair the mischiefs which had been committed.

Law himself had acted as the messenger of his recal; and it is said that D'Aguesseau's consent to re-accept the seals from the hand of this adventurer was much blamed by the literary corps, with which he had hitherto stood in high favour, as well as by the parliament. But his reputation appears to have sustained a much severer shock, when he endeavoured to prevail with the latter body to register the declaration of the late king in favour of the bull *Unigenitus*,—a measure which they held in great abhorrence, and which he had himself firmly opposed during the life of Louis. The regent's favourite, Dubois, then Archbishop of Cambray, had moved his master to insist upon this act of registration, in the hope that he might thereby obtain a cardinal's hat; and it seems to have been thought that the chancellor had yielded his better opinion in compliance with the wishes of this worthless minion. Be this as it may, it is certain that he opposed the favourite with firmness, when he attempted, after being made prime minister, to take precedence in the council; and he was in consequence, in 1722, sent a second time into exile.

He now passed five years on his estate at Fresnes; and he always spoke with delight of this tranquil period, when he was left free from the cares of professional duty, and the distractions of public life, to cultivate his mind. The Scriptures, which he read and compared in various languages, and the Jurisprudence of his own and other countries, formed the subjects of his more serious studies: the rest of his time was devoted to philosophy and literature, and the improvement of his park, where he was sometimes to be seen employed with a spade.

From these noble and congenial occupations he was again recalled, by the advice of Cardinal Fleury, in 1727; but the seals were not restored to him till ten years thereafter. During the intervening period he had endeavoured to mediate in the new disputes which had arisen between the court and the parliament; but his interference seems to have given satisfaction to neither party,—the one reproaching him with desertion from their cause, and the other with too great a leaning towards it. When the seals were at last restored to him, he completely withdrew from all affairs of state, and devoted himself entirely to his duties as chancellor, and to the introduction of those reforms which had long occupied his inquiries and meditations.

Besides some important enactments regarding Donations, Testaments, and Successions, he introduced various regulations for improving the forms of procedure, for ascertaining the limits of Jurisdictions, and for effecting a greater uniformity in the execution of the laws throughout the several provinces. These reforms constitute an epoch in the history of the jurisprudence of France, and have associated his name with those illustrious benefactors of her Civil Code, L'Hôpital and Lamoignon.

In 1750, when upwards of eighty-two years of age, he besought the king to accept his resignation; and he was accordingly permitted to retire, the king continuing to him the honours of his office as a special mark of his approbation. He died in the following year, and was interred, according to his own request, in the common burial-place of the village of Auteuil, where the remains of his wife, who died there in 1735, had been deposited. The name of this lady, whom he married in 1694, and by whom he had several children, was Anne Lefèvre d'Ormesson.

This great man has not, in all respects, been equally praised by those who have attempted to transmit his character to posterity. Saint-Simon and others reproach him with a degree of tardiness and indecision, which sometimes greatly obstructed the course of justice. His own answer to this charge has been recorded by Duclos, and is worthy of notice: "When I recollect," said he, "that a decision of the chancellor makes a law, I think myself warranted in taking a long time for consideration." In summing up his character, all must agree with Laharpe, that he was "a man who did honour to France, to the magistracy, and to letters, by his virtues, his talents, his profound and various learning, and his enlightened views in the science of jurisprudence."—*Cours de Littérature*, tom. xiv. c. 1.

His published writings form a collection of thirteen volumes quarto, of which the first was published at Paris in 1759, and the last in 1789. The far greater part of these volumes relates to matters connected with his professional occupations and studies; but they also contain a variety of pieces upon other subjects. Besides the already mentioned discourses, an elaborate treatise on money, and some theological pieces, there is a life of his father,—interesting from the view which it affords of his own early education under that excellent person; and Metaphysical Meditations, written in vindication of the grand truth, that independently of all revelation, and all positive law, there is that in the constitution of the human mind which renders *man a law to himself*.—See *Histoire des Hommes Illustres de Regnes de Louis* XIV. *et de Louis* XV. par le Duc de Saint-Simon; *Mémoires Secretes*, par Duclos; *Les Loisirs d'un Ministre d'Etat*, par D'Argenson; *Eloge de D'Aguesseau*, par Thomas. (M. N.)

AGUILAR *de la Frontera*, a very fertile district of the province of Cordova in Spain, with a population of 18,844, chiefly engaged in agriculture, cattle breeding, and the manufacture of oil and pottery.

Its chief town, of the same name, stands near the river Cabra, seven leagues S.S.E. of Cordova. The houses are well built, and distinguished by their cleanness and regularity, both external and internal. The principal buildings are the parish church, the chapter-house, the prison, and the markets. There are two convents, two public schools, a charity-hospital, and a house of refuge. Near the church are the ruins of a once magnificent castle. The principal products are wine and oil. Pop. 11,836.



AGUILAS, San Juan de las, a seaport of Murcia in Spain, with 4832 inhabitants. Its harbour is small but secure; and England, France, and Portugal maintain vice-consuls there.

AGUILLANEUF, or Auguillaneuf, a form of rejoicing used among the ancient Franks on the first day of the year. The word is compounded of the French *a*, to, *gui*, misletoe, and *l'an neuf*, the new year. Its origin is traced from a druidical ceremony. In the sacred month of December every year, the priests went in solemn procession to gather the misletoe of the oak. The prophets marched in front, singing hymns in honour of the gods; after them came a herald with a caduceus in his hand; these were followed by three druids abreast, bearing the things necessary for sacrifice; last of all came the chief or arch druid, accompanied by the train of people. The chief druid, ascending the oak, cut off the misletoe with a golden sickle, and the other druids received it in a white cloth. On the first day of the year they distributed it among the people, after having blessed and consecrated it by crying *A gui l'an neuf*, to proclaim the new year.

AGUILLON, or Aguillonius, Francis, a Jesuit, born at Brussels. He was rector of the Jesuit college at Antwerp, and eminent for his skill in mathematics. He was the first who introduced that science among the Jesuits in the Low Countries. He wrote a book of Optics, and was employed in finishing his Catoptrics and Dioptrics when he died in 1617.

AGUIMES, a town in the Great Canary Island, 1100 feet above the sea level, with a population of 3073, and manufactures of palm and olive oil, linen, cloth, &c.

AGUIRRE, Joseph Saenz d', a Benedictine, and one of the most learned men of the 17th century, was born at Logroño, March 24, 1630. He was censor and secretary of the supreme council of the inquisition in Spain, and interpreter of the Scriptures in the university of Salamanca. He printed three volumes in folio upon Philosophy, a commentary upon Aristotle's ten books of Ethics, and other pieces. He attained to the dignity of cardinal, and died at Rome on the 19th August 1699.

AGULHAS, Cape, the most southern point of Africa, 100 miles eastward of the Cape of Good Hope, in Lat. 34. 51. 30. S. Long. 19. 55. 30. E. It rises 155 feet above the sea; and in 1849 a lighthouse was opened on it nearer the water. An immense bank, the *Agulhas Bank*, extends from the Cape of Good Hope along this coast to the great Fish River, a distance of 560 miles, with a general breadth of 100: but opposite to the Cape it projects 100 miles more southward. The great oceanic current from the Indian Ocean to the Atlantic sets along its outward edge, and has sharply defined it. The soundings on the bank westward of Cape Agulhas show a muddy hollow in the bottom of the sea; but eastward it is sandy, with a mixture of comminuted shells. The oceanic current has such velocity that ships are often set far to the westward, and round the Cape of Good Hope, even against a smart breeze. The bank abounds with fish; and the approach to it is denoted by the appearance of many toothed whales such as the dolphin, sharks, seals, and innumerable sea-birds.

AGURAH, in *Jewish Antiquity*, the name of a silver coin, otherwise called *gerah* and *keshita*, value $1\frac{1}{2}$d.

AGUSADURA, in *Ancient Customs*, a fee due from vassals to their lord for the sharpening of their agricultural implements. Of old the tenants in some manors were not allowed to have them sharpened by any but those whom the lord appointed, for which an acknowledgment was to be paid, called *agusadura*, in some places *agusage;* which some take to be the same with what was otherwise called *reillage*, from the ancient French *reille*, a ploughshare.

AGYEI, in *Antiquity*, a kind of obelisks, sacred to Apollo, erected in the vestibules of houses, by way of security.

AGYNIANI (α priv. and γυνη), in *Church History*, a sect who condemned marriage and the use of flesh, as not instituted by God, but introduced at the instigation of the devil. They are sometimes also called *Agynenses*, and *Agynii;* and are said to have appeared about the year 694. It is not surprising that they soon became extinct. Their tenets coincide in a great measure with those of the Abelians, Gnostics, Cerdonians, and other preachers of chastity and abstinence.

AGYRIUM, the ancient name of a Sicilian town, in the Val di Demona, near the River Semetus, now called San Filippo d'Argiro, containing 6500 inhabitants. It was the birth-place of the historian Diodorus.

AGYRTÆ (αγειρω, I congregate), in *Grecian Antiquity*, a kind of strolling imposters, who went about the country to pick up money, by telling fortunes at rich men's doors; pretending to cure diseases by charms, sacrifices, and other religious mysteries; also to expiate the crimes of their deceased ancestors, by virtue of certain odours and fumigations; to torment their enemies, by the use of magical verses, and the like. The *Agyrtæ* corresponded to the *Æruscatores* of the Latins, and to our modern gypsies.

AHAB, son of Omri, and seventh king of Israel, reigned twenty-one years, from B.C. 918 to 897. Many of the evils of his reign may be ascribed to the close connection he formed with the Phœnicians, between whom and the Jews there had long been a beneficial commercial intercourse. Having married Jezebel, the daughter of Ethbaal, or Ithobaal, king of Tyre, Ahab was entirely under her control, and sanctioned the introduction, and eventually established the worship, of the Phœnician idols, and especially of the sun-god Baal. Hitherto the golden calves in Dan and Bethel had been the only objects of idolatrous worship in Israel, and they were intended as symbols of JEHOVAH. But all reserve and limitation were now abandoned. The king built a temple at Samaria, and erected an image, and consecrated a grove to Baal. Idolatry became the predominant religion; and so strong was the tide of corruption, that it appeared as if the knowledge of the true God was soon to be for ever lost among the Israelites. But Elijah the prophet boldly opposing himself to the regal authority, succeeded in retaining many of his countrymen in the worship of the true God. At length the judgment of God on Ahab and on his house was pronounced by Elijah, that, during the reign of his son, his whole race should be exterminated. Ahab died of the wounds he received in a battle with the Syrians, according to a prediction of Micaiah, which he refused to credit, yet endeavoured to avert, by disguising himself in the action.—1 Kings xvi. 29, xxii. 40.

AHALA, a noble Roman family of the gens Servilia, which produced many distinguished men. Of these the most celebrated is C. Servilius Structus Ahala, master of the horse to the dictator Cincinnatus, B.C. 439. He signalised himself by his boldness in slaying in the forum with his own hand the popular agitator Sp. Mælius, for refusing to appear before the dictator on a charge of conspiracy against the state. For this act of violence Ahala was afterwards brought to trial. He saved himself from condemnation by retiring into voluntary exile.

AHANTA, a district on the Gold Coast of Africa, on the Gulf of Guinea, in Lat. 5. N. and Long. 3. W.—See *Bowdich's Travels.*

AHASUERUS, or ARTAXERXES, the husband of Esther and, according to Archbishop Usher and F. Calmet, the Scripture name for Darius, the son of Hystaspes king of Persia. Scaliger supposed Xerxes to have been the husband of Esther, or the Ahasuerus of Scripture: and Dr Pridcaux believes him to be Artaxerxes Longimanus. See History of PERSIA, and ESTHER.

AHAUS, a circle in the department of Munster, and Prussian province of Westphalia, formed out of the old lordships of Bocholt and Horstmar. It is 264 square miles, or 168,960 acres, in extent, comprehending four cities, three market towns, and 11 villages, with 40,069 inhabitants. The soil is moderately fertile, and yields corn, buck-wheat, and flax. It is watered by the Aa, the Berkel, the Bechta, the Dinkel, and several smaller streams. The most valuable products are cattle, and especially sheep. There is some little spinning and weaving of linen; but the higher wages paid in Holland induce the labourers to go to that country, in the seasons of hay and corn harvest, to save the means of subsistence for the winter.—The chief city of the circle, of the same name, is the residence of the Prince of Salm-kyrburg; and contains, besides his castle, 271 houses, and 1658 inhabitants. Long. 7. 4. 34. E. Lat. 52. 4. 36. N.

AHAZ, king of Judah, the son of Jotham, remarkable for his vices and impieties. He made one of his sons pass through the fire, to do honour to the idol Moloch; and he offered sacrifices and incense upon the high places, upon hills, and in groves. Rezin, king of Syria, and Pekah, king of Israel, invaded Judah in the beginning of the reign of Ahaz; and having defeated his army and pillaged the country, they laid siege to Jerusalem. When they found that they could not make themselves masters of that city, they divided their army, plundered the country, and made the inhabitants prisoners of war. Rezin and his part of the confederate army marched with all their spoil to Damascus; but Pekah, with his division of the army, having attacked Ahaz, killed 120,000 men of his army in one battle, and carried away men, women, and children, without distinction, to the number of 200,000. But as they were carrying those captives to Samaria, the prophet Oded, with the principal inhabitants of the city, came out to meet them, and by their remonstrances prevailed with them to set their prisoners at liberty. At the same time the Philistines and Edomites invaded other parts of his kingdom, killed multitudes of the people, and carried off much booty. In this distressed condition, Ahaz sent ambassadors to Tiglath-pileser, king of the Assyrians; and to engage him to his interest, he stripped the temple and city of all the gold he could find, and sent it as a present. Tiglath-pileser marched to the assistance of Ahaz, attacked Rezin, and killed him, took his capital Damascus, destroyed it, and removed the inhabitants to Cyrene.

The misfortunes of this prince had no influence in amending his character; for in the times of his greatest affliction, he sacrificed to the Syrian deities, whom he looked upon as the authors of his calamities, and endeavoured thus to propitiate. He broke in pieces the vessels of the house of God, shut up the gates of the temple, and erected altars in all parts of Jerusalem. He set up altars likewise in all the cities of Judah, with a design to offer incense on them. His body, after his death, was refused a place in the sepulchres of the kings of Judah. Hezekiah his son succeeded him in the year of the world 3278, B.C. 726.

AHAZIAH, the son and successor of Ahab, king of Israel, reigned two years in conjunction with his father. Ahaziah imitated Ahab's impieties (1 Kings xxii. 52, *seq.*), and paid his adoration to Baal and Astarte, the worship of whom had been introduced into Israel by Jezebel, his mother. The Moabites, who had been always obedient to the kings of the ten tribes ever since their separation from the kingdom of Judah, revolted after the death of Ahab, and refused to pay the ordinary tribute. Ahaziah, however, had not leisure or power to reduce them. By an accidental fall, about this time, from a lattice of his palace, he received such injury as to put his life in danger. He despatched messengers to Ekron to inquire of the god Baalzebub whether or not he should recover. A more faithful oracle came to him in the person of the prophet Elijah, who forewarned him of his speedy death. This took place A.M. 3108, and Jehoram his brother succeeded to the throne. (2 Kings i.)

Ahaziah, king of Judah, the son of Jehoram and Athaliah, succeeded his father in the kingdom of Judah, A.M. 3119. He walked in the ways of Ahab's house, to which he was allied. He reigned only one year, and was slain by Jehu the son of Nimshi.

A-HEAD, a sea-term, signifying farther onward than the ship, or at any distance before her, lying immediately on that point of the compass to which her stem is directed. It is used in opposition to *a-stern*, which expresses the situation of any object behind the ship.

AHENOBARBUS, the name of a plebeian Roman family of the gens Domitia, which rose in the course of time to considerable distinction. The emperor Nero was of this family. The name was derived from the red beard and hair by which many of the family were distinguished.

AHIGAL, a town of Estremadura in Spain, with a population of 1370, and manufactories of soap, linen, oil, &c.

AHIJAH, or Ahiah, a prophet residing in Shiloh in the times of Solomon and Jeroboam. He appears to have put on record some of the transactions of the former reign. (2 Chron. ix. 29). It devolved on him to announce and sanction the separation of the ten tribes from the house of David, as well as the foundation (1 Kings xi. 29–39), and, after many years, the subversion, of the dynasty of Jeroboam. (1 Kings xiv. 7–11.)

AHIMELECH (*brother of the king*, i. e. *the king's friend*,) was the son of Ahitab, and brother of Ahiah, who was most probably his predecessor in the high priesthood. When David fled from Saul, he went to Nob, a city of the priests in Benjamin, where the tabernacle then was; and by representing himself as on pressing business from the king, he obtained from Ahimelech some of the sacred bread which had been removed from the presence-table. He was also furnished with the sword which he had himself taken from Goliah, and which had been laid up as a trophy in the tabernacle. (1 Sam. xxi. 1–9.) These circumstances were witnessed by Doeg, an Edomite in the service of Saul, and were so reported by him to the jealous king as to appear acts of connivance at, and support to David's imagined disloyal designs. Saul immediately sent for Ahimelech and the other priests then at Nob, and laid this crime to their charge, which they repelled by declaring their ignorance of any hostile designs on the part of David towards Saul or his kingdom. The king, however, commanded his guard to slay them. Their refusal to fall upon persons invested with so sacred a character might have brought even Saul to reason; but he repeated the order to Doeg himself, and was too readily obeyed by that malignant person, who, with the men under his orders, not only slew the priests then present, eighty-six in number, but marched to Nob, and put to the sword every living creature it contained. The only one of the priests that escaped was Abiathar, son of Ahimelech, who fled to David, and afterwards became high priest. (1 Sam. xxii.)

AHITHOPHEL (*brother of foolishness*, i. e. *foolish*), the very singular name of the man who, in the time of David, was renowned throughout all Israel for his worldly wisdom. He was of the council of David; but at the time of Absalom's revolt, was at Giloh, his native place, whence he was summoned to Jerusalem; and it shows the strength of Absalom's cause in Israel that a man so capable of foreseeing results, and estimating the probabilities of success, took his side in so daring an attempt. (2 Sam. xv. 12.) The news of this defection appears to have occasioned David more alarm than any other single incident in the rebellion. He earnestly prayed God to turn the sage counsel of Ahithophel "to foolishness" (probably alluding to his name); and being immediately after joined by his old friend Hushai, he induced him to go over to Absalom with the express view that he might be instrumental in defeating the counsels of this dangerous person. (xv. 31–37.) Hushai interposed with his plausible advice, the object of which was to gain time to enable David to collect his resources. When Ahithophel saw that his counsel was rejected for that of Hushai, he gave up the cause of Absalom for lost; and he forthwith returned to his home, and hanged himself, B.C. 1023. (ch. xvii.) This is the only case of suicide which the Old Testament records, unless the last acts of Samson and Saul may be regarded as such.



AHJOLI, a city on the bay of Borgas, in the Black Sea, surrounded with many wind-mills, and of commercial consequence from its copious salt-springs. It is in the Turkish province of Silistria, a part of ancient Bulgaria.

AHMEDABAD. See Amedabad.

AHMEDPOORA. The name of several towns in Hindustan.

AHRWEILER, a circle in the department of Coblentz, and the Prussian province of the Lower Rhine. It extends over 143 square miles, or 91,520 acres; and has 32,820 inhabitants, viz. 31,657 Catholics, 651 Protestants, 512 Jews, in three cities, three market towns, and 74 villages. The Rhine washes its eastern border, and receives the water of the Ahr, which issues out of a fertile valley, near Sinzig, whence some good wine from the sides of the hills is produced. The rest of the district is poor in agriculture, and indifferently furnished with cattle, game, fish, wood, and stone. The capital is a small city of the same name. It is on the banks of the Ahr, and contains 438 houses, and 2880 inhabitants, chiefly tanners, curriers, and makers of wine.

A-HULL, in naval language, the situation of a ship when all her sails are furled on account of the violence of the storm, and when, having lashed her helm on the lee-side, she lies nearly with her side to the wind and sea, her head being somewhat inclined to the direction of the wind.

AHUYS, a town of Sweden, in the principality of Gothland, and territory of Christianstadt, near the Baltic Sea, about ten miles from Christianstadt. It is small, but very strong in situation, and has a good port. Long. 14. 10. E. Lat. 55. 55. N.

AI (Sept. Ἀγγαί, Ἀγγαΐ, and Γαΐ; Vulg. *Hai*) a royal city of the Canaanites, east of Bethel. It existed in the time of Abraham, who pitched his tent between the two cities (Gen. xii. 8; xiii. 3); but it is chiefly noted for its capture and destruction by Joshua (vii. 2–5; viii. 1–29). At a later perion Ai was rebuilt, and is mentioned by Isaiah (x. 28), and also after the captivity. The site was known, and some scanty ruins still existed, in the time of Eusebius and Jerome (*Onomast.* in *Agai*), but Dr Robinson was unable to discover any certain traces of either. He remarks (*Bib. Researches*, ii. 313), however, that its situation with regard to Bethel may be well determined by the facts recorded in Scripture. That Ai lay to the east of Bethel is distinctly stated; and the two cities were not so far distant from each other but that the men of Bethel mingled in the pursuit of the Israelites as they feigned to flee before the king of Ai, and thus both cities were left defenceless (Josh. viii. 17). A little to the south of a village called Deir Diwan, and one hour's journey from Bethel, the site of an ancient place is indicated by reservoirs hewn in the rock, excavated tombs, and foundations of hewn stone. This, Dr Robinson inclines to think, may mark the site of Ai, as it agrees with all the intimations as to its position.

AIBAR, a Spanish town in a valley of the same name, in the province of Navarre, the scene of a bloody battle between the Spaniards and the Moors in 885. Pop. 1360.

AID-DE-CAMP, in *Military Affairs*, an officer employed to receive and carry the orders of a general.

AIDAN, a king of the Dalriad Scots, about the end of the 6th century.—See *Boece's History*.

AIDAN, *St*, a famous Scottish bishop of Lindisfarne or Holy Island, in the 7th century, was employed by Oswald, king of Northumberland, in the conversion of the English, in which he was very successful. He was a monk in the monastery of Iona, and died in 651.

AIDS, *Auxilia*, a pecuniary tribute under the feudal system, paid by a vassal to his lord on particular occasions; originally a mere gift, which, in process of time, became a demandable right. The aids of this kind were chiefly three, viz.:—1*st*, When the lord made his eldest son a knight; 2*d*, To provide a dower when he gave his eldest daughter in marriage; 3*d*, To ransom his lord when taken prisoner. The amount of the first two was limited by statute, but the last was, of course, uncertain.

AIGLE, a bailiwick in the territory of Romand in Switzerland, consists of mountains and valleys, the principal of which are the Aigle and Bex. Through these is the great road from Valais into Italy. In passing by Villeneuve, which is at the head of the lake of Geneva, the traveller enters into a deep valley three miles wide, bordered on one side by the Alps of Switzerland, on the other side by those of Savoy, and crossed by the river Rhone. Six miles from thence he arrives at Aigle, a town of 1900 inhabitants, situated in a wide part of the valley, adorned with vineyards, fields, and meadows. The governor's castle is on an eminence overlooking the town, and has a lofty marble tower. This government has nine large parishes; and is divided into four parts, Aigle, Bex, Olon, and Ormont. This last is among the mountains, and adjoins Rougemont. It is a double valley, abounding in pasture lands. Ivorna, in the district of Aigle, was in part buried by the fall of a mountain, occasioned by an earthquake, in 1584.

AIGLE, L', a city in France, in the arrondissement of Mortagne, and department of the Orne. It is situated on the river Rille, which divides it into three parts; one on each side of the river, and one in an island formed by two of its channels. It contains 844 houses, and 4720 inhabitants. It is an industrious place, with manufactures of linen, cotton, paper, leather, cutlery, needles, bottles, and other wares.

AIGUE PERSE, a town of France, in the department of Puy de Dome, twelve miles N.N.E. of Riom. In its vicinity are mineral springs, and the Château de la Roche, where the Chancellor de l'Hôpital was born. Pop. 2671.

AIGUES MORTES, a town of France, in the department of Gard, 20 miles south-west of Nismes. It was once a seaport town, and here St Louis embarked on his two expeditions to Africa; but it is now four miles distant from the coast, being connected with it by the Roubine canal. The surrounding marshes render it very unhealthy. Pop. 3365.

AIGUILLON, a town in the department of Lot and Garonne, in France, at the conflux of the rivers Garonne and Lot, containing 3919 inhabitants.

AIGUISCE, in *Heraldry*, denotes a cross with its four ends sharpened, but so as to terminate in obtuse angles. It differs from the cross fitchee, inasmuch as the latter tapers by degrees to a point, and the former only at the ends.

AIKEN, JOHN, M.D., born at Warrington in Lancashire, was the only son of the Rev. Dr John Aiken, who, for many years, was one of the masters in the Dissenting Academy at Warrington, before its removal to Hackney. The son received his elementary education at that seminary: his medical studies he prosecuted in the university of Edinburgh, and in London under the celebrated Dr William Hunter. He commenced his professional career as a surgeon at Chester; but not succeeding in that episcopal city, he tried to establish himself in his native town. Finally, he went to Leyden, took the degree of M.D. in that university, and attempted to establish himself as a physician in London. His success in this new field does not seem to have been considerable; partly owing to his delicate health, and partly from the singleness of purpose and keenness with which he entered into the engrossing political questions of the day, especially the grand principle of liberty of conscience. Hence he began at an early period to devote himself to literary pursuits. Dr Aiken's reputation now chiefly rests on his endeavours to popularise scientific inquiries, by rendering them easy of comprehension to the general reader. In conjunction with his sister, Mrs Barbauld, he commenced the publication of a series of volumes on this principle, entitled *Evenings at Home*, the sixth and last volume of which appeared in 1796. This attempt to popularise scientific inquiries was a favourate object of Dr Aiken; and the work obtained a great reputation. It is chiefly commendable for the purity of the principles it inculcates, and the pleasing views it gives of human nature. His love of nature, and his power in delineating her features, are well illustrated in *The Natural History of the Year*, as well as in his miscellaneous *Essays*.



In 1798 Dr Aiken retired from professional life, and devoted himself with great industry to literary undertakings of varied and numerous kinds, among which his valuable *Biographical Dictionary* holds a conspicuous place. In this he was assisted by Enfield. It appeared in ten quarto volumes, from 1799 to 1815. Besides these he published *Lives of John Selden and Archbishop Usher, Memoirs of Huet Bishop of Avranches, Geographical Delineations of All Nations*, &c. &c.

A stroke of apoplexy terminated his life on the 7th of December 1822. The following is a list of the principal works of Dr Aiken.—1. Essay on the Legation of Arlerias, 1771.—2. Thoughts on Hospitals, 1771.—3. Observations on the external use of preparations of Lead, 1771.—4. Essay on the application of Natural History to Poetry, 1777.—5. Essay on the Plan and Character of Thomson's Seasons, 1778.—6. Biographical Memoirs of Medicine in Britain, 1780.—7. Poems, 1791.—8. A view of the character and public services of John Howard, Esq., 1792.—9. Description of the country round Manchester, 1795.—10. Evenings at Home, 6 vols. finished in 1796.—11. Natural History of the Year.—12. Letters to a Son, 1796.—13. General Biography, 10 vols. 4to. 1799 to 1815.—14. Letters to a Son, 2 vols. 1806.—15. Essays on Song-Writing, 1810.—16. Annals of the Reign of George III., from 1760 to 1815.—17. England Described, 1818.—18. Works of the British Poets, 1820. (T. S. T.)

AIKMAN, WILLIAM, a painter of considerable eminence, was born in Scotland, October 24. 1682. He was the son of William Aikman, Esq. of Cairney, and was intended by his father to follow his own profession, which was that of an advocate at the Scottish bar. But the genius of the son led him to other studies. He devoted himself to the fine arts, especially that of painting; and having for some time prosecuted his studies in Britain, in the year 1707 he went to Italy, resided in Rome for three years, afterwards travelled to Constantinople and Smyrna, and in 1712 returned to his own country. About the year 1723 he fixed his residence in London, where he followed the profession of painting, and had the good fortune to be patronised by the Duke of Argyll, the Earl of Burlington, Sir Godfrey Kneller, and other liberal encouragers of the arts. He painted many portraits of persons of the first rank in England and Scotland, and a large picture of the royal family for the Earl of Burlington, now in the possession of the Duke of Devonshire, which was unfinished at his death. Some of his portraits painted in Scotland are in the possession of the Duke of Argyll, the Duke of Hamilton, and others. Mr Aikman died in London, June 4. 1731. Six months previous to his death he had lost a son at the age of 17. The remains of both were removed to Edinburgh, and interred in the Greyfriars' churchyard on the same day. Somerville the author of *The Chase*, Mallet, Allan Ramsay the author of *The Gentle Shepherd*, and Thomson, were among Mr Aikman's intimate acquaintance; and the muse of each, in elegiac numbers, offered a warm tribute to the memory of their departed friend. The following epitaph, from the pen of Mallet, was engraved on his tomb:

> Dear to the good and wise, disprais'd by none,
> Here sleep in peace the father and the son;
> By virtue, as by nature, close ally'd,
> The painter's genius, but without the pride;
> Worth unambitious, wit afraid to shine,
> Honour's clear light, and friendship's warmth divine.
> The son, fair rising, knew too short a date;
> But, oh! how more severe the father's fate!
> He saw him torn untimely from his side,
> Felt all a father's anguish—wept, and died.

Aikman's style of painting was an imitation of the pleasing simplicity of nature. It is distinguished by softness of light, mellowness of shade, and mildness and harmony of colouring. His compositions have more placid tranquillity of ease than boldness of touch and brilliancy of effect. His portraits are supposed to have some resemblance to those of Kneller, not only in the imitation of the dresses of the time, but in the similarity of tint and manner of working.

AILANA, Ailath, or Aheloth, anciently a town of Arabia Petræa, situated near the Sinus Elanites of the Red Sea. It is also called *Eliath*, and *Eloth* (Stephanus, Strabo, Moses), and is the same with *Elana*. See Akabah.

AILESBURY. See Aylesbury.

AILMER, or Æthelmare, Earl of Cornwall and Devonshire in the reign of King Edgar. It is not known of what family he was. His authority and riches were great, and so also in appearance was his piety. He founded the abbey of Cernel, in Dorsetshire; and had so great a veneration for Eadwald, the brother of St Edmund the Martyr, who had lived a hermit in that country, near the Silver Well, that, with the assistance of Archbishop Dunstan, he translated his relics to the old church of Cernel. In 1016, when Canute invaded England, Earl Ailmer, together with the traitorous Eadric Streone, Earl of Mercia, and Earl Algar, joined the Dane against their natural prince, Edmund Ironside, which contributed greatly to the ruin of the Saxon cause. Ailmer died not long after.

AILRED, or Ealred, an English historian who lived in the reigns of Stephen and Henry II. He was born in 1109, of a noble family, and educated in Scotland with Henry, the son of King David. Embracing a religious life, he became, first abbot of Revesby, in Lincolnshire, and afterwards of the celebrated abbey of Rievaux. He died on the 12th of January 1166, aged 57, and was buried in his monastery. "He was," says Leland, "in great esteem during his life; celebrated for the miracles wrought after his death; and admitted into the catalogue of saints." He was author of several works, most of which were published by Gilbo the Jesuit, at Douay, 1631: part of them may be also found in the *Bibliotheca Cisterciensis*, and *Bibliotheca Patrum*. His principal work is the *Speculum Charitatis*. Leland, Bale, and Pits, mention several manuscripts of his which never were published.

AILSA, an insulated rock on the western coast of Scotland, between the shores of Ayrshire and Cantyre. It is of a conoidal form, with an irregular elliptic base, and rises abruptly from the sea to the height of 1139 feet. Its area is estimated by Macculloch at 3300 by 2200 feet. The only part at which the rock can be ascended is on the east side, where there is a spit of rolled pebbles; the other sides are insurmountable, and for the most part perpendicular. The south-west and north-west are perpendicular, and generally present grand columnar forms, which, though not so regular as those of Staffa, are far more lofty, and in some parts are about 400 feet high. The rock is a greenstone or syenite, with a basis of grayish compact felspar, with small grains of quartz and hornblende. There is no difference between the columnar and massive portions of the rock; but it is traversed by numerous trap veins. A fine columnar cave of 50 feet by 12 feet, and 30 feet high, exists towards the north end. About one-fifth up on the east side are the remains of a tower, with several vaulted rooms. The ascent is laborious, as the fragments of rock are interspersed with the tall vegetation of the common nettle, of *Lychnis dioica*, and *Silene amœna*. Two springs occur on the eastern slopes, where *Hydrocotyle vulgaris* grows to a great size. The scanty grass affords subsistence to a few goats and numerous rabbits; but the rocks are the favourite abode of innumerable gannets, gulls, puffins, and auks. Lat. 55. 15. 13. N. Long. 5. 7. W. (T. S. T.)



AIN, one of the departments in the east frontier of France, deriving its name from a river so called, a part of the ancient province of Burgundy. It is bounded on the north by the departments of Saone-Loire and Jura; on the east by Switzerland and Savoy, from which the Rhone divides it; on the south by the department of Isere, separated also by the Rhone; and on the west by the departments of the Rhone and the Saone-Loire, from both which the Saone divides it. The extent is 2257 square miles, or 1,444,480 acres. The eastern part is very mountainous, being a protraction of the Jura group. The western part is hilly, but interspersed with marshes. Some tracts of valuable land are found in the intervals. The chief products are rye, maize, wheat, some wine, a little salt, and oil. The dairy yields good butter and cheese. The department is divided into five arrondissements, 35 cantons, and 446 communes; and contains 22 cities, 403 market-towns and villages, 1467 hamlets, and 7000 insulated houses. The population in 1851 amounted to 372,939, all Catholics, except in the arrondissement of Gers, where the greater part are Reformed Protestants.

AINSWORTH, a township and chapelry in the parish of Middleton and hundred of Salford, in the county of Lancaster. Pop. in 1841, 1598, and in 1851, 1781.

Ainsworth, *Dr Henry*, an eminent nonconformist divine, who about the year 1590 distinguished himself among the Brownists, which involved him in so much trouble that he was obliged to retire to Holland, and became minister of a church at Amsterdam. His skill in the Hebrew language, and his excellent Annotations on the Holy Scriptures, which are still highly esteemed, gained him great reputation. He also wrote several pieces in defence of the Brownists, and some other works.

Ainsworth, *Robert*, born at Woodyale in Lancashire in 1660, was master of a boarding-school at Bethnal Green, from whence he removed to Hackney, and to other places in the neighbourhood of London. After acquiring a moderate fortune, he retired, and lived privately to the time of his death, which happened in 1743. We are indebted to his industry for a Latin and English Dictionary, which has been much used in schools. It was first published in 1736, and was, after the author's death, enlarged by various hands to 2 vols. 4to, in which form it has been several times reprinted.

AINTAB, a large garrison town on the northern frontier of Syria, in the pashalic of Aleppo. Lat. 36. 58. N. Long. 37. 13. E., 65 miles north of Aleppo, 50 miles E. of Scanderoon, and 30 miles west of Bir on the Euphrates. Pop. 25,000 to 30,000.

AIR, in *Physics*. See ATMOSPHERE, METEOROLOGY, and PNEUMATICS.

AIR, in *Painting*, &c., denotes the manner and verisimilitude of action; or it is that which expresses the disposition of the agent. It is sometimes also used in a synonymous sense with gesture or attitude.

AIR, in *Music*. See MUSIC.

*AIR-Gun*, a pneumatic machine for propelling bullets, &c., with great violence. See PNEUMATICS.

*AIR-Jacket*, a sort of jacket formerly made of leather, in which were several bags or bladders, composed of the same material, communicating with each other. These were filled with air through a leather tube having a brass stop-cock accurately ground at the extremity, by which means the air blown in through the tube was confined in the bladders. The jacket is now superseded by a tubular belt of cloth, made air-tight by a solution of caoutchouc in naphtha, buckled round the breast, by the help of which the person is supported in the water, without making the efforts used in swimming.

*AIR-Pipes*. See VENTILATORS.

*AIR-Pump*, a machine by which the air contained in a proper vessel may be exhausted or drawn out. See PNEUMATICS.

*AIR-Shafts*, among *Miners*, denote holes or shafts descending from the open air to meet the adits and furnish fresh air. The damps, deficiency, and impurity of air which occur when adits are wrought 30 or 40 fathoms long, make it necessary to sink air-shafts, in order to give the air liberty to play through the whole work, and thus discharge vitiated air, and furnish good air for respiration: the expense of which shafts, on account of their great depths, hardness of the rock, drawing of water, &c., sometimes equals, nay, exceeds, the ordinary charge of the whole adit.

*AIR-Threads*, or *Air Gossamer*, a name given to the long filaments so frequently seen in autumn floating about in the air.

These threads are the work of spiders, especially of that species called the *aranea obtextrix*, which, having mounted to the summit of a bush or tree, darts from its tail several of these threads, till one is produced capable of supporting the creature in the air. On this it mounts in quest of prey, and frequently rises to a very considerable height.

*AIR-Vessels* are spiral ducts in the leaves, &c. of plants, supposed to be analogous to the lungs of animals, in supplying the different parts of a plant with air.

AIRANI, in *Church History*, an obscure sect of Arians in the fourth century, who denied the consubstantiality of the Holy Ghost with the Father and the Son. They are otherwise called *Airanists;* and are said to have taken their name from one *Airos*, who distinguished himself at the head of this party in the reigns of Valentinian and Gratian.

AIRDRIE, a thriving town of Lanarkshire, eleven miles east of Glasgow, and thirty-one from Edinburgh. Pop. in 1851, 14,435. The extensive coal and iron mines in the vicinity afford employment to a considerable part of its population, and have been the means of raising it, since the commencement of the century, from the insignificance of a village to its present prosperity. The town contains one principal street, from which others diverge, and is well-built, paved, and lighted with gas. It has a handsome town-hall with a spire and clock, three Established, and three Free Churches, an Independent, a Baptist, a Roman Catholic, and other places of public worship; three branch banks, a mechanics' institute, an academy, and other schools; a cotton factory, gas-works, iron-founderies, distilleries, breweries, &c. A considerable number of its inhabitants are also engaged in the weaving of cotton goods for the Glasgow manufacturers. By the Reform Act it was created a parliamentary borough; and it unites with Lanark, Hamilton, Linlithgow, and Falkirk, in sending a member to Parliament. The municipal government, under a charter dated 1833, is vested in a provost, three bailies, and twelve councillors. Airdrie is connected with Glasgow by railway, and also by the Monkland canal.



AIRE, a city of France, head of a canton of the same name, in the circle of St Omer, and department of Pas de Calais. It is situated on the river Lys. The population amounts to 5088 persons, who are chiefly employed in making cotton and woollen goods, hardware, and large quantities of oil from seeds. Long. 2. 24. E. Lat. 50. 38. N.

AIRE, a town of France, in the department of Landes, and circle of St Sever, on the river Adour. It was at one time the capital of the Visigoths, and has been since the fifth century the seat of a bishopric.

AIRE, a river of England in Yorkshire, one of the affluents of the Humber, from which it is navigable for a sloop of 100 tons as far up as Leeds, a distance of forty miles.

AIRY, or AERY, among *Sportsmen*, the nest of a hawk or eagle.

*AIRY Triplicity*, among *Astrologers*, denotes the three signs, Gemini, Libra, and Aquarius.

AISLE, in *Architecture*, is the term applied to the *wing* of a building; but it is chiefly used to designate the lateral divisions of a Gothic building divided by two longitudinal rows of piers. The space between these piers is sometimes inaccurately termed the *middle aisle;* but properly it is the *body* or middle of the nave, choir, or transept.

AISNE, a department in the north-east division of France, on a river of the same name, formed out of divisions of the ancient provinces of Picardy and Isle of France. It is bounded on the N. by the department of the Nord and the kingdom of the Netherlands, on the E. by the departments of the Ardennes and Marne, on the S. by the Marne and Seine-Marne, and on the W. by the Oise and Somme. The extent is 2812 square miles, or 1,799,680 acres. The whole department is a plain, with few hills of much elevation. The soil is generally calcareous, except in the northern part, where it becomes clayey, and in some spots slaty. It is of various degrees of fertility, but for the most part adapted to the growth of corn. Wine, cider, and flax, are the other agricultural products. The manufactures are cotton, linen, and hosiery. The department is divided into five arrondissements, 37 cantons, and 840 communes. Its population in 1851 was 558,989. The chief city of the department is Laon. St Gaubain is celebrated for its mirrors, which are the largest in the world; and Folembray is said to manufacture annually 8,000,000 of wine bottles. Both these towns are in the arrondissement of Laon.

AITOCZU, a considerable river of Lesser Asia, which rises in Mount Taurus, and falls into the south part of the Euxine Sea.

AITON, WILLIAM, an eminent botanist and gardener, was born at a village near Hamilton in Scotland in 1731. Having been regularly trained to the profession of a gardener, he travelled to England in the year 1754, and soon obtained the notice of the celebrated Philip Miller, then superintendent of the physic garden at Chelsea, who engaged him as an assistant. His industry and abilities recommended him to the princess-dowager of Wales as a fit person to manage the botanical garden at Kew. In 1759 he was appointed to this office, in which he continued during life, and which was the source of his fame and fortune. The garden at Kew, under the auspices of his Majesty George III., was destined to be the grand repository of all the vegetable riches which could be accumulated by regal munificence, from researches through every quarter of the globe. These treasures were fortunately committed to the hands of Mr Aiton, whose care and skill in their cultivation, and intelligence in their arrangement, acquired him high reputation among the lovers of the science, and the particular esteem of his royal patrons. Under his superintendence many improvements took place in the plan and edifices of Kew gardens, which rendered them the principal scene of botanical culture in the kingdom. In 1783 his merit was properly rewarded with the lucrative office of managing the pleasure and kitchen gardens of Kew, which he was allowed to retain with the botanical department. In 1789 he published his *Hortus Kewensis*, or a Catalogue of the Plants cultivated in the Royal Botanical Garden at Kew, in 3 vols. 8vo, with 13 plates; a work which had been the labour of many years. The number of species contained in this work amounted to between five and six thousand, many of which had not before been described. A new and curious article in it relates to the first introduction of particular exotics into the English gardens. The system of arrangement adopted is the Linnæan, with improvements, which the advanced state of botanical science required. Mr Aiton, with candour and modesty, acknowledges the assistance he received in this work from the two Swedish naturalists, Dr Solander and Mr Jonas Dryander. Indeed, his character was such as secured him the friendship and good offices of the most distinguished names in science of his time. He was for many years honoured with the friendship of Sir Joseph Banks, the president of the Royal Society. The *Hortus Kewensis* was received with avidity by the botanic world, and a large impression was soon disposed of. The best edition is in 5 vols.

Notwithstanding his great activity and temperance, Mr Aiton fell into that incurable malady, a scirrhous liver, of which he died in 1793, in his 62d year. His eldest son, devoted to the same pursuits, was, by the king's own nomination, appointed to all his father's employments. Mr Aiton's private character was highly estimable for mildness, benevolence, piety, and every domestic and social virtue. He was interred in the churchyard of Kew.

AIUS Locutius, the name of a deity to whom the Romans erected an altar. The following circumstance gave occasion to this. One M. Ceditius, a plebeian, acquainted the tribunes that, in walking the streets by night, he had heard a voice over the temple of Vesta announcing to the Romans that the Gauls were coming against them. The intimation was, however, neglected; but after the truth was confirmed by the event, Camillus acknowledged this voice to be a new deity, and erected an altar to it under the name of *Aius Locutius*.

AIX, an ancient city of France, the chief place of the arrondissement of the same name, in the department of the Mouths of the Rhone. It was, before the revolution of 1789, richly endowed with ecclesiastical establishments, which have since then been secularized. It stands on a plain surrounded by hills, which produce abundance of most excellent olives, which, with wine and fruits, form the most important branches of agricultural industry. There are manufactories of various rich silk goods, linen, and hardware. The ancient springs, known to the Romans, but disused till again discovered in 1704, are slightly warm, but their efficacy is not now highly valued. In 1846 the inhabitants amounted to 24,165. This city is celebrated for having given birth to two famous naturalists, Adanson and Tournefort, and to the painter Vanloo.

The arrondissement of the same name comprehends 846 square miles, or about 541,740 acres, divided into ten cantons and 59 communes, with, in 1846, 112,254 inhabitants.

Aix, a small island on the coast of France, between the isle of Oleron and the Continent. It is twelve miles north-west of Rochefort, and eleven south-south-west of Rochelle. Long. 1. 4. W. Lat. 46. 5. N.

Aix, a river of France, in the department of the Lower Loire, which joins the Ysable, and falls into the Loire.

AIX-LA-CHAPELLE, or in German Aachen, a district in the Prussian province of the Lower Rhine, with an area of 1600 square miles. It comprehends 10 circles, 15 cities, 12 market-towns, 789 villages, 65,401 dwelling-houses, and in 1849 contained 411,525 inhabitants, of whom 395,416 were Roman Catholics, 2685 Jews, and the remainder Protestants. The circle of the same name extends over 124 square miles, and has a population of 63,458.

Aix-la-Chapelle, the chief town of the district and circle of the same name, lies between the Rhine and the Meuse, in a pleasant valley surrounded by beautiful hills, about eighteen miles east of Mæstricht, and thirty-eight west of Cologne, with which last it is connected by railway. By the census of 1849 it had 3125 houses, 8869 families, and a population of 50,533, of whom 47,489 were Catholics, 2734 Protestants, and 310 Jews. It has a public library, a gymnasium, a school for artisans, a commercial school, a collection of models, and a picture gallery; and is the seat of a bishop, of a district court, a court of justice, and a commercial court. It is celebrated for its woollen manufactures, which give employment to many thousands, as also for its needle and pin works. It has also several tanworks, and a considerable trade, particularly in cloth and wool. Among the public buildings the most remarkable are the town-house, erected in 1353, on the site of Charlemagne's palace, in which the peace of 1748 was ratified, and in front of which, in the market-place, is a beautiful fountain; the cathedral, founded by Charlemagne, containing the marble seat on which the kings sat at their coronation, and many popish relics, which are only exhibited once in seven years, when great numbers of votaries resort to the city; and there is also an elegant theatre. Aix-la-Chapelle was for a long time the capital of the German empire, and the usual place of coronation. In 1668 and 1748 treaties of peace were concluded here; and from this town the celebrated congress of 1818 derives its name. This was the favourite residence of Charlemagne, and in the cathedral is his tomb. In the latter part of the last century it was opened, and his body, clothed in the imperial robes, was found seated on a throne of state. The whole crumbled into dust on being touched; but the diamond clasp that fastened his mantle is still preserved at Vienna.

Its thermal sulphureous baths are celebrated over Europe for the cure of rheumatic and arthritic pains. These waters have the high temperature of 136° Fahr., and contain 5·5 cubic inches of sulphuretted hydrogen per English pint. Aix-la-Chapelle is the Aquæ Sextiæ of the Romans.

AJACCIO, or Adjazzo, an arrondissement in the island and department of Corsica, in the Mediterranean, containing 12 cantons and 72 communes, with 53,463 inhabitants. Its extent is 736 square miles, or 471,000 English acres. The capital, which bears the same name, and is the best built town in the island, is situated in a fertile territory, which produces excellent wines. It has a small citadel and an excellent harbour, and contains 10,460 inhabitants. It is celebrated as the birthplace of Napoleon Bonaparte, to whose memory a column has been here erected.

AJALON, in *Ancient Geography*, a Levitical city of the tribe of Dan, in the valley of which Joshua commanded the moon to stand still. The site of Ajalon is occupied by the modern village of Yâlo.

AJAN, a maritime country of Africa on its eastern coast, extending from Cape Guardafui to Zanguebar, between Lat. 4° to 11° N. It abounds with all the necessaries of life, and produces a very good breed of horses. The whole sea-coast, from Zanguebar to the strait of Babelmandeb, is called the coast of Ajan; and a considerable part of it is styled the Desert coast.

AJAX, the son of Telamon, king of Salamis, was, next to Achilles, the most valiant of the Grecian generals at the siege of Troy. He performed many great actions, and proved himself no mean match for Hector in single combat. When the arms of Achilles were adjudged by Agamemnon to Ulysses, Ajax was so transported with rage and jealousy that he lost his senses. In his madness he fell upon the sheep in the Grecian camp, among which he committed great slaughter. On coming to his senses he was so overcome with shame that he killed himself with the sword which had been given to him by Hector. The Greeks paid great honour to him after his death, and erected a magnificent monument to his memory upon the promontory of Rhetium.—Iliad, Dictys. Cret., Ovid. Met., B. xiii.

AJAX, surnamed *Oïleus*, and the *Lesser* (to distinguish him from the former), the son of Oïleus, king of the Locrians, was one of the principal heroes at the siege of Troy. He is said, after the taking of Troy, to have ravished Cassandra the daughter of Priam, in the temple of Minerva, whither she had fled for refuge. On his return home he was shipwrecked and perished on the coast of Eubœa. Philostratus records of him that he had a tame serpent 5 cubits in length, which ate at his table, and followed him like a dog. The Locrians held the memory of Ajax in great veneration and honoured him in some degree as a tutelar deity.

AJAX, in *Grecian Antiquity*, a furious kind of dance, intended to represent the madness of the hero of that name after his defeat by Ulysses, to whom the Greeks had given the preference in his contest for Achilles's arms. Lucian, in his treatise of Dancing, speaks of dancing the *Ajax*.—There was also an annual feast called *Ajantia*, Αιαντεια, consecrated to that prince, and observed with great solemnity in the island of Salamis, as well as in Attica; where, in memory of the valour of Ajax, a bier was exposed, set out with a complete set of armour.

AJMERE, the ancient appellation of the whole of Rajpootana, but more recently restricted to the limits of a British district in the centre of that province. It is bounded on the N.W. by the Rajpoot state of Joudpore; on the east by the Rajpoot states of Kishenghur and Jeypore; on the south by that of Odeypore; and on the S.W. by the British district of Mhairwarra. It extends from Lat. 25. 43. to Lat. 26. 42, and from Long. 74. 22. to Long. 75. 33, and has an area of 2029 square miles. In the north and north-west portions of the district, the mountains attain considerable elevation. Taraghur, immediately overlooking the town of Ajmere, rises a thousand feet from the plain below, and three thousand above the level of the sea. Its principal summit sustains the celebrated fort of Ajmere. The Mudar range, east of the city, is little inferior in elevation. In their geological character, the rocks composing these ridges bear a near resemblance to each other, all being of primitive formation, and generally schistose.

Copper mines have been worked on Taraghur, and lead, manganese, and iron, are discovered in abundance. The soil is, for the most part, light and sandy, and in many localities impregnated with mineral salts. The only stream which has any pretension to be styled a river is the Kharee Nuddee. This river skirts the district to the south, separating it from the native state of Odeypore, and subsequently intersects the territory of Ajmere in a north-easterly direction to its confluence with the Banas; but its waters are unpalatable, except during the rains, in consequence of the quantity of carbonate of soda which they hold in solution. The other streams of Ajmere, including even the Looni, which derives its source from the Ana Sagur Lake, may be characterised rather as rain torrents, their channels being completely devoid of water during the dry season. Nor is the dearth of running water compensated by any abundant supply from springs; no natural lakes exist in the province; and as the wet season is of brief duration, there are no means by which an adequate supply of water can be secured to the inhabitants, but by the aid of tanks, which are filled by the mountain torrents during the rains. These abound in every village. Some of these reservoirs are of considerable magnitude, and one, indeed, the Ana Sagur, is deserving of special notice from its enormous dimensions. This artificial lake is in the immediate vicinity of the town, and owes its construction to Ana Rao, who ruled in Ajmere prior to the invasion of Mahmood of Ghuzni at the commencement of the eleventh century. The excavation is, however, rather the work of nature than of art, and required nothing for its completion as a reservoir but the erection of a dam across a valley bounded on all other sides by steep ridges. The waters of several rain torrents are thus collected into this vast basin; the extent of which, after the rains, exceeds six miles in circumference. It furnishes the means of irrigation to a large district on its banks, is full of fish, and affords excellent water to the inhabitants of the town.



The climate of Ajmere, though characterised by great aridity, is considered salubrious. During the season of the hot winds which prevail from March to June, the temperature is high and the heat oppressive. In the month of May in the year 1838, the thermometer marked during the night 110 degrees. The temperature might be diminished by encouraging the growth of trees. The hills are now bare of timber. Formerly extensive tracts were covered by forests and brushwood, but these were destroyed during Mahratta rule. Refreshing breezes set in with the rains, which continue from June till the end of September; but the showers are lighter and far less continuous than in tracts further to the south and east. After the rains, the climate becomes agreeable and invigorating, and in the clear nights of December, January, and February, the thermometer sinks below the freezing point, and ice is abundantly formed.

Ajmere is scarcely mentioned in history prior to the establishment of the dynasty of Ghuzni in Cabul. It appears, however, to have enjoyed an early independence, as the eighth prince in succession from its founder is represented as having reigned in the year 695. The earliest incursion of the Mahometans into India took place in 664; it was followed from time to time by successive irruptions; until in 997 the Hindu Rajah of Lahore became in his turn the assailant, and led an army through Peshawur into Cabul. He was met by Sebektegin, the father of Mahmood of Ghuzni; but before any encounter had taken place, the Hindu became disheartened, acceded to humiliating conditions, and withdrew. In the following year, Sebektegin advanced to Lahore to enforce the fulfilment of the treaty; and among the princes who united their forces to resist the Mussulman, was the Rajah of Ajmere. The confederated forces were totally routed. Three years later, in Mahmood's first expedition to India, the sultan encountered the old Rajah of Lahore, whom he defeated and took prisoner. After this, Mahmood allowed little repose to himself, or respite to his neighbours. In the tenth year of his reign, he undertook his fourth expedition against India. The princes of Hindustan, instigated by Anang Pal, the Rajah of Lahore, combined their forces, and advanced to the Punjaub, to resist the progress of the Mahometan arms. The Rajah of Ajmere had again joined the confederacy, but their renewed efforts were ineffectual, and Mahmood was again victorious. The part taken by the Rajah of Ajmere was not, however, forgotten by Mahmood; and in his last irruption into Hindustan, which was directed against the temple of Somnath, he marched his troops through the province of Ajmere, ravaged the country, and plundered the city. The Rajah took refuge in his fortress, and Mahmood pursued his course to Somnath. Thenceforward the power and resources of the Rajahs of Ajmere rapidly increased, and half a century later, their possessions constituted one of the four kingdoms into which Hindustan was then distributed. The three remaining kingdoms were those of Delhi, Canouj, and Guzerat; but the king of Delhi dying without male issue, his dominions lapsed to Pritwi Rao, the chief of Ajmere, who thus held sway over the half of India. Pritwi Rao, however, had no sooner gained this accession of power, than a new competitor presented himself for the imperial sceptre. This was Shahabudin, afterwards Mohammed Ghoory. In 1191 he had conquered the Punjaub, and threatened an advance upon Delhi. Pritwi Rao was not unprepared for the struggle. The two armies met at Tirouri, near Thanesur in Northern India, where a decisive battle was fought, in which the Hindu potentate prevailed, and the rout of Mohammed was complete. Pritwi Rao derived from this victory but a brief interval of repose. Mohammed reunited his army, and two years after reappeared at Thanesur, to try once again the chances of battle. Upon this occasion, fortune favoured Mohammed, and Pritwi Rao, being taken prisoner, was put to death. The conquest of Ajmere followed. Mohammed left his new possessions in charge of his general Kootb-ood-deen, who, upon the dissolution of the Ghorian empire, raised himself to the throne of Delhi, and established the line of SLAVE KINGS of India; so called from their founder having risen from the condition of a Turkistan slave to sovereignty. From this time Ajmere appears to have remained for a considerable period in various degrees of dependence upon the Mahometans. It was wrested in 1527 by Baber from Rajah Sanga, who had aspired to independence. Acbar, in recovering the dominions of which his father had been stripped by Shir Shah, obtained Ajmere without a battle, and under this emperor it became the principal place of an extensive province. On the decline of the Mogul empire, Ajmere fell into the hands of the Mahrattas, who retained it from the middle of the last century until the year 1818, when it was formally ceded to the British government by Scindia. The district of Ajmere has been distributed into ten subdivisions, and has a population of 224,891 inhabitants. The principal places are Ajmere, Kekree, Poshkur, Pesangun, Shapoora, Sawur, and the military cantonment of Nusseerabad.

AJMERE, a city of Hindustan, in the district of the same name, situate on the slope of a hill, and surrounded by a wall of stone. It was nearly ruined in the long period of anarchy and misgovernment which prevailed in Central India prior to 1818; but since its acquisition by the British, it has greatly improved. Bishop Heber, who visited it in 1825, describes it as a well-built town of moderate size. Its principal streets are broad and convenient, and among the mansions more recently erected, some are stated to have been constructed upon so grand a scale as to form imposing objects even from the outside of the city walls. Above, on the mountain top, is a very remarkable fortress called Taraghur, nearly two miles in circuit, but of irregular shape and surface. It consists of a plain stone wall along the edge of a mountain, strengthened with a few round bastions; and it has an abundant supply of good water in all seasons from cisterns cut in the rock. The fortress was dismantled in 1830, and the works are going to decay. The most beautiful of the buildings of Ajmere is an antique Jain temple on the lower part of the mountain Taraghur. Though much injured by time, or by the hands of the Mussulmans, the relics are not excelled in beauty of architecture and sculpture by any remains of Hindu art. The columns supporting the roof are forty in number; but no two are alike, and great fertility of invention, as well as much taste, is manifested in the execution of the ornaments. The portion of this building which has survived the attacks of time or hostile feeling, has been converted into a mosque. Ajmere is renowned as a place of pilgrimage, the great attraction being the tomb of Khoja-Moyen-ud-Deen, famed as a great Mahometan saint, whose miracles are celebrated all over India. The tomb is of white marble, but remarkable neither for style nor beauty of architecture. To this place the emperor Acbar made a pilgrimage on foot from Agra, a distance of upwards of 200 miles, to implore at the sainted tomb the blessing of male offspring. Outside the city wall is the ruinous palace of Shah Jehan, and another of Acbar, now converted into an arsenal. In 1849 a school having an English department was opened, but the results have not yet been reported. The town is well supplied with water from the Ana Sagur Lake; its population in 1837 was estimated at 23,000 inhabitants, and is believed to be progressively improving. Ajmere is distant from Delhi 258 miles; from Calcutta 1039. Lat. 26. 29. Long. 74. 43. (E. T.)



AJOFRIN, a town of Spain, nine miles south of Toledo, with a pop. of 2883, principally employed in the making of coarse cloth, blankets, serge, and matting.

AKABAH. This gulf, the *Sinus Elanites* of antiquity, is the eastern estuary at the upper extremity of the Red Sea, extending N.N.E. from Lat. 28. to 29. 32. N., a distance of about 100 miles, and varying from about 12 to 17 miles in breadth. The navigation is rendered dangerous by the number of coral reefs, and the heavy squalls that sweep from the adjacent mountains, many of which rise perpendicularly to the height of 2000 feet. Tiran, and several other small islands, lie at its mouth. Its only well-sheltered harbour at the present day, according to Lieut. Wellsted, is that of Meenap-el-Dsahâle, or the Golden Port (so called from the colour of its sand) on the western shore, nearly opposite to Mount Sinai. The castle of Akabâh, which stands about $2\frac{1}{2}$ miles from the head of the gulf, on the east side, 150 yards from the beach, is a massive bastioned quadrangle, erected by the Sultan el-Ghûry of Egypt in the sixteenth century, and is situated, as its Arabic name imports, on a steep declivity, in Lat. 29. 30. 58. N. Long. 35. 0. 54. E. It is surrounded with groves of the date-palm, and immediately behind it rises the lofty Jebel el-Ashhab. A few soldiers garrison the castle, which serves as a depôt to supply provisions to the troops and the Hajj Caravan in its progress from Cairo to Mecca. Within its walls are several Arab dwellings, and deep wells of good water. Fresh water is also obtained on the shore by digging a little way into the sand. The adjacent plain is rich in pasturage, though near the sea it is strongly impregnated with salt. The fierce predatory character of the neighbouring Bedouins is a serious impediment to travellers.

Though now a place of little importance, Akabâh is not devoid of historical interest: it is supposed to occupy the site of the Elath of Scripture, from which an extensive commerce was carried on in remote ages with Rhinocolura, now *El Arish*, on the Mediterranean, 116 miles distant. It was the Aila or Elana of the Romans; and during the Crusades it was taken by the Christians, and again wrested from them by Saladin, through means of ships transported on camels from Cairo. Midway between Akabâh and Kaszer el-Bedawy (a dilapidated castle standing southward one hour's journey on the east side of the gulf) there are ruins in the sea, consisting of houses, walls, and columns, visible only at low water, and rendered difficult of access by the shallows. They are supposed to be the remains of the Scripture Eziongeber "which is beside Eloth," where king Solomon made a navy of ships, which brought gold from Ophir (1 Kings ix. 26, 28; 2 Chron. viii. 17), and was probably the port to which his fleet returned from Tarshish once every three years, bringing "gold and silver, ivory, and apes, and peacocks." (2 Chron. ix. 21.) The mention of peacocks would seem to indicate that Tarshish was some part of the coast of India, as this bird is indigenous to that country: and it may likewise be inferred, from several other passages, that the Israelites were not a maritime people, as Solomon's ships, we are told, were manned by Hiram with Tyrian sailors. The "Akrabbim" (*i. e. steep of scorpions*), mentioned in Numbers xxxiv. 4, is supposed by Burckhardt to be the acclivity of the mountain-chain westward from the plain of Akabáh.—Burckhardt's *Travels in Syria:* Robinson's *Biblical Researches in Palestine:* Wellsted's *Travels in Arabia.*

AKEN, a Prussian town in the government of Magdeburg on the Elbe. Its chief manufactures are cloth, leather, and tobacco. Pop. in 1849, 4685.

AKENSIDE, Mark, was of respectable though humble parentage, his father being a butcher in Newcastle-upon-Tyne, where the poet was born on the 9th November 1721. His parents intended him for the Dissenting Church, and from an educational fund connected with his denomination, he received aid to prosecute the necessary studies at the university of Edinburgh. Subsequent reflection directed his aims to the study of medicine, and he afterwards honourably repaid to his denomination the sum which he had not devoted to the purpose for which it was bestowed. In 1741 he went to Leyden, to complete his medical curriculum. There he acquired the friendship of his afterwards munificent patron, Jeremiah Dyson, Esq. He received his degree of Doctor of Physic, and returning to England in 1744, published his *Pleasures of Imagination*, which was received with unbounded applause. He settled as a physician at Northampton, but found the field already pre-occupied. "Akenside tried the contest a while," says Johnson, "but, having deafened the place with clamours of liberty, he removed to Hampstead, and subsequently fixed himself in London, the proper place for a man of accomplishments like his." As medicine did not seem likely to earn for him the maintenance of a gentleman, his generous friend Mr Dyson, with whom he resided, settled on him an annuity of L.300 a-year. He used every means, however, of advancing his reputation in his profession, by the publication of medical treatises, by obtaining a degree from Cambridge, by becoming a member of the Royal Society, and of the College of Physicians; and by the acceptance of public lectureships. "He advanced gradually in medical reputation, but never attained to any great extent of practice, or eminence of popularity." Sir John Hawkins alleges that he defeated his own efforts by "the high opinion he everywhere manifested of himself, and the little condescension he showed to men of inferior endowments." He was certainly a man of solid ability and extensive scholarship, but the warmth of his temperament intensified his vanity and arrogance to a ludicrous extent, and often placed him in mortifying circumstances. The humbleness of his birth was a thorn in his flesh, which his opponents loved to irritate. His manners were formal and strainedly dignified. He was a brilliant and pleasing companion, but exacting and pedantic in conversation. In Smollett's *Peregrine Pickle* Akenside is the ode-writing doctor who gives the feast after the manner of the ancients. His features were manly and expressive; his temper, though irritable, was kind and benevolent. He continued to write and wrangle amidst the literary society of London till the year 1770, when he died of a putrid fever, while he was engaged in re-casting his great poem; bequeathing to his patron Dyson the office of his literary executor. He is buried in the parish church of St James's, Westminster.



The *Pleasures of Imagination* is certainly a remarkable effort of a young man between twenty and twenty-three years of age; though it cannot compare in profoundness of reflection with Pope's *Essay on Man*, nor in simple warmth of natural feeling with Campbell's *Pleasures of Hope*, both composed at the same period of life. Its design, as he himself explains, is "to give a view of these (pleasures), in the largest acceptation of the term; so that whatever our imagination feels from the agreeable appearances of nature, and all the various entertainment we meet with, either in poetry, painting, music, or any of the elegant arts, might be deducible from one or other of those principles in the constitution of the human mind, which are here established and explained." The poem has the fault of youth, in diffuseness and obscurity of expression in a train of subtle thinking; but its effect is brilliant and spirit-stirring; it is full of aspirations after the lofty, the liberal, and the good, and is coloured with the Attic graces resulting from a warm sympathy with the Grecian spirit. Of its philosophy the poet Gray speaks contemptuously as "infected with the Hutcheson jargon." Dr Thomas Brown has largely used its pictorial portions as illustrations in his ethical lectures. Of its poetry Johnson remarks that "his images are forms fantastically lost under a superfluity of dress.

"Pars minima est ipsa puella sui.

The words are multiplied till the sense is hardly perceived; attention deserts the mind and settles in the ear. The reader wanders through the gay diffusion, sometimes amazed, sometimes delighted, but after many turnings in the flowery labyrinth, comes out as he went in. He observed little, and laid hold of nothing." The following is Professor Spalding's estimate: "A vivid fancy, a warm susceptibility of fine emotion, and an alluring pomp of language, are lavished on a series of pictures, illustrating the feelings of beauty and sublimity. The mischief is, that the poet, theorizing and poetizing by turns, loses his hold of his readers more than other writers whose topics are less abstract. The philosophical thinker finds better teaching elsewhere; and the poetical student, unless he is also metaphysically inclined, has his enthusiasm chilled by the intrusive dissertations."—*History of English Literature.*

Akenside's profusion of odes, hymns, epistles, and inscriptions, follow the artificial fashion of the eighteenth century. Most of these possess no great merit, but Johnson's condemnation of them appears too severe. This may possibly be in part owing to the spirit of freedom many of them breathe. For in his "hot youth," Akenside was a theoretical republican, and he continued throughout life a Whig, so far as the term implies what we understand by liberal principles. "Whether, when he resolved not to be a Dissenting minister," says Johnson, in speaking of Akenside's politics, "he ceased to be a Dissenter, I know not. He certainly retained an unnecessary and outrageous zeal for what he called and thought liberty; a zeal which sometimes disguises from the world, and not rarely from the mind which it possesses, an envious desire of plundering wealth, or of degrading greatness." The *Epistle to Curio*, which he afterwards spoiled by converting it into the *Ode to Curio*, is a bitter stricture on Pulteney's desertion of his principles after the fall of Walpole. The *Hymn to the Naiads*, and the *Hymn to Science*, are perhaps the finest of Akenside's minor works.

The *Pleasures of Imagination*, his capital work, was first published in 1744. Extraordinary though it was, as the production of a man who had not reached his 23d year, he was afterwards sensible that it wanted revision and correction;

and he went on revising and correcting it for several years; but finding this task to grow upon his hands, and despairing of ever executing it to his own satisfaction, he abandoned the purpose of correcting, and resolved to write the poem over anew upon a somewhat different and enlarged plan. He finished two books of his new poem, a few copies of which were printed for the use of the author and certain friends; of the first book in 1757, of the second in 1765. He finished also a good part of a third book, and an introduction to a fourth; but his most munificent and excellent friend, conceiving all that was executed of the new work too inconsiderable to supply the place and supersede the republication of the original poem, and yet too valuable to be withheld from the public, caused them both to be inserted in the collection of his poems. (D. S.)

AKERBLAD, Jan David, a learned Swede, who greatly distinguished himself by his profound researches in Runic, Coptic, Phœnician, and ancient Egyptian literature. His researches on the hieroglyphics of the latter are held in much estimation. After having travelled much in the east, he retired to Rome, where he had a pension from the late Duchess of Devonshire, and died there, in the prime of life, in 1819.

AKERMAN, a circle in the Russian province of Bessarabia, extending along the banks of the Black Sea, where the Dneister forms an estuary. It is nearly destitute of population, except the capital, of the same name, which is built on a tongue of land projecting into the estuary. It is the ancient Roman colony of Alba Julia. It is surrounded with strong walls and ditches, contains a castle, two public baths, five churches, several mosques, and a synagogue for Jews. The population, of various nations, religions, and languages, amounts to about 25,000. Its situation renders it a place of considerable trade. It is in Long. 30. 24. 15. E. and Lat. 46. 11. 45. N. Here the treaty with Turkey was concluded in 1826.

AKHALIES, a class of religious warriors among the Sikhs, and the most dissolute and most turbulent members of the Sikh community. They are both fanatics and fatalists, and admit proselytes from the lowest dregs of society. They acknowledge no God, but make fate the cause of all things.

AKHALZIKE, a fortress on the south-west frontier of Russian Georgia, formerly the capital of a Turkish pashalic. Lat. 41. 35. N. Long. 42. 45. E. The adjoining town is supposed to have a population of 15,000. The neighbourhood produces silk, honey, and wax, with excellent raisins, peaches, apricots, figs, and other fruits.

AKHALZIKH, or Akiska, a city of Georgia, in Asiatic Russia, on an affluent of the Kur, 110 miles west of Tiflis. Lat. 41. 40. N. Long. 43. 1. E. It was formerly the capital of a pashalic, and carried on an active trade in white slaves, now entirely suppressed. It has a strong castle, a college, and library, a fine mosque, and a considerable trade in silk, honey, and wax. Pop. about 12,000.

AKHBAR, or Ukhbar, called also Acbar or Acber, or Akbar or Akber, the greatest and the best of the Mogul emperors of Hindustan, was the son of Humayun, the son of Baber, the founder of the empire. He was born at the foot of Anercote, in the desert of Sinde, on 14th October 1542; ascended the throne 15th February 1556, and died at Agra, 13th October 1605, after a chequered, but generally prosperous, reign of nearly fifty years. He established his dominion over all Hindustan, or Northern India, and was, in fact, the real founder of the empire; his two predecessors having commenced the conquest of India without complete success, and Humayun having lost nearly all that his father had gained. Although almost continually occupied with enemies abroad, and rebellions and revolutions at home, he found time to cultivate the arts of peace, and gave the most anxious and most enlightened attention to every-



thing that seemed calculated to promote the welfare of his people. He encouraged trade and commerce, reduced taxation, and kept a strict watch over the conduct of his officers. But what most of all distinguished him from other Mahometan rulers was his spirit of toleration. Professing no dogmatic faith himself, he not only did not persecute the adherents of any creed, but showed the same benevolent attention to the interests of all his subjects, whether Moslem or Hindu. The mildness of his character, his strict impartiality, magnanimity, and personal courage, are mentioned with praise even by the Jesuits, who visited India during his reign; and the memory of his good qualities and deeds still lives among the people of Hindustan. His body was deposited in a splendid mausoleum, which remains entire at Secundra, a ruinous village six miles north of Agra; and is considered to be one of the finest architectural monuments of India, inferior only to the Taj-Mehal at Agra. It is built of red stone, and consists of several tiers of arcades and galleries, on the top of which is a small platform, surrounded by a marble screen richly carved, and affording an extremely fine view of the surrounding country. In the centre of the platform is Akbar's monument, of white marble, with these words:—"*The god Akbar, may his glory be magnified*;" an inscription that is thought to countenance the charge made against him, that he had aspired to divine honours. The body reposes in a plain sarcophagus, under a lofty dome, on the ground floor. See Abulfazl.

AKHISSAR, the ancient Thyatira, a city of Natolia, in Asia, situate in a plain 18 miles broad, which produces plenty of cotton and grain. The inhabitants, who are reckoned to be about 8000, are Greeks, Armenians, and Turks. The houses are built of earth or turf dried in the sun, and are very low and ill constructed; but there are six or seven mosques which are all of marble. There are remarkable inscriptions on marble in several parts of the town, which are part of the ruins of the ancient Thyatira. It is on a branch of the river Hermus, 50 miles from Pergamos. Long. 28. 30. E. Lat. 38. 50. N.

AKHMETSCHET. See Simferopol.

AKHTIAR. See Sevastopol.

AKIBA, a famous rabbi, flourished a little after the destruction of Jerusalem by Titus. He kept the flocks of a rich citizen of Jerusalem till the fortieth year of his age, and then devoted himself to study in the academies for twenty-four years; and was afterwards one of the greatest masters in Israel. According to the Jewish accounts, he had 24,000 scholars. He declared for the impostor Barcochebas, whom he owned as the Messiah; and not only anointed him king, but took upon himself the office of his master of the horse. The troops which the emperor Hadrian sent against the Jews, who, under the conduct of this false Messiah, had committed horrid massacres, exterminated this faction. Akiba was taken, and put to death with great cruelty. He lived 120 years, and was buried with his wife in a cave upon a mountain not far from Tiberias. According to tradition, his 24,000 scholars were buried around bim. It is said that he invented a supposititious work under the name of the patriarch Abraham.

AKOND, an officer of justice in Persia, who takes cognisance of the causes of orphans and widows, of contracts, and other civil concerns. He is the head of the school of law, and gives lectures to all the subaltern officers. He has his deputies in all the courts of the kingdom, who, with the second *sadra*, make all contracts.

AKYAB, a town and seaport of Arracan, in the East Indies, situate on the eastern side of the island of the same name, and at the mouth of the river Kuladyne. Previous to its occupation by the British, in 1826, Akyab was a petty village, consisting of a few fishermen's huts; but since that period it has gradually increased in importance, and has now become the most flourishing place of the province. The town is regularly built, with broad streets running at right angles to each other; the houses are spacious and substantial, and the shops are said to be well supplied with native goods and British manufactures. Rice is the principal article of export; and so abundant is the supply, that Akyab is called the granary of Arracan. The harbour, though inferior to that of Khyouk Phyoo, has the advantage of being surrounded by a fertile tract of vast extent, and of communicating with the rivers which form the outlets for the export of the surplus produce of the province. The soil of the island is of a sandy description, which soon becomes dry after rain, and the atmosphere is consequently devoid of that humidity to which the interior of the province is subject; and the heat which there is found so oppressive is here tempered by refreshing sea-breezes. The population of the town in 1841 amounted to 5000. Akyab was ceded to the British by the Burmese, under the provisions of the treaty concluded at Yandaboo on the 24th February 1826. Lat. 20. 9. Long. 92. 56. (E. T.)

AL, an Arabic particle prefixed to words, and signifying much the same with the English particle *the*. Thus they say, alkermes, alkoran, &c., *i. e.* the kermes, the koran, &c.

AL, or ALD, a Saxon term, frequently prefixed to the names of places, denoting their antiquity; as, Aldborough, Aldgate, &c.

ALA, a Latin term, properly signifying a wing; from a resemblance to which several other things are called by the same name. Thus,

ALA is a term used by botanists for the hollow of a stalk, which either the leaf or the pedicle of the leaf makes with it; or it is that hollow turning, or sinus, placed between the stalk or branch of a plant and the leaf, whence a new offspring usually issues. Sometimes it is used for those parts of leaves otherwise called *lobes* or *wings*.

ALÆ, the plural number, is used to signify those petals or leaves of papilionaceous flowers placed between those others which are called the *vexillum* and *carina*, and which make the top and bottom of the flowers. Instances of flowers of this structure are seen in those of pease and beans, in which the top leaf or petal is the vexillum, the bottom the carina, and the side ones the alæ.

ALÆ is also used for those extremely slender and membranaceous parts of some seeds which appear as wings placed on them. It likewise signifies those membranaceous expansions running along the stems of some plants, which are therefore called *alated stalks*.

ALÆ, in *Anatomy*, a term applied to the lobes of the liver, the cartilages of the nostrils, &c.

ALÆ, in the *Roman Art of War*, were the two wings or extreme parts of the army drawn up in order of battle.

ALABAMA, one of the United States of North America, lying between Lat. 30. and 35. N. and Long. 85. and 88. W. It is bounded by Florida and the Gulf of Mexico on the south, the state of Mississippi on the west, Tennessee on the north, and Georgia on the east. Its length is 330 miles, breadth 174, and area 50,722 square miles. The country, to the extent of more than 50 miles from the coast, consists of uneven lands, of a poor sandy soil, bearing little except pines, but interspersed with marshes and alluvial tracts on the sides of the streams, which are extremely fertile. Higher up, the country becomes fertile and beautiful, and it bears that aspect as far as the mountains occupying the northern part of the state. These mountains are about 50 miles in breadth, and are supposed to exceed 1500 feet in height, but have peaks rising much higher. They are covered with a stony soil, but on their southern side are many rich and beautiful valleys, clothed with forests of oak, hickory, walnut, gum, and maple. The country abounds in coal and iron ore, with numerous marble and hard and soft limestone quarries. The climate in the southern and low-lying parts of the country is very warm, but in the more elevated parts mild and salubrious. Its principal river, the Alabama, is formed by the junction of the Coosa and the Tallapoosa, and flowing S.S.W., unites with the Tombeckbee, 45 miles above Mobile Bay, to form the river Mobile. The population of this state has rapidly increased during the last forty years, being in 1810 only 20,845, and in 1850, 779,001; of whom 344,323 were slaves. Its commercial prosperity has fully kept pace with the increase of its population; for in the year ending 30th June 1851, the value of its exports amounted to $18,528,824, being greater than that of any of the other states, with the exception of New York and Louisiana. Its imports for the same period amounted to $413,446. The following are the principal of its agricultural productions for the year 1850:—560,360 bales of ginned cotton; 637,829 lb. of wool; 292,429 bushels of wheat; 28,485,966 bushels of Indian corn; 163,605 lb. of tobacco; 3,961,592 lb. of butter; 30,423 lb. of cheese; and 31,801 tons of hay. In the same year the quantity of improved land amounted to 4,387,088 acres; the value of its farming implements and machinery was $5,066,814; and of its live stock $31,558,686. It enjoys great facilities for commerce from its rivers being navigable to a great distance from the sea, as also from its railroads, of which, in January 1852, 121 miles were open, and 190 miles in progress; and besides these, it has 52 miles of canals. Several large cotton factories have been established, and the people are now beginning to direct their attention to the mineral wealth of the country: coal-mining is carried on to a considerable extent, and several iron forges have recently been erected. The facilities presented for shipbuilding are likewise beginning to attract notice. By the last census (1850) the representative population was 631,272, who send seven members to Congress. The government is vested in a governor, senate, and house of representatives, who meet biennially at Montgomery. The senate consists of 33 members, elected for four years, one-half going out every two years: the house of representatives consists of 100 members elected for two years. The members of both houses receive $4 a-day each, and the governor has a salary of $2500. In 1847, the public records and offices were removed from Tuscaloosa to Montgomery, where the meetings of the legislature are now held. The Capitol was destroyed by fire in 1849, but another has been erected on its site, completed in November 1851. The judges of the supreme and chancery courts are elected by the joint vote of both houses of the General Assembly for a period of six years: and by an amendment in the jurisdiction ratified in January 1850, the people elect the judges of the circuit courts for a similar period. The jurisdiction of the circuit courts extends to all civil and criminal causes in the state, and that of the supreme court to hearing and deciding in appeals from the inferior courts. A well-endowed university has been founded at Tuscaloosa, and there is also a Baptist, a Catholic, and a Methodist college. This state is divided into fifty-three counties. It was admitted into the Union as an independent state, by an act of Congress in 1819.



ALABARCHA, in *Antiquity*, a kind of magistrate among the Jews of Alexandria, whom the emperor allowed them to elect, for the superintendence of their policy, and the decision of differences and disputes.

ALABASTER, WILLIAM, an English divine, was born at Hadley, in the county of Suffolk. He was one of the doctors of Trinity College in Cambridge; and attended the Earl of Essex as his chaplain in the expedition to Cadiz in the reign of Queen Elizabeth. Apparently from pique at not being advanced in the English Church according to his own estimation of his merits, he there joined the Romish communion. Disappointed, however, in his expectations, he returned to England in order to resume his former religion. He obtained a prebend in the cathedral of St Paul, and after that the rectory of Therfield in Hertfordshire. He was well skilled in the Hebrew tongue; but wasted his ingenuity in the study of the Cabala, as is testified by his theological writings. He was also a poet, and is honoured with the praises of Spenser and Herrick. He died in the year 1640.

Alabaster, in *Natural History*, a mineral substance whose base is calcareous earth. It differs from marble in being combined, not with the carbonic, but with the sulphuric acid. The *oriental alabaster* of the antiquary and sculptor is a fibrous carbonate of lime.

Alabaster, in *Antiquity*, a term used for a vase wherein odoriferous liquors were anciently put. The reason of the denomination is that vessels for this purpose were frequently made of the alabaster stone, which Pliny and other ancients represent as peculiarly proper for this purpose.

Alabaster is also said to have been used for an ancient liquid measure, containing ten ounces of wine, or nine of oil. In this sense the alabaster was equal to half the sextary.

ALABASTRUM Dendroide, a kind of laminated alabaster, beautifully variegated with the figures of shrubs, trees, &c., and found in great abundance in the province of Hohenstein.

ALACRANES, a reef or shoal in the Gulf of Mexico, off the north coast of Yucatan, from which it is 80 miles distant. It extends 14 miles from N. to S., and 11 from E. to W. On the south side there is a secure harbour, well sheltered by dry reefs. On the 12th of February 1847, the mail steamship Tweed was wrecked on this reef; and in January 1849 a similar disaster befell the Forth, another steamer belonging to the same company. Lat. of the port, 22. 23. 6. N. Long. 89. 49. W.

ALADINISTS, a sect among the Mahometans, answering to freethinkers among us.

ALADSCHAHISSAR, a Turkish pashalic (Sandschah), part of the ancient Bulgaria, a mountainous district, in which the river Moravia rises in two branches, and runs into the Danube. It extends from Long. 21. 45. to 22. 30. E. and from Lat. 42. 30. to 43. 20. N. The great road from Belgrade passes through the northern part of the province. It is productive of wine, feeds much cattle, and has some rivers near Camplina. The capital, of the same name, sometimes called Krusechevarz, is the seat of a Greek bishop, and has a castle, once the residence of the predatory chief Von Serf, and wrested from him by the Sultan Murad the Second. It is near the east bank of the river Moravia.

ALADULIA, or Adadeul, a considerable province of Turkey in Asia, in that part called Natolia, between the mountains of Antitaurus, which separate it from Amasia on the north, and from Caramania on the west. It has the Mediterranean Sea on the south; and the Euphrates divides it on the east from Diarbekir. It comprehends the Lesser Armenia of the ancients, and the east part of Cilicia. Formerly it had kings of its own; but the head of the last king was cut off by Selim I. emperor of the Turks, who had conquered the country. It is now divided into two parts: the north, comprehended between Taurus, Antitaurus, and the Euphrates, is a beglerbeglie, which bears the name of Marash, the capital town; and the south, seated between Mount Taurus and the Mediterranean, is united to the beglerbeglie of Aleppo. The country is rough, rugged, and mountainous; yet there are good pastures, and plenty of horses and camels. The people are hardy and thievish. The capital is Malatia.

ALAEJOS, a Spanish town in the province of Valladolid, with two fine churches of Doric architecture, a convent, a hospital, and four schools. The chief manufacture is linen. Pop. 3255.



ALAGON, a Spanish town in the province of Zaragoza, near the confluence of the Ebro and the Jalon. Pop. 1932.

Alagon, a river of Spain, rising in the province of Salamanca, on the southern side of the Sierra de Herreros, and flowing through the provice of Caceres. After a course of 90 miles from N. to S. and S.W. it falls into the Tagus near Alcantara.

ALAIN, Chartier, secretary to Charles VII. king of France, born in the year 1386. He was the author of several works in prose and verse; but his most famous performance was his Chronicle of King Charles VII. Bernard de Girard, in his preface to the History of France, styles him "an excellent historian, who has given an account of all the affairs, particulars, ceremonies, speeches, answers, and circumstances, at which he was present himself, or had information of." Giles Coroxet tells us that Margaret, daughter to the king of Scotland, and wife to the Dauphin, passing once through a hall where Alain lay asleep, she stopped and kissed him before all the company who attended. Some of them telling her, that it was strange she should kiss a man who had so few charms in his person, she replied, "I did not kiss the man, but the mouth from whence proceed so many excellent sayings, so many wise discourses, and so many elegant expressions." Fontenelle, among his Dialogues of the Dead, has one upon this incident, between the princess Margaret and Plato. Pasquier compares Alain to Seneca, on account of the great number of beautiful sentences interspersed throughout his writings.

ALAIS, an arrondissement in the department of the Gard, in France, extending over 529 square miles, or 338,900 acres. It is divided into nine cantons and ninety-five communes, and in 1846 contained 98,133 inhabitants.

Alais, the chief city of the arrondissement of the same name. It is situate on the river Gardon, at the foot of the Cevennes. It contains 16,983 inhabitants, who are employed in manufacturing ribbons, sewing-silk, silk-hosiery, cotton-goods, glass, porcelain, and other articles. Long. 3. 29. 40. E. Lat. 44. 7. N. It has mines of coal and iron.

ALAJAR, a town of Spain, in the province of Huelva, with a population of 1995.

ALAMAGAN, one of the Ladrone or Marianne islands, in the Indian Ocean, is situated in Long. 146. 47. E. Lat. 18. 5. N. It is of an irregular form, and about 12 miles in circumference. The land in some places of this island is pretty high, so that it may be seen at the distance of 12 or 14 leagues. Near the north end of the island there is a volcano, which emitted an immense body of smoke in the year 1799, when it was visited by Captain Bass. The volcano is in a mountain close to the sea, rising above its level 1200 or 1500 feet. The high parts of the island are rugged and sterile. In the lower parts there is a profusion and luxuriance of vegetation. These abound with cocoa-nut trees, several kinds of stone-fruit, and the mellora or bread-tree of the Nicobar islands. Some small sugar-canes, some banana trees, and one bread-fruit tree, were discovered. Lizards, land-crabs, large partridges, quails, pigeons, owls, thrushes, and bullfinches, are numerous. But no fresh water, which was the object of Captain Bass's visit, could be found.

ALAMANNI, or Alemanni, Luigi, an Italian statesman and poet, was born at Florence in 1495. Having taken part in an unsuccessful conspiracy against Giulio de Medici, afterwards Pope Clement VII., he was obliged to take refuge in Venice, and afterwards in France. The Florentines having in the meantime recovered their liberty, Alamanni returned to his country, and took a prominent part in the affairs of the state. On the occurrence of a new revolution he was again banished, and retired into France. Here he composed the greater part of his works. He was greatly esteemed by Francis I., who, after the peace of Crespi in 1544, sent him as ambassador to Charles V. It is related that in the course of his address before the emperor, having spoken with complimentary emphasis of the imperial eagle, Charles quickly interrupted him with the words,

"l'aquila grifagna,
Che per più devorar, duoi rostri porta."

The lines were the ambassador's own, written with satirical allusion to the imperial crest. Alamanni replied that these were the words of a poet, and spoken in the heat of youth, but that now he spoke as an ambassador, uttering the words of truth and soberness. Charles was pleased with this ready reply, and congratulated him on enjoying the patronage of so distinguished a monarch as Francis I. After the death of Francis, Alamanni was still retained in the favour of his successor, Henry II., who in 1551 sent him as his ambassador to Genoa. He died at Amboise in 1556. He wrote a large number of poems distinguished by the purity and elegance of their style: the best of these is his didactic poem, entitled *La Coltivazione*. He is also the author of notes on the Iliad and Odyssey: those on the Iliad are inserted in the Cambridge edition of 1689, and in Barnes' fine edition of 1711.

ALAMOS, Balthasar, a Spanish writer, born at Medina del Campo, in Castile. After having studied the law at Salamanca, he entered into the service of Anthony Perez, secretary of state under Philip II. He was in high esteem and confidence with his master, on which account he was imprisoned after the disgrace of this minister. He was kept in confinement 11 years, when Philip III. coming to the throne, set him at liberty, according to the orders given by his father in his will. Alamos continued in a private capacity till the duke of Olivarez, the favourite of Philip IV., called him to public employments. He was a man of excellent wit as well as judgment. He died in the 88th year of his age. His Spanish translation of Tacitus, and the aphorisms which he added in the margin, gained him great reputation. This work was published at Madrid in 1614, and was to have been followed, as mentioned in the king's privilege, with a commentary, which, however, has never yet appeared. The author composed the whole during his imprisonment.

ALAN, Cardinal William, was born at Rossal in Lancashire, in the year 1532. He went to Oxford at the age of 15, and in 1550 was elected fellow of Oriel College. In 1556, being then only 24 years old, he was chosen principal of St Mary's Hall, and one of the proctors of the university. In 1558 he was made canon of York; but, upon Queen Elizabeth's accession to the throne, he left England, and settled at Louvaine, in an English college, of which he became the chief support. In 1565 he visited his native country; but on account of his extreme activity in the propagation of the Roman Catholic religion, he was obliged to fly the kingdom in 1568. He went first to Mechlin, and then to Douay, where he was made doctor of divinity. Soon after he was appointed canon of Cambray, and then canon of Rheims. In 1587 he was created cardinal with the title of *St Martin in Montibus*, and obtained from the king of Spain a rich abbey in the kingdom of Naples, and afterwards the bishopric of Mechlin. It is supposed to have been by his advice and instigation that Philip II. attempted to invade England. He died on the 20th of October 1594, aged 63, and was buried in the English college at Rome. He was a man of considerable learning, and an elegant writer. He wrote many books in defence of the Romish religion. The most remarkable are, 1. *A defence of the Twelve Martyrs in one Year*. Tho. Alfield was hanged for bringing into England and publishing this and others of Alan's works in the year 1584. 2. *A Declaration of the Sentence of Sextus V.*, &c.; a work intended to explain the pope's bull for the excommunication of Queen Elizabeth, and to exhort the people of England to take up arms in favour of the Spaniards. Many thousand copies of this book, printed at Antwerp, were put on board the Armada; but the enterprise failing, they were afterwards destroyed. 3. *Of the Worship due to Saints and their Relics*, 1583. This treatise, which was answered by Lord Burleigh, is esteemed the most elegant of the cardinal's writings.



ALAND, a group of islands at the entrance of the Gulf of Bothnia, between Lat. 59. 50. and 60. 32. N. and Long. 19. 10. and 21. 7. E. It consists of more than 80 inhabited, and more than 200 uninhabited islets, and rocks, most of which rise to a considerable elevation above the level of the sea. The surface is either a thin layer of clay, a rich mould, slate-stone, or sand. The arable soil produces rye and barley sufficient for home consumption, with hops, potatoes, and various culinary vegetables. The pasture grounds are generally very poor, yet they maintain considerable numbers of sheep, goats, and beeves. The fisheries are also productive, and waterfowl abound. The climate, though keen, and often severe, is more temperate than that of Finland. The inhabitants amount to about 14,000, mostly Swedes; 9000 of them being settled in Aland, the largest of the group. These islands were ceded by Sweden to Russia in 1809. Several of the harbours have been fortified, and are the station of a large military force, and a numerous flotilla.

ALANJE, a small town of Spain, 33 miles from Badajoz, with medicinal baths, which in 1844 afforded relief or cure to 388 out of 427 patients.

ALANT, in *Heraldry*, is a mastiff dog with short ears.

AL ARAF, in the *Mahometan Theology*, the partition wall that separates heaven from hell. The word is plural, and is derived from the Arabic verb *arafa*, to distinguish; in the singular it is written *al arf*. It gives the denomination to the seventh chapter of the Koran, wherein mention is made of this wall. Mahomet seems to have borrowed this idea either from the great gulf of separation mentioned in the New Testament, or from the Jewish writers, who also speak of a thin wall dividing heaven from hell. Mahometan writers differ extremely as to the persons who are to be found on Al Araf. Some take it for a sort of limbus for the patriarchs, prophets, &c.; others place here those whose good and evil works so exactly balance each other that they deserve neither reward nor punishment; others imagine this intermediate space to be possessed by those who, going to war without their parents' leave, and suffering martyrdom there, are excluded paradise for their disobedience, yet escape hell because they are martyrs.

ALARIC I., a celebrated general of the Visigoths, sprung from one of the noblest families of that people, and afterwards elected their king. He is first noticed in history as the leader of the Gothic auxiliaries of Theodosius the Great, A.D. 394. After the death of that emperor, the Goths revolted from his son, and Alaric entered Greece at the head of 200,000 men. His march was arrested by the Thessalians on the river Peneus, but he forced his way into Greece, and returned into Epirus laden with spoil. Five years afterwards he marched through Pannonia into Italy, where he was defeated by Stilicho in the bloody battle of Pollentia. Driven out of Italy, he obtained from Honorius the præfecture of Illyricum. On the murder of Stilicho, Alaric, A.D. 400, again invaded Italy, and sat down before the walls of Rome; but he accepted a ransom and raised the siege. After a fruitless negotiation with the feeble Honorius, he raised a competitor to the purple, whom he soon degraded, and obtained possession of Rome by the treachery of the slaves and domestics of the Romans. The imperial city was given up to be plundered by his followers, and though ecclesiastical writers have celebrated the piety and clemency of Alaric, it cannot be denied that the unfortunate inhabitants sustained the greatest outrages from this ruthless barbarian. This memorable event took place on the 24th August 410. The rest of Italy was also ravaged, and the conqueror intended to pass into Sicily, when death put an end to his career at Cosenza in 411. The inhuman rites attending his funeral have been forcibly described by Gibbon.—See *Zosimus; Claudian; Jornandes; Gibbon;* and the article Roman History.

Alaric II., eighth king of the Visigoths in Spain, succeeded his father Evaric in 484. He was careful to maintain the peace which his father had concluded with the Franks; but the ambitious Clovis, eager to possess himself of the rich Gothic provinces in Gaul, took arms against him, and in a battle near Poitiers, gained a complete victory, slaying Alaric with his own hand, A.D. 507. With Amalaric his son ended the Gothic dynasty in France.

During the reign of Alaric, and under his authority, was compiled the digest of laws known as the *Breviarium Alaricianum*, or Code of Alaric.

ALARM, in the *Military Art*, denotes either the apprehension of being suddenly attacked, or the notice thereof signified by firing a cannon, firelock, or the like. False alarms are frequently made use of to harass the enemy, by keeping them constantly under arms. Sometimes also this method is taken to try the vigilance of the picquet-guard, and what might be expected from them in case of real danger.

Alarm, in *Fencing*, is the same with what is otherwise called an appeal or challenge.

*Alarm-Bell*, that rung upon any sudden emergency, as a fire, mutiny, or the like.

ALARO, a town in the island of Minorca, with a population of 4081, and manufactures of oil, brandy, soap, linen, &c. In the neighbourhood is an air volcano, called *el Buflador*, or the Blower.

ALASCANI, in *Church History*, a sect of Anti-Lutherans, whose distinguishing tenet, besides their denying baptism, is said to have been this, that the words, *This is my body*, in the institution of the eucharist, are not to be understood of the bread, but of the whole action or celebration of the Supper. They are said to have taken the name from Alasco, superintendent of the foreign church in England. See the next article.

ALASCO, John, a Polish nobleman of the 16th century, who, imbibing the reformed opinions, was expelled his country, and became preacher to a Protestant congregation at Embden; but foreseeing persecution there, he came to England about the year 1551, while the reformation was carrying on under Edward VI. The publication of the *Interim* driving the Protestants to such places as afforded them toleration, 380 were naturalised in Britain, and obtained a charter of incorporation, by which they were erected into an ecclesiastical establishment, independent of the church of England. The church of the Augustin friars was granted them, with the revenues, for the maintenance of Alasco as superintendent, with four assistant ministers, subject to the approval of the king. This congregation lived undisturbed until the accession of Queen Mary, when they were all banished. They were kindly received, and permitted to settle at Embden; and Alasco at last, after an absence of twenty years, returned, by the favour of Sigismund, to his own country, where he died in 1560. Alasco was much esteemed by Erasmus, and the historians of his time speak greatly in his praise. He wrote a considerable number of theological treatises in defence of the doctrines of the Swiss Reformers. His real name was *Lascki*.



ALA-SHER. See Philadelphia, in Asiatic Turkey.

ALASHKA, or Aliaska, a long narrow peninsula on the north-west coast of North America, forming apparently a continental continuation of the chain of the Aleutian islands. It consists mostly of a ridge of steep rocky mountains, which in some parts attain a great elevation. At its eastern extremity, N. Lat. 60°, there is an active volcano 14,000 feet in height, and at the western extremity there are several cones of great elevation, which have been seen burning, and are covered for two thirds of their upper portions with perpetual snow. At the same extremity, the island of Unimak, separated only by a narrow strait, has enormous volcanoes, one of them named Chichaldinsk, rising in a regular cone to the height of 8083 feet.

ALASSIO, a seaport in the duchy of Genoa, in the Sardinian kingdom, with 6000 inhabitants, who equip several vessels annually to the coral fishery on the shores of the island of Sardinia.

ALASSONA, a town in European Turkey, with 3000 inhabitants. It is in the pashalic of Trikala, the ancient Thessaly. A great fair is held here.

ALATAMAHA, a large river of North America, which, rising in the Appalachian Mountains, runs south-east through the province of Georgia, and falls into the Atlantic Ocean, below the town of Frederica. It is formed by the junction of the Oakmutgee and Oconee, and is navigable for steamboats for 300 miles from its mouth.

ALATRIUM, now Alatri, a town in the Roman Campagna, six miles north of Frosinone, with considerable remains of its ancient fortifications, and other objects of antiquity. Pop. 8000.

ALAUDA, Lark, a numerous genus of birds. See Ornithology.

Alauda, was the name given by Cæsar to one of his transalpine legions about 55 years B.C., probably from the crest of their helmets resembling that on the head of the lark.—*Suet. Cæs.* 24.

ALAUTA or Alt, a considerable river of Turkey in Europe, which, after watering the north-east part of Transylvania and part of Wallachia, falls into the Danube almost opposite to Nicopolis.

ALAVA, a province in the north of Spain, one of those three usually denominated Provincias Vascongadas, or Basques, which enjoy privileges that distinguish them from the other dominions of the Spanish monarchy, and speak a language most remote from the Castilian, generally called by the natives Vascuence, and by other people the Basque. This province is of a triangular shape, bounded on the north by Guipúzcoa and Biscay, on the east by Navarre, on the south and south-west by Rioja, from which it is divided by the river Ebro, and on the west by the northern part of Old Castile. The extent of this province is 814 geographical square miles; and the population, by the census of 1849, amounted to 81,397 souls, giving a density of inhabitants somewhat exceeding the general average of Spain.

The surface of the province is very mountainous, and is abundantly clothed with woods and lofty trees. Its valleys are fertile. The soil yields more corn than the subsistence of its inhabitants requires, as well as flax, hemp, some oil, and a kind of wine called chacoli, which is drunk when new, and will not long retain its qualities. The mountains abound in iron-ore; and there were once extensive manufactories of iron goods, though they have of late decreased, owing to the destruction of the forests which supplied them with fuel; besides which, their productions are charged with heavy imposts on their introduction into Castile. The salt-works of Añana are among the largest in Spain, and yield a yearly average of 50,000 bushels, which is said, however, to be not more than one-eighth of what they are capable of producing. There are numerous weavers of coarse cloths and blankets over the whole province. Shoes and hats are manufactured; but these articles, like the ironware, have experienced a sensible declension of late years. The capital of the province is Vittoria, situated on the river Zadora, which empties itself into the Ebro. The other rivers are the Ayuda, which runs into the Zadora; and the Omecillo, which empties itself into the Ebro.

ALAY, signifying, in the Turkish language, "The Triumph," a ceremony which accompanies the assembling together the forces of that vast empire upon the breaking out of a war. It consists of the most insipid buffoonery, and is attended with acts of the most shocking barbarity.

ALAYOR, a Spanish town, in the island of Minorca, with a trade in linen, brandy, flour, wine, &c. Pop. 4722.

ALB, or ALBE, in the *Romish Church*, a vestment of white linen hanging down to the feet, and answering to the surplice of the English clergy. In the ancient church it was usual with those newly baptized to wear an alb, or white vestment; and hence the Sunday after Easter was called *dominica in albis*, on account of the albs worn by the baptized on Easter-day.

ALB is also the name of a Turkish coin, otherwise called *asper*.

ALBA, a province in the duchy of Piedmont, in the continental Sardinian dominions. It is a fine plain of 366 square miles, or 234,240 acres, producing abundant harvests of corn, wine, fruits, oil, and truffles, besides the best silk. The cattle are not numerous. There are no mines, but quarries of marble, slate, and rock-salt. The inhabitants amount to 150,000, living in two cities and 75 towns and villages. There is scarcely any demand for labour, but that which agriculture requires.

ALBA, a city of Italy, capital of the province of the same name, in Piedmont. It is situated on the river Tanaro, between Asti and Cherasco; is the seat of a bishop, and contains, besides the cathedral, six churches and seven religious establishments for the two sexes of ecclesiastics. Pop. 8286. Long. 8. 3. E. Lat. 44. 36. N.

ALBA DE TORMES, a district in the east of the province of Salamanca in Spain, with an agricultural population of 14,162.

Its chief town of the same name gave their title to the Dukes of Alva. The remains of their once magnificent castle stand on an eminence near the town, overlooking the plain of the Tormes. Pop. 2176. Here the French, under Kellermann, defeated the Spaniards, Nov. 26. 1809.

*ALBA Firma*, or *Album*, in our old customs, denoted rent paid in silver, and not in corn, which was called *black mail*.

*ALBA Longa*, in *Ancient Geography*, a colony from Lavinium, in Latium, fifteen miles south-east from Rome, established by Ascanius, the son of Æneas, at the foot of the Mons Albanus. It was called *Alba*, from a white sow found by Æneas, which farrowed thirty white pigs on that spot; which circumstance was interpreted to portend the building of a city there in thirty years after. (Propertius.) The epithet *Longa* was added on account of its length. It was the royal residence till the building of Rome, as was foretold by Anchises, (Virgil); was destroyed by Tullius Hostilius, all but the fane or temple; and the inhabitants were transplanted to Rome. (Strabo.)

*ALBA Terra*, one of the numerous names for the philosopher's stone.

ALBACETE, one of the new provinces of Spain, in the north-west of the ancient province of Murcia. The extent of the actual province is small; Pop. 19,000; but the judicial *audiencia* of Albacete embraces Murcia, Ciudad Real, and Cuenca, including a population of nearly one million.



Its chief town of the same name is a place of great traffic from its central situation, and its importance as the seat of the high court of appeal. From the extent and celebrity of its steel-manufactures, it has been called the *Sheffield* of Spain, but the designation is but comparatively applicable. An important article of export is saffron, which the province produces in great abundance. Pop. of the town 13,143.

ALBAHURIM, *figura sexdecim laterum*, a figure of great importance, according to astrological physicians, who built their prognosties on it.

ALBAN, ST, is said to have been the first person who suffered martyrdom for Christianity in Britain; he is therefore usually styled the protomartyr of this island. He was born at Verulam, and flourished towards the end of the third century. In his youth he took a journey to Rome in company with Amphibalus, a monk of Caerleon, and served seven years as a soldier under the emperor Diocletian. On his return home he settled at Verulam, and, through the example and instructions of Amphibalus, renounced the errors of Paganism, in which he had been educated, and became a convert to the Christian religion. It is generally agreed that Alban suffered martyrdom during the great persecution under the reign of Diocletian; but authors differ as to the year when it happened. Bede and others fix it in 286; some refer it to the year 296; but Usher reckons it amongst the events of 303. Between 400 and 500 years after St Alban's death, Offa, King of the Mercians, built a large and stately monastery to his memory; and the town of St Albans, in Hertfordshire, takes its name from our protomartyr.

ALBANENSES, in *Church History*, the same with Albigenses. See ALBIGENSES.

ALBANI, in *Roman Antiquity*, a college of the *Salii*, or priests of Mars; so called from Mount Albanus, the place of their residence.

ALBANI, *Cardinal Gian Francesco*, was elected Pope in November 1700, as the successor of Innocent XII. After his election, he hesitated about accepting the high office; but after some days ascended the chair of St Peter by the title of Clement XI. Whatever were his reasons for hesitation, he became one of the most active and zealous pontiffs in supporting the prerogatives and pretensions of the Holy See; which embroiled him with Victor Amadeus of Savoy, with Naples, and with Austria. But his most noted interference was in the religious dissensions in France; when by his bull entitled "Vineam Domini," he confirmed the edict of his predecessors against the Jansenists; but the issuing of his celebrated bull "Unigenitus," in 1713, set the kingdom of France in a flame. In this he condemned as heretical 101 propositions in Quesnel's *Reflections Morales sur le Nouveau Testament*, in which that author had maintained various opinions of St Augustin and the older fathers, which favoured the Jansenist doctrines on Grace and Free Will.

After a severe struggle and keen debates, Le Tellier, the Jesuit confessor of Louis XIV., persuaded his master to receive the bull; and it was at length registered by the Parliament of Paris; but these questions had for several years estranged France from the Holy See.

Another affair which troubled this pope was the disputes concerning the Jesuit missionaries in China, who had risen high in the consideration of the Imperial government, and seemed too independent of the court of Rome. Clement sent as his legate Cardinal Tournon in 1702; but he died at Macao, and his successor, Father Mezzbarba, was but coldly received at Pekin, and soon after ordered to quit China, at the instigation, as it was alleged, of the Jesuits; a source of deep mortification to this aspiring pontiff.

Clement warmly espoused the cause of the exiled house of Stuart, and furnished the son of James II. with money for his ill-advised attempt on Britain in 1715. After the failure of that expedition, he offered the prince an asylum at Urbine, where, as the Chevalier de St George, he had from the Pope a pension of 30,000 scudi; and, on his marriage with Clementina, daughter of the heroic John Sobieski, gave him a palace at Rome for his residence. This Pope died in March 1721.

Clement was a scholar, and wrote an excellent Latin style. His Homilies have been translated into Italian by Cescimbeni.

ALBANI, or ALBANO, *Francesco*, a celebrated Italian painter, was born in Bologna in 1578, and died in 1660. His father was a silk-merchant, and intended to bring up his son to the same occupation; but the young Albani was already, at the age of 12, filled with so strong an inclination for painting, that on the death of his father, he devoted himself entirely to art. His first master was Denys Calvert, with whom Guido Reni was at the same time a pupil. He was soon left by Calvert entirely to the care of Guido, and contracted with him a close friendship. He followed Guido to the school of the Caracci; but after this, owing to mutual rivalry, their friendship began gradually to cool. They kept up for a long time a keen competition, and their mutual emulation called forth some of their best productions. Notwithstanding this rivalry, they still spoke of each other with the highest esteem. Albani, after having greatly improved himself in the school of the Caracci, went to Rome, where he opened an academy and resided for many years. Here he painted, after the designs of Ann. Caracci, the whole of the frescoes in the chapel of St Diego in the church of San Giacomo degli Spagnuoli, besides numerous other pictures. On the death of his wife, he returned to Bologna, where he married a second time, and resided till his death in the enjoyment of much domestic happiness and general esteem.

Albani was naturally of a happy and amiable disposition, and his paintings breathe the same soft and joyous spirit. "In point of original invention," says Lanzi, "he is superior to Domenichino, perhaps to any other of the school; and in his representation of female forms, according to Mengs, he has no equal. By some he is denominated the Anacreon of painting. Like that poet, with his short odes, so Albani, from his small paintings, acquired great reputation; and as the one sings Venus and the Loves, and maids and boys, so does the artist hold up to the eye the same delicate and graceful subjects. Nature, indeed, formed, the perusal of the poets inclined, and fortune encouraged his genius for this kind of painting; and possessing a consort and twelve children, all of surprising beauty, he was, at the same time, blest with the finest models for the pursuit of his studies. He had a villa most delightfully situated, which farther presented him with a variety of objects enabling him to represent the beautiful rural views so familiar to his eye. Passeri greatly extols his talent in this branch, remarking that where others, being desirous of suiting figures to the landscape, or its various objects to one another, most frequently alter their natural colour, he invariably preserves the green of his trees, the clearness of his waters, and the serenity of the air, under the most lovely aspect, and contrives to unite them with the most enchanting power of harmony." The most of his works are at Bologna. Among the most celebrated of his pictures are those of the *Four Elements;* those of *Diana and Venus* in the Florentine gallery; the *Toilet of Venus*, in the Louvre; *Venus landing at Cythera*, in the Ghigi palace at Rome, &c. Among the best of his sacred subjects are a *St Sebastian* and an *Assumption of the Virgin*, both in the church of St Sebastian at Rome.

ALBANIA, a country of considerable extent, which, though frequently ruled by turbulent and nearly independent chiefs, ranks as one of the provinces of the Turkish empire. It extends from the thirty-ninth to the forty-third degree of north latitude, for the space of about 250 miles, along the Mediterranean and the Gulf of Venice. The extent inland nowhere exceeds 100 miles, and is in the southern part not more than 30. The chain of Pindus, called now the mountains of Sagori, of Metzovo, and of Suli, separate it by an ill-defined line from Macedonia and Thessaly. The Turks divided it into pashalics, of which the principal were those of Scutari, Ochrida, Vallona, and Butrinto; but these distinctions, amid late revolutions, have been in a great measure obliterated. The divisions chiefly recognised are those formed by the varieties of the native tribes. Colonel Leake, who is considered one of the best-informed authorities on this head, divides them into the Ngege, or Ghegides, whose principal towns are Dulcigno, Scutari, and Durazzo; the Toske or Toskides, who occupy Berat and Elbasan; the Liape, a poor and predatory race, who inhabit the mountains between the Toske and Delvino; and the Tsami, who inhabit the most southerly district, and whose principal towns are Suli and Paramithia. In 1838, it was divided by the Turks into six sanjaks, besides a number of smaller divisions.

Albania nearly coincides with the ancient Epirus, but comprising part of Macedonia, Illyria, and Chaonia. This country was then, as now, distinguished by the rude valour of its inhabitants. Its remote situation, and the want of union among its tribes, generally prevented it from acting any conspicuous part in Grecian politics. The only remarkable exception occurs in the reign of Pyrrhus II., who was justly ranked with the greatest captains of antiquity. After his death the country was again split into a number of petty states, which were unable to resist the united strength of Macedon; and to that kingdom Epirus continued subject, till both were alike subdued by the Roman arms.

It was during the time of the Greek empire that the name of Albania was first given to this district. During the decline of the empire the Albanians gradually rose to distinction, and at last to independence. Their valour enabled them to maintain their ground against the Bulgarians, who had occupied all the neighbouring districts of Greece. Nor were they less successful against the Turks, a more formidable enemy. Under the command of the celebrated George Castriot, commonly called Scanderbeg, they baffled all the efforts of Mahomet II. the conqueror of Constantinople. That powerful monarch entered Albania only to experience a succession of defeats, and was at length compelled to acknowledge its independence by a formal treaty. On the death of Scanderbeg, the Turks redoubled their efforts against Albania, which was at length reduced to a state of nominal subjection. The siege of Scutari, in 1478, formed the termination of this memorable struggle. The subjection, however, was always imperfect; revolts were frequent, and the inhabitants of the mountainous districts still preserved their independence. It was by the motives of pay and plunder, rather than by compulsion, that these hardy soldiers were allured into the Turkish ranks. In proportion as the Ottoman empire declined in vigour, its hold of Albania became less firm; and the vigorous and enterprising genius of Ali Pasha again converted this dependency into what might almost be called a separate kingdom.

Ali was born at Tepellene, a small town in the interior of Albania. His father held the rank of a pasha of two tails, but was not possessed of any extensive power; and he died when Ali was only fifteen. In a district so turbulent, and filled with warlike and hostile leaders, the young chief was necessarily placed in a very critical situation. He was himself accustomed to boast, that he began his fortune with sixty paras and a musket; and an Albanian who attended a late traveller (Mr Hobhouse) declared, that he remembered to have seen Ali with his jacket out at elbows. Ali was ere long driven from Tepellene, his native place, and was abandoned by almost all his followers. A plan was next formed for his destruction, by the inhabitants of Gardiki, a neighbouring town; and for this purpose they surrounded, in the night time, a village where he had taken refuge. Ali escaped through a garden, but his mother and sister fell into the hands of the Gardikiotes, and were treated with every species of indignity; wrongs for which he afterwards took a dreadful vengeance. His address and activity enabled him gradually to repair his fortunes. He insinuated himself into the favour of Coul Pasha, then the principal chief of Albania, whose daughter he at length married. Having thus been enabled to collect some followers, he succeeded in surprising Yanina, the capital, and in prevailing upon the Porte to recognise him as pasha of that important district. From this time he took the lead among the Albanian chiefs; employing sometimes force, sometimes money, and sometimes treachery, to increase his authority, and add to the extent of his dominions.

The most formidable adversaries with whom Ali had to contend were the Suliotes, a people placed in the southern extremity of Albania. They inhabit an almost inaccessible range of mountains, beneath whose gloomy shade winds a river, which Dr Holland conjectures, on very plausible grounds, to be the Acheron of the ancients. (*Travels in the Ionian Isles and Albania.*) The strength of their native bulwarks, their passion for war, and contempt of death, made them the terror of Albania, which they frequently invaded; while no foreign power had ever ventured to scale the tremendous barriers by which they were guarded. Ali at length succeeded, partly by force and partly by bribery, in gaining the passes which led into their country; and the whole nation, after a furious resistance, was reduced to subjection, and partly extirpated.

In 1811 and 1812 Ali attacked and defeated the pashas of Berat and Delvino; by which means he gained possession of some of the finest parts of Albania, and a population of between 200,000 and 300,000 souls. Tepellene, his native place, now fell into his power; and now also it was that he obtained the means of inflicting signal vengeance on Gardiki. With his accustomed duplicity he pretended a complete oblivion of all grounds of resentment, until he had surrounded and inclosed the city with his troops; when upwards of 700 of those of the inhabitants who were supposed to have been most deeply involved in the ancient guilt, were dragged into a large khan near the city, and bound together with cords. On a signal given by Ali, the Albanian soldiery, who were stationed on the walls of the khan, began a discharge of musketry, which continued until the destruction of the whole 700 was completed.

The dominions of Ali were not confined within the limits of Albania; he extended his sway over the mountainous district of Macedonia, nearly the whole of Thessaly, and great part of Livadia. He was kept in check by Ismael Bey, who possessed an authority nearly as independent over the plains of Macedonia. In Albania, his power was almost absolute; and while little regard was paid to the imperial firman, a letter with the signature of Ali commanded implicit obedience. The Albanians were enthusiastically attached to him; they viewed him as a native sovereign; they admired the energy of his character, and, when they heard of any other chief, commonly remarked, "he has not a head like Ali."

The natives estimated Ali's military force as high as 50,000, 60,000, or even 100,000 men. This could only apply to the case of a general levy *en masse*, in the event of invasion. It does not appear that Ali ever brought into the field a greater disposable force than 15,000. His standing army was supposed to be about 10,000, of whom 4000 or 5000 were stationed round his capital Yanina. The amount of his revenues was still more uncertain. They arose from the following sources:—1. A land-tax, amounting generally to about 10 per cent. of the produce; 2. a tax on cities and towns, levied in the form of requisition; 3. the customs, which he raised to six per cent.; 4. the inheritance of all who died without male heirs.



Ali's figure was corpulent and unwieldy, his neck short, his stature about five feet nine inches. The expression of his countenance was striking and majestic; and his features gave no indications of those terrible qualities by which he was characterised. His abilities were certainly of no mean order. He displayed that union of deep thought and contrivance, with prompt and decisive action, which indicate a mind equally formed for politics and for war. He was remarkable for his address, both in gaining friends, and in lulling asleep the suspicions of his bitterest enemies. But, if his abilities were of a superior order, his moral qualities were of a kind which rendered him an object of fear and detestation. His cruelty rather resembled that of an Indian savage than of even the least civilised European. Impaling and roasting alive were among the common punishments reserved for those who had unhappily offended him. The fierceness of his cruelty was only exceeded by the depth of his dissimulation. It was impossible for the most skilful observer to conjecture, from his outward deportment, the real sentiments with which he regarded any individual. The only observable difference consisted in a peculiar kindness of manner towards those unfortunates whose cruel doom he had silently and unrelentingly sealed.

Ali's ordinary residence was near Yanina, in an immense building which combines the characters of a palace and a fortress. The outer courts were irregularly crowded with Albanian soldiers, and with persons of all descriptions, who attended upon him, or had petitions to present. Each petitioner in approaching, knelt and kissed his garment. He exercised in person the whole judicial authority, and his decisions, though necessarily given too promptly, are, however, said to have been guided by an apparent wish of arriving at the truth, and of doing justice. He rose at six in the morning, and, with the exception of an hour at dinner, and an hour at supper, spent the whole day in business. His habits at table were extremely temperate, though he was not so strict a Mussulman as to decline the use of wine. His harem contained 390 females of various descriptions. It formed an edifice entirely distinct from the rest of the seraglio, and is said to have been furnished in a style of the most gorgeous magnificence; but no European ever found admission into it.

Although the government of Ali was completely despotical, yet, viewed comparatively, it appears to have been better for Albania than the terrible anarchy to which it was formerly exposed.

The progress of this enterprising chief was viewed by the Porte with jealousy and alarm, though it was found prudent to maintain an outward good understanding with him, by investing him with the government of the provinces which he had subdued. The Sultan having in vain attempted to induce Ali to repair to Constantinople, with the secret intention of despatching him, at length sent against him Pacho Bey, a former adherent of Ali, but afterwards one of his bitterest opponents. A recent and daring attempt, by two hired agents of Ali, to assassinate this person, furnished sufficient ground for placing Ali under the ban of the empire. He soon found himself deserted by the tribes in whom he had trusted, and Pacho Bey reached Yanina without firing a gun. The ferocious Ali ordered the capital to be given up to indiscriminate plunder by his bandit followers, and retreated to an impregnable castle in the midst of the lake, where be bade defiance to his enemies; who, after an ineffectual blockade, were obliged to retreat. Mahmoud, highly dissatisfied with the result of these operations, invested Chourschid, Pasha of the Morea, with the supreme command. Having assembled all the forces of the surrounding pashalics, he again hemmed in Ali within the precincts of his castle. The tower into which Ali had retired with his wives and treasures being closely beset, he surrendered to Chourschid, under a solemn promise that his life should be spared, and that he should have an honourable retreat; but scarcely had the agreement been concluded when a firman arrived from the Porte decreeing his immediate death.

In the grand insurrection of Greece, the Albanians, accustomed to view with disdain the Ottoman yoke, showed a considerable disposition to make common cause with the Greeks; and their co-operation would have almost insured success. But the Greeks, imprudently and unhappily, could not divest themselves of the feelings of enmity cherished during the long series of wars which Ali had waged against them. At the siege of Tripolizza overtures were made to them by a corps of 3000 Albanians, who formed part of the garrison; but the Greeks, having succeeded in entering the place, began a dreadful and indiscriminate massacre, in which the Albanians were equally involved. At the siege of Arta, although the capture was much facilitated by the coming over of a corps of Albanians, the Greeks treated them extremely ill. The Albanian nation was thus forcibly thrown into the arms of the Porte, to which it has since continued nominally subject.

The inhabitants of Albania are estimated at 800,000, of which a considerable proportion are Turks and Greeks; but the basis of the population consists of the original race, called Arnauts. This remarkable people differ completely from every other included within the limits of the Turkish empire. Their conversion to Mahometan tenets has been very imperfect, and chiefly induced by political motives. In every family the males usually go to the mosque, the females to church; and some members of a family are seen in the most amicable manner eating from the same table, and even from the same plate, meats forbidden to the others. With the Turks, accordingly, infidel and Albanian are terms nearly synonymous. Ali did not appear to make religion a ground of any the slightest distinction between the different classes of his subjects.

The native Albanian is of a middle stature; his face is oval, with high cheek-bones; his neck long, his chest full and broad. His air is erect and majestic to a degree which never fails to strike the traveller. He holds in utter contempt that dissimulation which is characteristic of the Greek, and piques himself upon giving utterance to every sentiment without the smallest reserve. Equally remote from the grave and sluggish deportment of the Turk, he is gay, lively, and active. Averse, however, to regular industry, his whole delight is in arms and plunder. He goes constantly armed; and there are few Albanians who, in the prime of their life, have not belonged to some of the numerous bands of robbers who infest the mountains of their native country, of Thessaly, and of Macedonia. This profession carries with it no disgrace: it is common for the Albanian to mention circumstances which occurred "when he was a robber." In proportion as the trade of robbing becomes overstocked, part of those engaged in it seek employment in the service of the sultan, and of the different pashas throughout the Turkish empire; by all of whom the Albanians are regarded as the most valuable of their troops.

An Albanian military force, according to the description of Dr Holland, cannot so properly be called an army, as a tumultuous assemblage of armed men. There is no regular distribution into corps; nor is much regard paid to the authority of any officer, with the single exception of the pasha himself. Yet such is their activity and intrepidity, that they have sometimes proved formidable to the best-disciplined European armies. The main strength of the Turkish infantry in the Russian campaigns consisted of Albanians.

This fierce and haughty race display a greater degree of contempt for the female sex than is usual even among the most barbarous nations. The females are literally regarded as inferior animals, and treated as such; but in the country districts they are not confined or veiled, as is customary in Mahometan countries.

The dress of the Albanian consists of a cotton shirt, a jacket, a mantle, sandals, and a red cap; to which is added a large *capote*, or great coat, as a shelter from the weather. Every part except the shirt consists of woollen. As they have usually one suit, which they wear day and night, it soon exhibits a dreadful spectacle of dirt and vermin, and at length literally falls to pieces. The dress of the females is more various, and often fantastical. A singular custom prevails among the girls, of stringing together the pieces of money which they have collected for their portion, and wearing them upon their heads. Some of them have their hair hanging down in braids to a great length, loaded with this species of ornament.

Yanina, the present capital, is beautifully situated on the banks of a small lake, inclosed within a circuit of lofty mountains. The houses in general are not externally either splendid or elegant; and they are built in the most irregular manner, with scarcely any approach to the form of streets. The intermixture, however, of gardens and trees gives to the city a fine appearance from a distance; particularly when combined with the magnificent background which everywhere crowns the landscape. There is a considerable number of Greeks at Yanina, who display an active and intelligent character, and cultivate with ardour the different branches of science and literature. The total number of inhabitants is estimated at upwards of 36,000.

The commerce of Albania is chiefly carried on through Arta, a small city situated on a gulf of the same name, in the most southern district of the country. The principal merchants, however, are Greeks residing at Yanina, among whom a very active commercial spirit appears to prevail. The mercantile houses of this city have often branches in other countries, particularly Germany and Russia; and several of them suffered considerably by the conflagration of Moscow. Under the continental system of Napoleon, Malta became the great channel for the trade of Albania, and, notwithstanding the subsequent political changes, probably retains it to a certain extent. The exports consist almost entirely of unmanufactured produce. Notwithstanding its mountainous character, the fertility of its plains affords a surplus of grain, of which a considerable quantity is sent to Italy, the Ionian Isles, Malta, and other places. Wool is exported chiefly unmanufactured, but partly also wrought into coarse cloth. Other important articles of export are, oil, tobacco of good quality, cotton and cotton yarn, chiefly from Thessaly. Some cargoes of wood for building and fire are annually sent to Malta. The chief imports consist of woollen cloths, used for winter coverings. For this purpose the preference is given to a coarser and cheaper species than any that is usually manufactured in Great Britain. This is supplied from Germany. Albania imports also guns, gunpowder, hardware, coffee, and sugar. On the 8th of October, an annual fair is opened in the neighbourhood of Yanina, and continues for fourteen days, when the imported articles are exchanged for native commodities, which then pour in from every quarter.

The reader will find much interesting information in regard to this country, and its late ruler, in the *Travels* of Mr Hobhouse and of Dr Holland. The latter resided for some time at Ali's court, where, in quality of physician, he enjoyed the privilege of a familiar intercourse with that extraordinary personage; and in the pages of Colonel Leake, we have still later notices of this country. (H. M.)

ALBANIA, a country of Asia, bounded on the west by Iberia; on the east by the Caspian Sea; on the north by Sarmatia; on the south by Armenia and the river Cyrus, now Kur, which, springing from the Moschian Mountains that separate Colchis from Armenia, falls into the Caspian Sea within a small distance from the southern borders of this country. The whole country, formerly called *Albania*, now goes under the names of *Daghistan*, *Schirwan*, and *Leghistan*, and is extremely fruitful and pleasant. The ancient historians take notice of the Albanian men as tall, strong-bodied, and, generally speaking, of a very graceful appearance; far excelling all other nations in comeliness as well as stature. Modern travellers extol the beauty of the women. The Albanians were anciently an independent and pretty powerful people; but we find no mention made of their kings till the reign of Alexander the Great, to whom the king of Albania is said to have presented a dog of extraordinary fierceness and size. It does not appear that the Albanians were ever conquered by the Romans, even when their power was at the greatest height; though, when they ventured to engage in war with that powerful empire, they were always defeated, as might naturally be expected.

ALBANO, a city near the lake of the same name, in the Campagna di Roma, in the Papal territories. It is much admired for the picturesque scenery around it. It is well built, and the Roman aqueduct and other monuments of antiquity are in tolerable preservation. The city contains a cathedral, four monasteries, a nunnery, and 5600 inhabitants. Long. 12. 43. 47. E. Lat. 41. 48. 50. N.

ALBANO, *Lake of*, about thirteen miles S.E. from Rome, is of a beautiful oval form, surrounded with high wooded banks, and about seven miles in circumference. It has long been a favourite object to the painter and the traveller; and on a cliff overhanging the lake is Castel Gandolfo, the only summer residence of the sovereign pontiffs, to which they retire during the unwholesome season at Rome. It has evidently been the crater of an extinct volcano. In the fourth century of ancient Rome, during the siege of Veii, the rise of the waters of this lake was so extraordinary, that the oracle of Delphi was consulted, and it gave no hope of success against Veii, while the Alban lake was allowed thus to swell. This prompted the Romans to drain the lake by an emissory or tunnel cut through the rock, a mile and a half in length, 4 feet wide, and 6 high, which is still perfect. As the nature of the *peperino* rock is crumbling, the cut is carefully cased with solid masonry. Its upper end is about the level of the ordinary surface of the lake, which is 920 feet above the level of the sea. Ten years after this work was finished, Veii succumbed to her hated rival.

ALBANO is also a town in the kingdom of Naples, remarkable for the fertility of the surrounding territory, and for the nobility of the inhabitants.

ALBANS, ST, a market-town of Hertfordshire, stands on the north side of the Ver, on the opposite side to the Roman city of Verulamia. It is chiefly remarkable for its immense Abbey church, the longest ecclesiastical structure in Great Britain. It was founded by the king of Mercia on his conversion to Christianity in the year 790; but the present building contains specimens of every style of English architecture. In the older portions, we find heavy circular arches, devoid of all ornament, springing from rude square piers, and sometimes large arches, divided by two interior arches, that rest on a low circular pier. This style is by some termed Saxon; but our best antiquaries now consider it as only early Norman. Some of the piers are clustered, showing a much later kind of architecture. This church is 556 feet long, by 174 feet in breadth at the transepts. The tower which surmounts it is only 150 feet in height; but from being on a moderate hill in a flat country, is visible from a great distance. The vast quantity of Roman bricks used in this structure is very striking; these were derived from the remains of the Roman Verulamia, which were extensively destroyed by the 8th and 9th abbots of St Albans, Ealdred and Eadmer, who rebuilt the church, and whose researches, according to Camden, were rewarded by the discovery in the ruins of great treasures of gold and silver, coins, and ancient MSS. Among the latter was said to be the famous *Book of St Albans*, the life of the saint in British, afterwards translated by a monk into Latin. The church contained, it is said, the bones of St Alban, but certainly those of Offa, and of the good Duke Humphrey of Gloucester, whose tomb was discovered in the last century. His bones show him to have been tall and vigorous. The town is divided into three parishes, St Albans, St Michaels, and St Peters. In St Michael's church, a small structure within the precincts of the ancient Verulam, is the tomb of the illustrious Lord Bacon; and in St Peter's church were deposited the bodies of the nobles who fell in the two battles of St Albans, in the civil wars of the two Roses. St Albans is twenty miles from London, in Lat. 51. 46. Long. 0. 21. W. The population in 1851 was 7000; and the number of inhabited houses 1361. It has hitherto returned two members to parliament; but in consequence of the gross corruption practised in electing the members, it is believed that it will shortly be deprived of that privilege, if not altogether disfranchised.



ALBANUS MONS, in *Ancient Geography*, now called *Mont Albano*, a mountain 14 miles from Rome, near the site of Alba Longa. It rises about 2000 feet above the surface of the lake.

ALBANY, the capital of the state of New York in North America, on the western bank of the river Hudson, about 145 miles above the city of New York. Placed on one of the noblest rivers of that part of America, and backed by a rich country, it has every natural requisite for commercial importance. These natural advantages have been increased by canals connecting it with Lakes Erie and Champlain; while a tissue of railways unites it with Boston and the valley of the Mohawk. It contains many handsome buildings, and valuable institutions of various kinds. Of its public buildings, the principal are the capitol, a handsome stone edifice 115 feet in length by 90 in width, with richly furnished apartments for the Senate and Assembly, &c.; the city hall, a superb building of white marble, surmounted with a large gilded dome; the exchange, &c. On 17th August 1848, a dreadful fire broke out which consumed one-eighth of the city. Its population in 1850 amounted to 50,771. Lat. 42. 39. N. Long. 73. 32. W.

ALBANY, a port and trading station of the Hudson's Bay Company, on the south-western shore of that sea, in Lat. 52. 20. N. Long. 82. 20. W.

ALBANY, a district in the eastern part of the British colony of the Cape of Good Hope, with an area of 2000 square miles, and a population of about 12,000. See GOOD HOPE, CAPE OF.

ALBARRACIN, a judicial district of the province of Teruel, in Spain. Pop. about 20,000. The country is cold, mountainous, and barren, but produces iron, and wool of a very fine quality.

Albarracin, *Sta. Maria de*, the chief town of the above district, on the banks of the Guadalaviar. It is the see of a bishop; and was once a place of great strength and importance, but its old fortifications are for the most part in ruins, and its population scarcely amounts to 2000.

ALBARIUM Opus, in *Antiquity*, the incrustation or covering of the interior of houses with white plaster, plain or ornamental. This is otherwise called *opus album*. It differed from *Tectorium*, which is a common name given to all roofing or ceiling, including even that formed of lime and sand, or lime and marble.

ALBATEGNI, an Arabic prince of Batan, in Mesopotamia, and a celebrated astronomer, who lived about the year 880, as appears by his observations. He is also called *Muhammed ben Geber Albatani, Mahomet the son of Geber*, and *Muhamedes Aractensis*. He made astronomical observations at Antioch, and at Racah or Aracta, a town of Chaldea. He is highly spoken of by Dr Halley, as a man of great genius, and an excellent observer. He received the title of the *Arabian Ptolemy*.

Instead of the tables of Ptolemy, which were imperfect, he computed new ones: these were adapted to the meridian of Aracta or Racah, and were long used as the best among the Arabs. He also composed in Arabic a work under the title of *The Science of the Stars*, comprising all parts of astronomy, according to his own observations and those of Ptolemy. This work was translated into Latin by Plato of Tibur, and published at Nuremberg in 1537, with some additions and demonstrations of Regiomontanus. It was reprinted at Bologna in 1645, with this author's notes. Dr Halley detected many faults in these additions. (*Philosophical Transactions* for 1693, No. 204.) In this work Albategni gives the motion of the sun's apogee since Ptolemy's time, as well as the motion of the stars, which he makes one degree in 70 years. He makes the longitude of the first star of Aries to be 18° 2′, and the obliquity of the ecliptic 23° 35′. Upon Albategni's observations were founded the Alphonsine tables of the moon's motion.

ALBATI Equi, an appellation given to such horses, in the games of the ancient circus, as wore white furniture.

ALBATROSS. See Ornithology, *Index*.

ALBAYDA, the name of a district, town, and river, in the province of Valencia in Spain. The district contains about 23,000 inhabitants, is extremely fertile and richly cultivated, and produces a great abundance of wine. Population of the town, 3130.

ALBAZIN, a town of Greater Tartary, with a strong castle. It is situated upon the river Amur or Yamour, and belongs to the Russians. Long. 103. 30. E. Lat. 54. N.

ALBEMARLE. See Aumale.

Albemarle, a county of Virginia, 700 square miles in extent, and in 1850 containing 25,684 inhabitants.

Albemarle Sound, an arm of the sea, 60 miles long and 10 wide, on the coast of N. Carolina.

ALBENGA, a seaport town of Italy, about 45 miles S.W. of Genoa. It is the see of a bishop, and is a very ancient, handsome town, but not well peopled, on account of the insalubrity of the air. It is seated in a well-cultivated and beautiful plain; and the suburbs are surrounded with olive-trees. Pop. 4735. Long. 8. 13. E. Lat. 44. 4. N.

ALBERIQUE, a district and town in the south of the province of Valencia, in Spain. Population of district about 16,000, of the town 3000. The chief products are silk, rice, and fruit.

ALBERONI, Julius, the son of a poor gardener in the suburbs of Placentia, born in 1664, who, by his great abilities and good fortune, rose from this low origin to the employment of first minister of state at the court of Spain, and to the dignity of cardinal. He roused that kingdom out of the lethargy it had sunk into for a century past, awakened the attention and raised the astonishment of all Europe by his projects, one of which was to set the Pretender on the throne of Great Britain. He was at length deprived of his employment, and banished to Rome. He died in 1752 at the advanced age of 87. His *Testament Politique*, collected from his memoirs and letters, was published at Lausanne in 1753.



ALBERT, a name borne by a large number of German princes, both temporal and spiritual, the more important of whom will be referred to under the several countries to which they belonged.

Albert, Margrave of Brandenburg, and the last grand master of the Teutonic order, laid aside the habit of his order, embraced Lutheranism, and concluded a peace at Cracow 1525, by which he was acknowledged duke of the east part of Prussia (formerly called for that reason *Ducal Prussia*), but to be held as a fief of Poland, and to descend to his male heirs. He was born in 1490; married in 1527 Dorothea, a princess of Denmark, and died in 1568. See Prussia.

ALBERTI, Leon Battista, one of the most distinguished men of his age, was descended of the noble and ancient family of the Alberti of Florence, where most probably he was born, about the year 1404. Having received from his father an excellent education, at twenty years of age he produced a Latin comedy entitled *Philodoxius*, which, from its classic style, was generally believed to be the work of an ancient poet; and indeed, by a mistake, it was afterwards edited and published as such by the younger Aldus. Alberti was originally of a powerful frame, and excelled in feats of strength and agility; but his constitution was irreparably injured by a severe illness in early life. The energy of his mind, however, suffered no diminution; and he pursued his studies with extraordinary ardour. He is generally regarded as one of the restorers of the ancient style of architecture, and has been called by some writers the Florentine Vitruvius. He was much employed by Pope Nicolas V. in his buildings; and specimens of his skill are to be seen at Rome, Florence, Mantua, and Rimini. He was also distinguished as a mathematician, a poet, and a philosopher. His writings in the various departments of science are numerous: his treatises on sculpture and painting, in particular, are highly esteemed; but his most celebrated work is the treatise on architecture, *De Re Ædificatorid*, which has been translated into Italian, French, and English. A splendid edition of this work in English and Italian, by Leoni, was published at London in 1726, in 3 vols. folio. This most accomplished man appears to have possessed an amiable and generous disposition, and was greatly respected and esteemed by his contemporaries. He died at Florence in his 85th year; and it is supposed that his remains were laid in the family sepulchre of the Alberti, which is still shown in that city. His life has been written by Poretti.

ALBERTUS MAGNUS (*Albert the Great*), one of the most celebrated philosophers and theologians of the middle ages, was born of the family of the Counts of Bollstädt, at Lauingen in Suabia. The date of his birth, according to the most probable calculation, is in 1193. He began his studies at Padua; where he became acquainted with Jordanus the General of the Dominicans, by whose influence he was led in 1222 to enter that order. After going through the regular course of philosophy and theology, he taught successively at Ratisbon, Strasburg, Friburg in Brisgau, Hildesheim, and Cologne. At the latter place, which became his favourite residence, he numbered among his pupils two future saints, Thomas of Cantimprato, and the "angelic" Aquinas. Aquinas followed him, when in 1245 he repaired to Paris for the purpose of obtaining the degree of doctor [*magister*]. During the requisite term of three years spent in public lecturing, Albert's instructions drew so large a concourse of scholars that he was obliged, in the ancient fashion, to teach in the open air. The name of the place *Maubert* (a contraction of *magister* or *magnus*, and *Aubert*), and that of the neighbouring *Rue de Maître-Albert*, still preserve the record of these Aristotelic hours.

On his return to Cologne he was made regent of the school of the Dominicans; and in 1254 he was elected Provincial of his order, the duties of which office he discharged with unwearied zeal, visiting on foot all the bounds of his extensive jurisdiction. During this residence at Cologne, he is said to have fabricated the famous speaking automaton, which, together with his scientific acquirement sand alchemistical pursuits, gained him the reputation of a magician. This curious machine is said to have so provoked the pious horror of the "angelic doctor" by its diabolical jargon, that he broke it in pieces with his staff. In 1255, Albert was called to Rome to defend the privileges of his order against the University of Paris; a mission which he fulfilled with partial success; leaving its completion to his friend Aquinas. At Rome he discharged the office of reader to the Pope, lecturing on the Gospel of John and the Epistles. In 1260 he was made Bishop of Ratisbon; but the troublesome duties of this office suited ill with his retired and studious habits, and after three years he resigned it. He retired once more to Cologne, where he continued to teach till within a few years of his death. During this period he was frequently delegated with episcopal authority; and on one occasion he travelled at the request of Urban IV. through Germany and Bohemia, preaching the crusade. He died in 1280 at the advanced age of 87; and was buried in the choir of the Dominican church at Cologne. His tomb, which had the fame of working miracles, was opened in 1483, in presence of the general of the Dominicans, and his bones taken out to be distributed as relics.

Albert is chiefly remarkable as having been beyond question the most learned man of his age, and as the first who gave its decided direction to the general tendency of speculative intelligence towards the system of Aristotle. Without according to him the possession of profound or original genius, we may well sympathise in the admiration that bestowed on him the title of *Great;* did we only consider the fact, in connection with the time in which he lived, that his writings, ranging over the domains of natural history, metaphysics, and theology, and containing a body of knowledge, however imperfect or unmethodical, yet marvellous in its universality, occupy no less than 21 folio volumes. They were published at Lyons in 1651, edited, under superior authority, by Pierre Jammy, a Dominican monk. A detailed list of Albert's works, the genuineness of many of which it is impossible to determine, is to be found in the *Scriptor. Ord. Predicat.* of Quétif and Echard, vol. i. p. 171.

His disciples were distinguished by the name of *Albertists.*

ALBESIA, in *Antiquity*, a kind of shields, otherwise called *Decumana.*

ALBI or ALBY, an arrondissement in the south-west of France, in the department of the Tarn, comprehending an extent of 558 square miles, or 357,276 acres. It is divided into eight cantons and 92 communes, and in 1846 contained 91,232 inhabitants.

ALBI, a city in the above arrondissement, the capital of the Albigeois. It is built on the river Tarn, 35 miles N.E. of Toulouse. The cathedral is dedicated to St Cecilia, and has one of the finest choirs in the kingdom. Here is a very valuable silver shrine, of exquisite mosaic work: it contains the relics of St Clair, the first bishop of the city. The chapel of that saint is magnificent, and adorned with paintings. La Lice is a fine promenade without the city, distinguished by a terrace above a deep mall, which serves instead of a fosse, and bordered with two rows of very fine trees. At one end is the convent of the Dominicans. The archbishop's palace is a very beautiful edifice. The river washes its walls, and serves both for ornament and defence. Pop. in 1846, 12,452. Long. 2. 9. E. Lat. 43. 56. N.



ALBIGEOIS, L', an ancient territory of France, in Upper Languedoc, about twenty-seven miles in length, and twenty in breadth, abounding in sheep, corn, wood, grapes, saffron, and plums. There is a considerable trade in dried prunes, grapes, a coarse sort of cloth, and wine of Gaillac. These wines are the only sort in this district that are fit for exportation: they are carried down to Bourdeaux, and generally sold to the British. There are likewise several coal-mines.

ALBIGENSES, in *Church History*, a sect or party of reformers, about Toulouse and Albigeois, in Languedoc, who sprung up in the 12th century, and distinguished themselves by their opposition to the discipline and ceremonies of the Romish church.

The name is supposed to have been derived, either from there being great numbers of them in the diocese of Albi, or because they were condemned by a council held in that city. It does not indeed appear that they were known by this name before the time of that council. They were also called *Albiani, Albigesei, Albii*, and *Albanenses*, though some distinguish these last from them. Other names given to them are *Cathari, Abelardists, Berengarians, Bulgarians*, &c.; some on account of the qualities they assumed; others from that of the country from whence it is pretended they were derived; and others on account of persons of note who adopted their cause, as Peter de Brius, Arnold of Brescia, Abelard, Henry, &c. Berengarius, if not Wycliffe himself, is by some ranked in the number. The *Albigenses* are frequently confounded with the *Waldenses;* from whom, however, they differ in many respects, both as being prior to them in point of time, as having their origin in a different country, and as being charged with different heresies, particularly Manicheism, with which the *Waldenses* are not charged. From that imputation, however, several Protestant writers have vindicated them. Dr Allix shows that a great number of *Manichees* did spread over the western countries from Bulgaria, and settled in Italy, Languedoc, and other places, where there were also *Albigenses;* by which means, being both under the imputation of *heresy*, they came, either by ignorance or malice, to be confounded, and called by the same common name, though in reality entirely different.

Grave errors were imputed to them by their malicious opponents: such as that they admitted two Christs; one evil, who appeared on earth; the other good who has not yet appeared: that they denied the resurrection of the body, and maintained human souls to be demons imprisoned in our bodies, by way of punishment for their sins: that they condemned all the sacraments of the church, rejected baptism as useless, held the eucharist in abhorrence, excluded the use of confessions and penance, maintained marriage unlawful, laughed at purgatory, prayers for the dead, images, crucifixes, &c. There were likewise said to be two classes of them, the Perfect and the Believers. The Perfect boasted of their living in continence, of eating neither flesh, eggs, nor cheese. The Believers lived like other men, and were even loose in their morals; but they were persuaded they should be saved by the faith of the perfect, and that none were damned who received imposition of hands from them. But from these charges also they are generally acquitted by Protestants, who consider them as the pious inventions of the Romish church, which accounts it no sin, but rather meritorious by any means to blacken heretics.

However this be, the Albigenses grew so formidable, that the Catholics agreed upon a holy league or crusade against them. They were at first supported by Raymond Count of Toulouse. Pope Innocent III., desirous to suppress them, sent legates into their country, who even inflicted capital punishment on pertinacious heretics. These legates were known by the name of Inquisitors. On the murder of one of these, the pope proclaimed a crusade against the Albigenses, and their supporter Raymond VI., Count of Toulouse. The French barons took the field under Simon de Montfort (Earl of Leicester) in 1209; and Raymond found it his interest to side with them. Soon after, however, finding himself plundered by the crusaders, he proclaimed war against them, and was joined by his relation the king of Aragon, who lost his life in the first battle. The defeat of his army was followed by the surrender of the city of Toulouse, and the conquest of the greater part of Languedoc and Provence. The war was attended with circumstances of the greatest atrocity: at the massacre of Beziers, Arnald the pope's legate, on being asked how the heretics and the orthodox were to be distinguished, replied—" Slay all, and God will find his own." Montfort was killed at the siege of Toulouse in 1218, and Raymond died four years afterwards. Their sons renewed the war; but at last the Count of Toulouse was compelled to make peace in 1229. From this time the Albigenses gradually dwindled, till the time of the Reformation, when such of them as were left fell in with the Vaudois, and became conformable to the doctrine of Zuinglius and the discipline of Geneva.—*Mosheim's Eccles. Hist; General Hist. of Languedoc*, Paris, 1730.

ALBIGENSES is also a name sometimes given to the followers of Peter Vaud or Waldo. See VALDENSES.

ALBINI, in *Antiquity*, the workmen employed in what was called *opus albarium.* They made a different profession from the *dealbatores* or *whiteners.*

ALBINOS, the name by which the Portuguese call the white Moors, who are looked upon by the negroes as monsters. At a distance they might be taken for Europeans; but on a nearer view, their white colour appears like that of persons affected with leprosy.

In Saussure's *Voyages dans les Alpes* is the following account of the two boys at Chamouni, who have been called *Albinos*:—" The elder, who was at the end of the year 1785 about twenty or twenty-one years of age, had a dull look, with lips somewhat thick, but nothing else in his features to distinguish him from other people. The other, who is two years younger, is rather a more agreeable figure; he is gay and sprightly, and seems not to want wit. But their eyes are not blue; the iris is of a very distinct rose colour: the pupil, too, when viewed in the light, seems decidedly red, which seems to demonstrate that the interior membranes are deprived of the uvea, and of that black mucous matter that should line them. Their hair, their eyebrows, and eye-lashes, the down upon their skin, were all during their infancy of the most perfect milk-white colour, and very fine; but their hair is now of a reddish cast, and has grown pretty strong. Their sight, too, is somewhat strengthened, though they exaggerate to strangers their aversion for the light, and half shut the eye-lids, to give themselves a more extraordinary appearance; but those who, like me, have seen them in their infancy, before they were tutored to this deceit, and when too few people came to Chamouni to make this affectation profitable to them, can attest that then they were not very much offended with the light of day. At that time they were so little desirous of exciting the curiosity of strangers, that they hid themselves to avoid such; and it was necessary to do a sort of violence to them before they could be prevailed on to allow themselves to be inspected. It is also well known at Chamouni, that when they were of a proper age they were unable to tend the cattle like the other children at the same age; and that one of their uncles maintained them out of charity, at a time of life when others were capable of gaining a subsistence by their labour.

" I am therefore of opinion, that we may consider these two lads to be albinos; for if they have not the thick lips and flat noses of the white negroes, it is because they are albinos of Europe, not of Africa. This infirmity affects the eyes, the complexion, and the colour of the hair; it even diminishes the strength, but does not alter the conformation of the features. Besides, there are certainly in this malady various degrees—some may have less strength, and be less able to endure the light; but these circumstances in those of Chamouni are marked with characters sufficiently strong to entitle them to the unhappy advantage of being classed with that variety of the human species denominated albinos.

" I at first imagined that this disease might be referred to a particular sort of organic debility; that a relaxation of the lymphatic vessels within the eye might suffer the globules of the blood to enter too abundantly into the iris, the uvea, and even into the retina, which might occasion the redness of the iris and of the pupil. The same debility seemed also to account for the intolerance of the light, and for the whiteness of the hair.

" But a learned physiologist, M. Blumenbach, professor in the university of Göttingen, who has made many profound observations on the organs of sight, and has considered with great attention the albinos of Chamouni, attributes their infirmity to a different cause.

" The study of comparative anatomy has furnished him with frequent opportunities of observing this phenomenon; he has found it in brutes, in white dogs, and in owls; he says it is generally to be seen in the warm-blooded animals, but that he has never met with it in those with cold blood.

" From his observations, he is of opinion that the redness of the iris, and of the other internal parts of the eye, as well as the extreme sensibility that accompanies this redness, is owing to the total privation of that brown or blackish mucus, which, about the fifth week after conception, covers all the interior parts of the eye in its sound state. He observes that Simon Pontius, in his treatise *de Coloribus Oculorum*, long ago remarked, that in blue eyes the interior membranes were less abundantly provided with this black mucus, and were therefore more sensible to the action of light. This sensibility of blue eyes agrees very well, says M. Blumenbach, with northern people, during their long twilight; while, on the contrary, the deep black in the eyes of negroes enables them to support the splendour of the sunbeams in the torrid zone.

" As to the connection between this red colour of their eyes and the whiteness of the skin and hair, the same learned physiologist says, that it is owing to a similarity of structure, *consensus ex similitudine fabricæ.* He asserts that this black mucus is formed only in the delicate cellular substance, which has numerous bloodvessels contiguous to it, but contains no fat, like the inside of the eye, the skin of negroes, the spotted palate of several domestic animals, &c. And, lastly, he says that the colour of the hair generally corresponds with that of the iris—*Gazette Litt. de Gottingue*, Oct. 1784.

" At the very time that M. Blumenbach was reading this memoir to the Royal Society of Göttingen, M. Buzzi, surgeon to the hospital at Milan, an élève of the celebrated anatomist Moscati, published in the *Opuscoli Scelti de Milan*, 1784, tom. vii. p. 11, a very interesting memoir, in which he demonstrates by dissection what Blumenbach had only supposed.

" A peasant of about thirty years of age died in the hospital of Milan of a pulmonary disorder. His body being exposed to view, was exceedingly remarkable for the uncommon whiteness of the skin, of the hair of the beard, and of all the other covered parts of the body. M. Buzzi, who had long desired an opportunity of dissecting such a subject, immediately seized upon this. He found the iris of the eyes perfectly white, and the pupil of a rose colour. The eyes were dissected with the greatest possible care, and were found entirely destitute of that black membrane which anatomists call the *uvea;* it was not to be seen either behind the iris or under the retina. Within the eye there was only found the choroid coat, extremely thin, and tinged of a pale red colour, by vessels covered with discoloured blood. What was more extraordinary, the skin, when detached from different parts of the body, seemed almost entirely divested of the *rete mucosum;* maceration did not discover the least vestige of this, not even in the wrinkles of the abdomen, where it is most abundant and most visible.

"M. Buzzi likewise accounts for the whiteness of the skin and of the hair, from the absence of the *rete mucosum*, which, according to him, gives the colour to the cuticle, and to the hairs that are scattered over it. Among other proofs of this opinion, he alleges a well-known fact, that if the skin of the blackest horse be accidentally destroyed in any part of the body, the hairs that afterwards grow on that part are always white, because the *rete mucosum* which tinges those hairs are never regenerated with the skin.

"The proximate cause of the whiteness of albinos, and the colour of their eyes, seems therefore pretty evidently to depend on the absence of the *rete mucosum;* but what is the remote cause?

"M. Buzzi relates a singular fact, which seems to throw some light on this subject.

"A woman of Milan, called Calcagni, had seven sons. The two eldest had brown hair and black eyes; the three next had white hair, white skins, and red eyes; the two last resembled the two eldest. It is said that this woman, during the three pregnancies that produced the albinos, had a continual and immoderate appetite for milk, which she took in great quantities; but that, when she was with child of the other four children, she had no such desire. It is not, however, ascertained that this preternatural appetite was not itself the effect of a certain heat, or internal disease which destroyed the *rete mucosum* in the children before they were born.

"The albinos of Chamouni are also the offspring of parents with dark skins and black eyes. They have three sisters by the same father and mother, who are also brunettes. One of them that I saw had the eyes of a dark brown, and the hair almost black. They are said, however, to be all afflicted with a weakness of sight. When the lads are married, it will be curious to observe how the eyes of their children will be formed. The experiment would be particularly decisive if they were married to women like themselves. But this faulty conformation seems to be more rare among women than among men; for the four of Milan, the two of Chamouni, the one described by Maupertuis, the other by Helvetius, and almost all the instances of these singular productions, have been of our sex. It is known, however, that there are races of men and women affected with this disease, and that these races perpetuate themselves in Guinea, in Java, at Panama, &c.

"Upon the whole, this degeneration does not seem to be owing to the air of the mountains; for though I have traversed the greatest part of the Alps, and the other mountains of Europe, these are the only individuals of that kind that I ever met with."

Very perfect albinos, exactly answering to those described by Saussure, occur in our own island. A Welsh family in which every alternate child was an albino, is described by Dr Traill of Liverpool, in *Nicholson's Journal*, vol. xix. p. 81; and several other instances have since occurred in Britain.



ALBINOVANUS, C. Pedo, a Latin poet, whom Ovid calls *sidereus Pedo, the starry*, on account of the loftiness of his style. There is now nothing of his extant except three elegies, of doubtful genuineness, and a fragment in Seneca.

ALBINUS or Albus, the name of a noble Roman family, the head of the gens Postumia. It produced many consuls and distinguished men. The first of the name, surnamed Regillensis, commanded, according to Livy, as dictator, in the great battle of the Lake Regillus; but Niebuhr considers the name to have been derived merely from the place of his residence.

Albinus, *Bernhard Siegfred*, a celebrated physician and anatomist, was born of an illustrious family at Frankfort-on-the-Oder in 1697. His father was then professor of the practice of medicine in the university of Frankfort; but in the year 1702 he repaired to Leyden, being nominated professor of anatomy and surgery in that university. Here his son had an opportunity of studying under Boërhaave and other eminent masters, who, from the singular abilities which he then displayed, had no difficulty in prognosticating his future eminence. But while he was distinguished in every branch of literature, his attention was particularly turned to anatomy and surgery. His peculiar attachment to these branches of knowledge gained him the intimate friendship of Ruysch and Rau, who at that time flourished in Leyden; and the latter, so justly celebrated as a lithotomist, is said to have seldom performed a capital operation without inviting him to be present. Having finished his studies at Leyden, he went to Paris, where he attended the lectures of Du Verney, Vaillant, and other celebrated professors. But he had scarcely spent a year there when he was invited by the curators of the university of Leyden to be a lecturer on anatomy and surgery at that place. Though contrary to his own inclination, he complied with their request, and upon that occasion was created doctor of physic without any examination. Soon after, upon the death of his father, he was appointed to succeed him as professor of anatomy; and upon being admitted into that office on the 9th of November 1721, he delivered an oration *De vera via ad fabricæ humani corporis cognitionem ducente*, which was heard with universal approbation. In the capacity of a professor, he not only bestowed the greatest attention upon the instruction of the youth intrusted to his care, but on the improvement of the medical art. With this view he published many important discoveries of his own; and, by elegant editions, turned the attentions of physicians to works of merit which might otherwise have been neglected. By these means his fame was soon extended over Europe; and the societies of London, Petersburg, and Haarlem cheerfully received him as an associate. In 1745 he was appointed professor of the practice of medicine at Leyden, and was succeeded in the anatomical chair by his brother, Frid. Bern. Albinus. He was twice rector of the university, and as often he refused that high honour when it was voluntarily offered him. At length, worn out by long service and intense study, he died on the 9th of September 1770, in the 74th year of his age.

Albinus, *Clodius*, a native of Africa, was a distinguished military commander in the reigns of Marcus Aurelius, Commodus, and Pertinax. On the death of Pertinax he was proclaimed emperor by the legions in Britain and Gaul, but was defeated and slain by his formidable competitor Severus, in a battle near Lyons, A.D. 197.

ALBION, the ancient name of Britain. See Britain.

Albion, *New*, a name given by Sir Francis Drake to California on the north-west coast of America, which he discovered and took possession of in the year 1578. Captain Cook visited this coast in 1778, and landed in a place situate in Long. 235. 20. E. Lat. 44. 33. N. In the year 1792 it was again visited by Captain Vancouver, who was employed in surveying the western coast of North America. The name is now applied to that part of the coast which lies between 43° and 48° N. Lat.

ALBIREO, in *Astronomy*, a star of the third or fourth magnitude, in the constellation Cygnus.

ALBIS, in *Ancient Geography*, now the Elbe, which divided Ancient Germany in the middle, and was the boundary of this country, so far as it was known to the Romans. All beyond they owned to be uncertain, no Roman except Drusus, Tiberius, and D. Ahenobarbus having penetrated so far as the Elbe.

ALBITE, a species of felspar, called also CLEAVLANDITE. See MINERALOGY.

ALBOGALERUS, in *Roman Antiquity*, a white cap worn by the *flamen Dialis*, on the top of which was an ornament of olive branches.

ALBOIN, King of the Lombards. See LOMBARDS.

AL BORAK, amongst the Mahometan writers, the beast on which Mahomet rode in his journeys to heaven. The Arab commentators give many fables concerning this extraordinary mode of conveyance. It is represented as of an intermediate shape and size between an ass and a mule. A place, it seems, was secured for it in Paradise, at the intercession of Mahomet; which, however, was in some measure extorted from the prophet, by Al Borak's refusing to let him mount when the angel Gabriel was come to conduct him.

ALBORAN, a small and barren rocky islet in the Mediterranean sea, 66 miles S.S.W. of Almeria in Spain, Lat. 35. 58. N., Long. 3. 1. W.

ALBOX, a town of Spain, in the province of Almeria. It is well-built and healthy, and contains 7425 inhabitants. Principal manufactures, oil, flour, pottery, woollen and linen stuffs. The latter give employment to about 400 looms chiefly worked by women.

ALBRECHTSBERGER, JOHANN GEORGE, a musician, born at Kloster-Neuburg, Vienna, in 1729. He was a very learned contrapuntist, and became court organist at Vienna, was a member of the Academy, and had the honour of being the instructor of Beethoven. He died in 1809. Twenty-seven of his numerous compositions have been printed. His excellent *Guide to Composition, with Examples*, was first published at Leipsic, in 1790; and a collection of his writings on harmony, in 3 vols., appeared at Vienna in 1826.

ALBRIC, ALBRICIUS, or ALFRICUS, a learned British physician and philosopher, who flourished at London about the end of the eleventh century, or, according to others, in the beginning of the thirteenth. The following works of his are cited by Bale: [*Script. Illustr. Magn. Brit.*]—1. *De Deorum Imaginibus;* 2. *De Ratione Veneni;* 3. *Virtutes Antiquorum;* 4. *Canones Speculativi.* The first alone has been published, and is to be found in the *Mythographi Latini*, Amsterdam, 1681.

ALBUERA, a small village of Spain, in the province of Estremadura, 12 miles S.S.E. of Badajos. It has been rendered celebrated by a victory gained there on the 16th of May 1811, by the English, Portuguese, and Spaniards, under Marshal Beresford, over the French army, commanded by Marshal Soult.

ALBUFEIRA, a Portuguese town, on a bay in the province of Algarve, containing 2665 inhabitants. Its harbour is capable of containing large ships, and is well defended by a castle and battery. Lat. 37. 7. N. Long. 7. 19. W.

ALBUFERA DE VALENCIA, a lake seven miles south of Valencia, in Spain, about twelve miles in length and four in breadth. It has an opening to the sea, and abounds with fish and waterfowl. The banks are inhabited by fishermen. On the days of St Martin and St Catalina, the public have the freedom of fishing and shooting on the lake, which on these occasions is covered with hundreds of boats.



ALBUM, in *Antiquity*, a kind of white tablet or register, wherein the names of certain magistrates, public transactions, &c., were entered. Of these there were various sorts; as the *album decurionum, album senatorum, album judicum, album prætoris, &c.*

The high priest entered the chief transactions of each year into an *album*, or tablet, which was hung up in his house for the public use.

ALBUM is also used, in later times, to denote a kind of tablet, or pocket-book, for containing autographs, sketches, and original compositions.

ALBUMAZAR, a celebrated Arabian astronomer of the ninth century, born at Balkh, in Khorassan. He had reached the age of 47 before he entered on the studies to which he owes his fame. His principal works are *An Introduction to Astronomy*, and the *Book of Conjunction*, both published in a Latin translation at Augsburg, in 1489, and again at Venice in 1515; and a work *On the Revolution of the Years* is also attributed to him.

ALBUMEN, a substance found both in animal and vegetable matters, and in great abundance in the white of eggs. It coagulates by heat, and becomes insoluble in water after that process. See CHEMISTRY.

ALBUQUERQUE, a town of Spain, in a district of the same name, in the province of Estremadura, on an eminence, nine miles from the frontiers of Portugal. It is defended by an almost impregnable fortress, built on a high mountain. It was taken by the allies of Charles, king of Spain, in 1705, but was restored to the Crown in 1715. It has some trade in woollen and linen manufactures, and exports cattle and fruits. Long. 7. 0. W. Lat. 38. 52. N. Pop. 6787.

ALBUQUERQUE, *Alfonso*, the celebrated commander who laid the foundations of the Portuguese power in India, was born at Melinda, in Africa, in 1452. He died in 1515, at the mouth of the Persian Gulf. See PORTUGAL.—*Historia de Barros; Lafiteau, Conquêtes des Portugais.*

ALBURN, the English name of a compound colour, being a mixture of white and red, or reddish brown. Skinner derives the word, in this sense, from the Latin *albus*, and the Italian *bruno*, brown.

ALBURNUM, the soft white substance which in trees is found between the *liber* or inner bark and the wood, and in process of time acquiring solidity becomes itself the wood. From its colour and comparative softness, it has been styled by some writers the fat of trees, *adeps arborum.* Its popular name is sap-wood.

ALCÆUS, one of the great lyric poets of Greece, was a native of Mitylene, in Lesbos, aud flourished about the year 600 B.C. From the fragments of his poems which have come down to us, we learn that his life was greatly mixed up with the political disputes and internal feuds of his native city. He sided with the nobles, and took an active part against the tyrants, who at that time set themselves up in Mitylene. He was obliged, in consequence, to quit his native country, and spend the rest of his life in exile. The date of his death is unknown. His poems, which were composed in the Æolian dialect, were collected afterwards, and apparently divided into ten books. The subjects, as we can still see from the fragments, were of the most varied kind: some of his poems were hymns to the gods; others were of a martial or political character; others again breathed an ardent love of liberty and hatred of the tyrants; and lastly, some were of an erotic kind, and appear to have been particularly remarkable for the fervour of the passion they described. Horace looks upon Alcæus as his great model, and has, in one passage (*Od.* ii. 13. 26. *et seq.*), given a fine picture of the poetical powers of the Æolian bard. The care which Alcæus bestowed upon the construction of his verses was probably the reason why one kind of metre, the Alcaic, was named after him. Not one of his compositions has come down to us entire, but a complete collection of all the extant fragments may be found in Bergk's "*Poetae Lyrici Græci*," Lipsiae, 1852, 8vo. (L. S.)

ALCÆUS, an Athenian comic poet, or rather a writer of what is termed mixed comedy. He left ten pieces, one of which, *Pasiphaë*, he produced when he contended with Aristophanes, in the year B.C. 388.

ALCÆUS, of Messene, the author of 22 Epigrams in the Greek Anthology. He was contemporary with Philip III., king of Macedon, whom he did not spare in his Epigrams, and who replied to one of them in another, containing a broad hint of a dreadful retaliation if he should fall into his hands.

ALCAICS, in *Ancient Poetry*, a name given to several kinds of verse, from Alcæus, their alleged inventor.

The first kind consists of five feet, viz. a spondee or iambic, an iambic, a long syllable, a dactyle, another dactyle. Such are the following lines of Horace:

*Omnes | eo|dem | cogimur, | omnium*
*Versa|tur ur|na | serius, | ocius,*
*Sors exitura.*

The second kind consists of two dactyles and two trochees; as,

*Exili|um imposi|tura | cymbæ.*

Besides these two, which are called *dactylic Alcaïcs*, there is another, simply styled *Alcaïc*, consisting of an epitrite, a choriambus, another choriambus, and a bacchius. The following is of this species:

*Cur timet fla|vum Tiberim | tangere, cur | olivum?*

*ALCAIC Ode*, a kind of manly ode, composed of several strophes, each consisting of four verses; the first two of which are always alcaïcs of the first kind; the third verse is an iambic dimeter hypercatalectic, or consisting of four feet and a long syllable; and the fourth verse is an alcaïc of the second kind. The following strophe is of this species, which Horace calls "*minaces Alcæi camenæ.*"

*Non possidentem multa vocaveris*
*Recte beatum; rectius occupat*
*Nomen beati, qui deorum*
*Muneribus sapienter uti,* &c.

ALCAID, ALCAYDE, or ALCALDE, in the polity of the Moors, Spaniards, and Portuguese, a magistrate or officer of justice, answering nearly to the French provost and the British justice of peace. The alcaid among the Moors is vested with supreme jurisdiction, both in civil and criminal cases. Alcalde is still the title of the *mayors* of Spanish towns.

ALCALA DE GUADAIRA, a town of Spain, in Andalucia, upon the river Guadaira, with 7000 inhabitants, chiefly engaged in agriculture and the making of bread. It has abundance of springs, from which water is conveyed to Seville by an aqueduct. Long. 5. 47. W. Lat. 37. 15. N.

ALCALA *de Henares*, a city of Spain, on the river Henares, in the province of New Castile. It was formerly celebrated for its university, which has latterly been transferred to Madrid. This university was founded by Cardinal Ximenes, and it was here that the famous edition of the Holy Bible, known as the *Complutensian Polyglot*, was prepared. Alcala contains 5153 inhabitants, and has a military school for the artillery and engineer corps. Among many distinguished men to whom it had the honour of giving birth are, the poet Figueroa, the naturalist Bustamente de la Cámara, the historian Solis, and last and greatest of all, Cervantes.



ALCALA *de los Gazules*, a town of Seville in Spain, 27 miles N.W. of Cadiz, in a picturesque mountainous district. It has about 6000 inhabitants, chiefly engaged in agriculture.

ALCALA *la Real*, a city of Andalucia in Spain, 18 miles S.W. of Jaen. It stands between two mountain ridges, at an elevation of about 3000 feet above the sea. It has a fine abbey, two parish churches, and two convents, and a population chiefly agricultural, of about 7000. Alonso de Alcala, a celebrated physician and jurist of the sixteenth century, was born here. In 1810 the Spaniards were defeated here by the French.

ALCALY, or ALCALI, or ALKALI. See CHEMISTRY, *Index*.

ALCAMENES (Ἀλκαμένης), a famous Athenian sculptor, a pupil of Phidias, who is celebrated for his skill in art by Cicero, Pliny, Pausanias, Lucian, &c. He appears as one of the great triumvirate of Greek sculptors, Phidias, Alcamenes, and Polycletus. He competed with his master in a statue of Minerva. It would appear that in this attempt his style was exquisite in finish, but that he failed in the spirit of his work, when compared to that of his mighty master. His statue of Venus Urania, that adorned her temple at Athens, was reckoned his masterpiece. He flourished about 430 years B. C.

ALCAMO, a city of Sicily, on the river Freddo or St Bartholomew, in the intendancy of Trapani. It is a parliamentary city, in a district of peculiar fertility, which produces some of the best wines of the island. It contains a very strong castle, many churches and monasteries, and 13,000 inhabitants. Near to it are remains of the ancient Segesta, with its temple and theatre in good preservation; and near the sea are some celebrated warm baths.

ALCANIZ, a Spanish town upon the Guadaloupe, in the province of Teruel, with a fine town-house, a college, three parish churches, six monasteries, one hospital, and 5100 inhabitants. The surrounding country is wild, but rich in olives, mulberry trees, and alum.

ALCANNA, or ALKANNA, in *Commerce*, a powder prepared from the leaves of the Egyptian privet, in which the people of Cairo drive a considerable trade. It is much used by the Turkish women, to give a golden colour to their nails and hair. In dyeing, it gives a yellow colour when steeped with common water, and a red when infused in vinegar. There is also an oil extracted from the berries of alcanna, which is sometimes used in medicine.

ALCANTARA, the *Interamnium* of the Romans, a town of Estremadura in Spain, on the left bank of the Tagus, with 4273 inhabitants. Alcantara (*Arabice*, Al Kantrah, *i.e.* the bridge), derived its name from the magnificent Roman bridge which spanned the Tagus at this point; and which was erected, according to the inscription, in A.D. 104, at the joint expense of the several towns therein mentioned, in honour of the Emperor Trajan, who was a native of Spain. This noble monument of antiquity was injured by the English, and afterwards, with gratuitous barbarism, blown up by the French general Victor, during the campaign of 1809. It was repaired with timber in 1818, and again burnt in 1836 to prevent the passage of the Carlist troops. Lat. 39. 41. N. Long. 6. 44. W.

*Knights of ALCANTARA*, one of the five military orders of Spain, which took its name from the above-mentioned city. They make a very considerable figure in the history of the expeditions against the Moors. The knights of Alcantara make the same vows as those of Calatrava, and are only distinguished from them by this, that the cross fleur-de-lis, which they bear over a large white cloak, is of a green colour. They possess 37 commanderies. By the terms of the surrender of Alcantara to this order, it was stipulated that there should be a confraternity between the two orders, with the same practices and observances in both; and that the order of Alcantara should be subject to be visited by the grand master of Calatrava. But the former soon released themselves from this engagement, on pretence that their grand master had not been called to the election of that of Calatrava, as had been likewise stipulated in the articles. After the expulsion of the Moors, and the taking of Granada, the sovereignty of the order of Alcantara and that of Calatrava was settled in the crown of Castile by Ferdinand and Isabella. In 1540 the knights of Alcantara sued for leave to marry, which was granted them.

ALCARAZ, a small city of La Mancha, in Spain, now in the province of Albacete. The judicial district of the same name contains 28,000 inhabitants. It is a very mountainous region, interspersed with fertile valleys. The principal mountain chain is the Sierra de Alcaraz, a prolongation of the Sierra Morena. The city stands near the river Guardamena, and has the remains of a once strong castle, and of a magnificent Roman aqueduct. It is mentioned by Ptolemy under the name of *Urcesa*, converted by the Arabs into Al Karrasch. Pop. 7325.

ALCAUDETE, a town of Andalucia, in Spain, in the province of Jaen, in a fertile territory, producing wine, oil, corn, and abundance of fruits. It has a castle, two parish churches, four monasteries, and 6499 inhabitants.

ALCAVALA was a duty imposed in Spain and its colonies on all transfers of property, whether public or private. It was originally imposed in 1341, as an *ad valorem* tax of 10, increased afterwards to 14, per cent., charged on all commodities, whether raw or manufactured, as often as they were sold or exchanged, being always rated according to their selling price. The levying of this tax required a multitude of revenue officers sufficient to guard the transportation of goods not only from one province to another, but from one shop to another. It subjected not only the dealers in some sort of goods, but those in all sorts, every farmer, every manufacturer, every merchant and shopkeeper, to the continual visits and examination of the tax-gatherers. This monstrous impost was permitted to ruin the industry and commerce of the greater part of the kingdom down to the invasion of Napoleon. Catalonia and Aragon purchased from Philip V. an exemption from the alcavala, and from another pernicious tax called the *milliones* (duties on butcher-meat, and other articles of provisions), by the substitution of a tax on the rents of lands and houses, and on profits, and the wages of labour. Extremely onerous as this latter tax was, Catalonia and Aragon were in a comparatively flourishing state, in consequence of their exemption from the oppressive alcavala.—M'Culloch *on Taxation*.

ALCAZAR DE SAN JUAN, a Spanish town in a district of the same name, in the province of Ciudad Real, and diocese of Toledo. It contains 7540 inhabitants. It has manufactures of soap, saltpetre, and gunpowder. This is the *Alce* of the Romans, taken by T. Sempronius Gracchus after a victory over the Celtiberians, B.C. 180.—*Livy*, xl. 48, 49.

ALCAZAR DO SAL, a town of Portugal, in Estremadura, with a castle said to be impregnable. It is fortified both by art and nature, being built on the top of a rock exceedingly steep on all sides. The salt produced here, whence the town takes its name, is of remarkable whiteness. The fields produce large quantities of rushes, of which mats are made, which are transported out of the kingdom. Pop. 4000. Long. 9. 10. W. Lat. 38. 18. N.

ALCAZAR KEBIR, a city of Barbary, seated about two leagues from Larache, in Asga, a province of the kingdom of Fez. It was of great note, and the seat of the governor of this part of the kingdom. It was built by Jacob Almanzor, king of Fez, about the year 1180, and designed for a magazine and place of rendezvous for the great preparations he was making to enter Granada in Spain, and to make good the footing which Joseph Almanzor had got some time before. It is said his father first invaded Spain with 300,000 men, most of whom he was obliged to bring back to Africa to quell a rebellion that had broken out in Marocco. This done, he returned to Spain again with an army, as is said, of 200,000 horse and 300,000 foot. The city is now fallen greatly to decay, so that of fifteen mosques, two only are used, probably in consequence of the bad situation of the town; for it stands so low, that it is excessively hot in summer, and in winter almost overflowed with water. Population about 5000. Near this city there is a high ridge of mountains running towards Tetuan, whose inhabitants were never brought entirely under subjection. Not far from this is the river Elmahassen, famous for the battle fought between Don Sebastian, king of Portugal, and the Moors, in which the Portuguese were defeated, and their king slain. Long. 12. 35. W. Lat. 35. 15. N.



ALCAZAR, *Luis de*, a learned Spanish Jesuit, born at Seville in 1554. His ingenuity was chiefly directed to the interpretation of the Apocalypse, on which subject he wrote various treatises. He was greatly beloved in his native city, where he died in 1613.

ALCEDO, the genus *Kingfisher*, in Ornithology.

ALCEDO, *Antonio de*, a Spanish geographer of the West Indies, whose work printed, in 5 vols. 4to, in 1786-9, was suppressed by the government. It was translated into English in 1812-15 by Mr G. A. Thompson; but is now entirely superseded.

ALCESTER, a parish and market town in the county of Warwick, 13 miles W.S.W. of Warwick, with 2027 inhabitants, who manufacture needles and fish-hooks. It was the ancient *Alauna*.

ALCESTIS, the daughter of Pelias, and wife of Admetus king of Pheræ in Thessaly, who consented to die in place of her husband, and was afterwards restored to life by Hercules. This beautiful instance of female devotion forms the subject of one of the best plays of Euripides.

ALCHADEB, a Spanish rabbi, who flourished about the end of the 15th century. He was celebrated as an astronomer, but his works, with one exception, exist only in MS.

ALCHEMY, a word of equally doubtful origin with the science which it denotes. The prefix *al* suggests an Arabic source, and the word has accordingly been explained as signifying *the chemistry*, with reference to the "great projection," as the terminating and highest result of the science.

It is impossible now to connect the *hermetic art* of the Egyptians, and the traces of alchemy in the later history of Rome, with its first historical development in the middle ages, beginning in the eighth century with the Arabian Gebir. From the Arabians it passed into Europe; and the period from the eleventh to the sixteenth century inclusive constitutes the proper reign of alchemy. During this period it numbered among its adepts the great names of Roger Bacon, Albertus Magnus, Aquinas, Raymond Lully, Arnauld of Villa Nova, Basil Valentine, and Paracelsus. From these, the genuine and highest type of alchemists, we must take our estimate of the art, and not from the baser class of visionaries and impostors with whom the name has too long been universally associated. These men, then, will be found to have been in reality laborious experimental chemists, and their belief in the particular doctrines of alchemy to have been the very natural offspring of the contact of high speculative intellect, in a dark and enthusiastic age, with the wonders of a science pregnant above all others in marvels and in mystery. That these men contributed little to our real knowledge of nature, even if true, might well be accounted for, by the fact that the trammels of spiritual authority still fettered the human mind, and that the jealous guardianship of superstition too faithfully bounded the inquiries of a bold curiosity. Modern science, however, stands indebted in no small degree to the alchemy of the middle ages.

The peculiar objects of the enthusiastic and patient pursuit of the alchemist were, 1*st*, the *alkahest*, or universal solvent, an element to which modern chemistry has made a kind of approximation. 2*d*, the transmutation of metals, an idea under different forms, which will be found to pervade the whole course of chemical inquiry. "The improvements," says Sir Humphry Davy, "taking place in the methods of examining bodies, are constantly changing the opinions of chemists with respect to their nature; and there is no reason to suppose that any real indestructible principle has yet been discovered. Matter may ultimately be found to be the same in essence, differing only in the arrangement of its particles; or two or three simple substances may produce all the varieties of compound bodies." The possibility of the realisation of this idea still remains, however, to be demonstrated. 3*d*, The *elixir vitæ*, or universal medicine, for the cure of all diseases, and the indefinite prolongation of human life, an idea which, we may remark, has not been peculiar to the alchemists, having substantially been held by Bacon and Descartes. For fuller historical particulars see CHEMISTRY, *History*.

ALCIATI, ANDREA, an eminent Italian jurist, who was born near Milan, in 1492, and died in 1550. He mixed much of polite learning in the explication of the laws, and happily drove out the barbarity of language which till then had reigned in the lectures and writings of lawyers: for which Thuanus highly praises him. He published a great many law-books, and some notes upon Tacitus. His *Emblems* have been much admired, and translated into French, Italian, and Spanish. His *History of Milan* appeared after his death.

ALCIBIADES, the celebrated Athenian general, son of Clinias and Deinomache, was born at Athens about the year 450 B.C. Of high birth, princely fortune, and surpassing personal beauty, he was eminently distinguished for the brilliancy and versatility of his talents; but his youth was disgraced by debauchery and excess, from which his friend Socrates strove in vain to reclaim him. Mutual services had cemented their friendship; Socrates having rescued him from death at the battle of Potidæa, as he afterwards saved the life of Socrates at that of Delium. On the death of Cleon, in 422, he became one of the leaders in the Athenian commonwealth, and the head of the war party, in opposition to Nicias. He warmly advocated the Sicilian expedition, of which he was chosen a joint commander with Nicias and Lamachus. Shortly after his arrival there, he was recalled to Athens, to stand his trial respecting the mysterious mutilation of the Hermes busts, with which act of impiety he was charged as a ringleader previously to his departure; but contriving to escape from the state vessel that was conveying him, he proceeded to Sparta, where he acted as the avowed enemy of his country. Sentence of death was passed upon him at Athens, and his property confiscated. The machinations of Agis II. obliged him to leave Sparta; and taking refuge with Tissaphernes, he induced that commander to desert the Spartans, and declare himself in favour of the Athenians, who thereupon recalled Alcibiades from exile. Before he returned, however, the Athenians under his command gained the victories of Cynossema, Abydos, and Cyzicus, and took possession of Chalcedon and Byzantium; after which, in 407, he entered Athens in triumph, and was appointed commander of all the land and sea forces. But the year following he was superseded, in consequence of the defeat of his fleet at Notium, occasioned by the rashness of his lieutenant Antiochus, and he retired into voluntary exile to his fortified domain at Bisanthe. Before the fatal battle of Ægos-Potamos, he gave an ineffectual warning to the Athenian leaders. After the fall of Athens, he was banished and took refuge with Pharnabazus, and was about to proceed to the court of Artaxerxes, when assassins, hired either by the Spartans or by the brothers of a lady whom he had seduced, fired his house in the night; and in attempting to escape, he was slain with darts, in the forty-sixth year of his age, B.C. 404. He left a son, of his own name, by his wife Hipparete.



ALCIDAMAS, a Greek rhetorician, who gave instructions in eloquence at Athens, where he resided between the years B.C. 432 and 411. His chief works are lost; but there are two orations extant that pass under his name.—See Reiske's *Oratores Græci*; and Bekker's *Oratores Attici*.

ALCIDES, a name of Amphitryon, son of Alcæus, and more especially of Hercules the grandson of Alcæus.

ALCINOUS, a Platonic philosopher of uncertain date, author of a work entitled Ἐπιτομὴ τῶν Πλάτωνος δογμάτων, which has been translated into English by Stanley in his History of Philosophy. The best edition of the Greek original is that by Fisher, Lips. 1783, 8vo.

ALCINOUS, a mythical king of the Phæacians, in the island of Scheria or Drepane, which it would be difficult to identify with any modern island, was son of Nausithous, and grandson of Neptune and Peribœa. This king has been immortalised in the Odyssey. He received Ulysses with much civility, when a storm had cast him on his coast. His people loved pleasure and good cheer, yet were skilful seamen; and Alcinous is described as a good prince.

ALCIPHRON, the most eminent of the Greek epistolary writers, was probably a contemporary of Lucian. His letters, of which 116 have been published, are written in the purest Attic dialect: the imaginary authors of them are country people, fisherwomen, courtesans, and parasites; who express their sentiments and opinions on familiar subjects in refined and elegant language, yet without any very apparent inconsistency. The new Attic comedy being the principal source from which Alciphron derived his information, these letters are valuable as delineating the private life of the Athenians at that period. The best editions are by Bergler, Lips. 1715, and Wagner, Lips. 1798.

ALCIRA, the ancient *Sucro*, a Spanish town upon an island in the river Júcar, in the province of Valencia. It is surrounded with walls, and has two parish churches, six monasteries, one hospital, four poorhouses, and 13,000 inhabitants. Its principal productions are silk, rice, and oranges, which are exported to Seville, France, and England.

ALCMÆON, a philosopher of Crotona, who lived about 550 B.C. He is said to have been a pupil of Pythagoras, and according to some he was the first who dissected the human body. His writings are lost, but his opinions may be gathered from Stobæus, Plutarch, and Galen.

ALCMAER, a city of the United Provinces, in North Holland, seated about four miles from the sea, 15 from Haarlem, and 18 from Amsterdam. The streets and houses are extremely neat and regular, and the public buildings very beautiful. The church of St Lawrence is a fine Gothic building of the fifteenth century, with a beautiful porch. Alcmaer has a court of primary jurisdiction, a college, a theatre, &c. In 1850 the number of inhabitants was 10,148.

ALCMAN, sometimes also called ALCMAEON, one of the most ancient, and, in the opinion of the Alexandrian critics, the most distinguished among the lyric poets of Greece. According to one account he was by birth a Lydian, while others state that he was a native of Sparta, where, at any rate, he lived from a very early age. The time at which he flourished is uncertain, though it is generally assumed that it was the period between the years 620 and 640 B.C. Alcman may in some respects be regarded as the father of lyric poetry among the Greeks, and it was probably for this reason that the Alexandrian critics put him at the head of their lyric canon. His poems, which seem to have formed a collection of six books, are known to us only from a number of small fragments. Many of them were of an erotic character, but others of them were hymns, and *scolia*. All were written in the vigorous broad dialect of the Dorians. The best collection of these fragments was published by F. G. Welcker, Giesen, 1815, 4to; they are also contained in Bergk's "*Poetæ Lyrici Græci*," 1852, 8vo. (L. S.)

ALCMANIAN, an ancient lyric kind of verse, consisting of two dactyles and two trochees: as,—

*Virgini|bus pue|risque|canto.*

It derived its name from the poet above mentioned.

ALCMENA, the daughter of Electryon, king of Mycenæ, and wife of Amphitryon. She was the mother of Hercules by Zeus, who assumed the likeness of her husband during his absence; and at the same birth she bore Iphicles by Amphitryon.

ALCOBAZA, a town of Portugal, to the north of Lisbon, in the province of Estremadura, at the confluence of the two rivers Alcoa and Baza. It is celebrated for its monastery, one of the richest and most splendid establishments in the kingdom. It contains 295 houses and 2000 inhabitants.

ALCOCK, JOHN, doctor of laws, and bishop of Ely in the reign of Henry VII., was born at Beverley in Yorkshire, and educated at Cambridge. He was first made dean of Westminster, and afterwards appointed master of the rolls. In 1471 he was consecrated bishop of Rochester; in 1476 he was translated to the see of Worcester; and in 1486 to that of Ely, in the room of Dr John Morton, preferred to the see of Canterbury. He was a prelate of great learning and piety, and so highly esteemed by King Henry, that he appointed him lord-president of Wales, and afterwards lord-chancellor of England. Alcock founded a school at Kingston-upon-Hull, and built the spacious hall belonging to the episcopal palace at Ely. He was also the founder of Jesus College in Cambridge, for a master, six fellows, and as many scholars. This house was formerly a nunnery, dedicated to St Radigund; and Godwin says that the building being greatly decayed, and the revenues reduced almost to nothing, the nuns had all forsaken it, except two; whereupon Bishop Alcock procured a grant from the crown, and converted it into a college. But Camden and others tell us, that the nuns of that house were so notorious for their incontinence, that King Henry VII. and Pope Julius II. consented to its dissolution: Bale accordingly calls this nunnery *spiritualium meretricum cœnobium*, a community of spiritual harlots. Bishop Alcock wrote several pieces, among which are the following:—1. Mons Perfectionis; 2. In Psalmos Pœnitentiales; 3. Homiliæ Vulgares; 4. Meditationes Piæ. He died October 1. 1500, and was buried in the chapel built by himself in Ely cathedral.

ALCOENTRE, a town of Portugal, in the province of Estremadura. It is within the lines of Torres Vedras, and was occupied by the allied troops as cantonments during the important period when those lines were the barrier that secured the safety of the peninsula.

ALCOHOL, or ALKOHOL, in *Chemistry*, spirits of wine highly rectified. It is also used for any highly rectified spirit. *Absolute* alcohol has been obtained of a specific gravity, 794·2. See MATERIA MEDICA.

ALCOHOLIZATION, the process of rectifying any spirit.

ALCOR, the name of a small star adjoining to the large bright one in the middle of the tail of *Ursa major*. The word is Arabic. It is a proverb among the Arabians, applied to one who pretends to see small things, but overlooks much greater: *Thou canst see Alcor, and yet not see the full moon.*



ALCORA, a town of Valencia in Spain, celebrated for its delft and porcelain manufactory. Pop. 6000.

ALCORAN, or AL-KORAN, the scripture or bible of the Mahometans. The word is compounded of the Arabic particle *al*, and *koran*, derived from the verb *karaa*, to read. It therefore properly signifies *the reading*, or rather *that which ought to be read.* By this name the Mahometans denote not only the entire book or volume of the Koran, but also any particular chapter or section of it; just as the Jews call either the whole Scripture, or any part of it, by the name of *Kara* or *Mikra*, words of the same origin and import.

Besides this peculiar name, the Koran is also honoured with several appellations common to other books of Scripture: as *al Farkan*, from the verb *foraka*, to divide or distinguish; not, as the Mahometan doctors say, because those books are divided into chapters or sections, or distinguish between good and evil, but in like manner as the Jews use the word *Perek* or *Pirka*, from the same root, to denote a section or portion of Scripture. It is also called *al Moshaf*, the volume, and *al Kitah*, the book, by way of eminence, which answers to the *Biblia* of the Greeks; and *al Dhikr*, the admonition, which name is also given to the Pentateuch and Gospel.

The Koran is divided into 114 larger portions of very unequal length, which we call *chapters*, but the Arabians *sowar*, in the singular *sura*, a word rarely used on any other occasion, and properly signifying a row, order, or a regular series; as a course of bricks in a building, or a rank of soldiers in an army; and is the same in use and import with the Sura or Tora of the Jews, who also call the fifty-three sections of the Pentateuch *Sedarim*, a word of the same signification.

These chapters are not distinguished in the manuscript copies by their numerical order, but by particular titles, which are taken sometimes from a particular matter treated of, or person mentioned therein; but usually from the first word of note, exactly in the same manner as the Jews have named their *Sedarim;* though the word from which some chapters are denominated be very far distant, towards the middle, or perhaps the end of the chapter; which seems ridiculous. But the occasion of this appears to have been, that the verse or passage wherein such word occurs was, in point of time, revealed and committed to writing before the other verses of the same chapter which precede it in order; and the title being given to the chapter before it was completed, or the passages reduced to their present order, the verse from whence such title was taken did not always happen to begin the chapter. Some chapters have two or more titles, occasioned by the difference of the copies.

Some of the chapters having been revealed at Mecca, and others at Medina, the noting of this difference makes a part of the title; but the reader will observe that several of the chapters are said to have been revealed partly at Mecca and partly at Medina; and as to others, it is yet a dispute among the commentators to which of the two places they belong.

Every chapter is subdivided into smaller portions, of very unequal length also, which we customarily call *verses;* but the Arabic word is *ayat*, the same with the Hebrew *ototh*, and signifies *signs* or *wonders:* such as are the secrets of God, his attributes, works, judgments, and ordinances, delivered in those verses; many of which have their particular titles also, imposed in the same manner as those of the chapters.

Besides these unequal divisions of chapter and verse, the Mahometans have also divided their Koran into sixteen equal portions, which they call *Ahzab*, in the singular *Hizb*, each divided into four equal parts; which is also an imitation of the Jews, who have an ancient division of their Mishna into sixty portions called *Massictoth.* But the Koran is more usually divided into thirty sections only, named *Ajza*, from the singular *Joz*, each of twice the length of the former, and in like manner subdivided into four parts. These divisions are for the use of the readers of the Koran in the royal temples, or in the adjoining chapels, where the emperors and great men are interred. There are thirty of these readers belonging to every chapel, and each reads his section every day; so that the whole Koran is read over once a day.

Next after the title, at the head of every chapter, except only the ninth, is prefixed the following solemn form, by the Mahometans called the *Bismallah*, IN THE NAME OF THE MOST MERCIFUL GOD; which form they constantly place at the beginning of all their books and writings in general, as a peculiar mark or distinguishing characteristic of their religion, it being counted a sort of impiety to omit it. The Jews, for the same purpose, make use of the form, *In the name of the LORD*, or *In the name of the great GOD;* and the eastern Christians that of *In the name of the Father, and of the Son, and of the Holy Ghost.* But Mahomet probably took this form, as he did many other things, from the Persian Magi, who used to begin their books in these words, *Benam Yezdan bakshaishgher dadar;* that is, *In the name of the most merciful just GOD.*

There are twenty-nine chapters of the Koran which have this peculiarity, that they begin with certain letters of the alphabet, some with a single one, others with more. These letters the Mahometans believe to be the peculiar marks of the Koran, and to conceal several profound mysteries, the certain understanding of which, the most intelligent confess, has not been communicated to any mortal, their prophet only excepted. Notwithstanding which, some will take the liberty of guessing at their meaning by that species of Cabala called by the Jews *Notarikon*, and suppose the letters to stand for as many words, expressing the names and attributes of God, his works, ordinances, and decrees; and therefore these mysterious letters, as well as the verses themselves, seem in the Koran to be called *signs.* Others explain the intent of these letters from their nature or organ, or else from their value in numbers, according to another species of the Jewish Cabala, called *Gematria;* the uncertainty of which conjectures sufficiently appears from their disagreement. Thus, for example, five chapters, one of which is the second, begin with these letters, A. L. M. which some imagine to stand for *Allah latiff magid, GOD is gracious and to be glorified;* or, *Ana li minni*, i. e. *to me and from me*, viz. belongs all perfection, and proceeds all good; or else for *Ano Allah alam, I am the most wise GOD*, taking the first letter to mark the beginning of the first word, the second the middle of the second word, and the third the last of the third word; or for *Allah, Gabriel Mohammed*, the author, revealer, and preacher of the Koran. Others say, that as the letter A belongs to the lower part of the throat, the first of the organs of speech; L to the palate, the middle organ; and M to the lips, which are the last organ; so these letters signify that God is the beginning, middle, and end, or ought to be praised in the beginning, middle, and end, of all our words and actions: or, as the total value of those three letters, in numbers, is seventy-one, they signify, that, in the space of so many years, the religion preached in the Koran should be fully established. The conjecture of a learned Christian is at least as certain as any of the former, who supposes those letters were set there by the amanuensis, for *Amar li Mohamed*, i. e. *at the command of Mohammed*, as the five letters prefixed to the nineteenth chapter seem to be there written by a Jewish scribe, for *Coh yaas, Thus he commanded.*



The Koran is universally allowed to be written with the utmost elegance and purity of language, in the dialect of the tribe of Koreish, the most noble and polite of all the Arabians, but with some mixture, though very rarely, of other dialects. It is confessedly the standard of the Arabic tongue, and, as the more orthodox believe and are taught by the book itself, inimitable by any human pen (though some sectaries have been of another opinion); and therefore insisted on as a permanent miracle, greater than that of raising the dead, and alone sufficient to convince the world of its divine original.

And to this miracle did Mahomet himself chiefly appeal for the confirmation of his mission, publicly challenging the most eloquent men in Arabia, which was at that time stocked with thousands whose sole study and ambition it was to excel in elegance of style and composition, to produce even a single chapter that might be compared with it.[1]

To the pomp and harmony of expression some ascribe all the force and effect of the Koran, which they consider as a sort of music, equally fitted with other species of that art to ravish and amaze. In this Mahomet succeeded so well, and so strangely captivated the minds of his audience, that several of his opponents thought it the effect of witchcraft and enchantment, as he himself complains. Others have attributed the effect of the Koran to the frequent mention of rewards and punishments,—heaven and hell occurring almost in every page. Some suppose that the sensual pleasures of paradise, so frequently set before the imaginations of the readers of the Koran, were what chiefly bewitched them; though, with regard to these, there is a great dispute whether they are to be understood literally or spiritually. Several have even allegorized the whole book.

The general design of the Koran was to unite the professors of the three different religions then followed in the populous country of Arabia (who for the most part lived promiscuously, and wandered without guides, the far greater number being idolaters, and the rest Jews and Christians mostly of erroneous and heterodox belief) in the knowledge and worship of one God, under the sanction of certain laws, and the outward signs of ceremonies partly of ancient and partly of novel institution, enforced by the consideration o rewards and punishments both temporal and eternal, and to bring them all to the obedience of Mahomet, as the prophet and ambassador of God, who, after the repeated admonitions, promises, and threats of former ages, was at last to establish and propagate God's religion on earth, and to be acknowledged chief pontiff in spiritual matters, as well as supreme prince in temporal.

The great doctrine, then, of the Koran is the unity of God, to restore which point, Mahomet pretended, was the chief end of his mission; it being laid down by him as a fundamental truth, that there never was, nor ever can be, more than one true orthodox religion. For, though the particular laws or ceremonies are only temporary, and subject to alteration, according to the divine directions, yet the sub-

[1] As the composition and arrangement of words, however, admit of infinite varieties, it can never be absolutely said that any one is the best possible. In fact, Hamzah Benahmed wrote a book against the Koran with at least equal elegance; and Moselema another, which even surpassed it, and occasioned a defection of a great part of the Mussulmans. (*Jour. de Sçav.* tom. xiii. p. 280. *Œuv. de Sçav.* Nov. 1708, p. 404.)

stance of it being eternal truth, is not liable to change, but continues immutably the same. And he taught, that whenever this religion became neglected, or corrupted in essentials, God had the goodness to re-inform and re-admonish mankind thereof, by several prophets, of whom Moses and Jesus were the most distinguished, till the appearance of Mahomet, who is their seal, and after whom no other is to be expected. The more effectually to engage the people to hearken to him, great part of the Koran is employed in relating examples of dreadful punishments formerly inflicted by God on those who rejected and abused his messengers. Several of these stories, or some circumstances of them, are taken from the Old and New Testaments, but many more from the apocryphal books and traditions of the Jews and Christians of those ages, and are set up in the Koran as truths in opposition to the Scriptures, which the Jews and Christians are charged with having altered. But in fact few or none of the relations or circumstances in the Koran were invented by Mahomet, as is generally supposed, it being easy to trace the greater part of them much higher, as the rest might be, were more of those books extant, and were it worth while to make the inquiry.

The rest of the Koran is taken up in prescribing necessary laws and directions, frequent admonitions to moral and divine virtues, the worship and reverence of the Supreme Being, and resignation to his will. One of their most learned commentators distinguishes the contents of the Koran into *allegorical* and *literal*. Under the former are comprehended all the obscure, parabolical, and enigmatical passages, with such as are repealed or abrogated; under the latter, such as are clear and in full force.

The most excellent moral in the whole Koran, interpreters say, is that in the chapter *Al Alraf*, viz. "Show mercy, do good to all, and dispute not with the ignorant;" or, as Mr Sale renders it, "Use indulgence, command that which is just, and withdraw far from the ignorant." Mahomet, according to the authors of the *Keschaf*, having begged of the angel Gabriel a more ample explication of this passage, received it in the following terms:—"Seek him who turns thee out, give to him who takes from thee, pardon him who injures thee; for God will have you plant in your souls the roots of his chief perfections." It is easy to see that this commentary is copied from the Gospel. In reality, the necessity of forgiving enemies, though frequently inculcated in the Koran, is of a later date among the Mahometans than among the Christians; among those latter, than among the heathens; and to be traced originally to the Jews. (See Exodus xxiii. 4, 5.) But it matters not so much who had it first, as who observes it best. The caliph Hassan, son of Ali, being at table, a slave unfortunately let fall a dish of meat, reeking hot, which scalded him severely. The slave fell on his knees, rehearsing these words of the Koran:—"Paradise is for those who restrain their anger." "I am not angry with thee," answered the caliph. "And for those who forgive offences against them," continues the slave. "I forgive thee thine," replies the caliph. "But, above all, for those who return good for evil," adds the slave. "I set thee at liberty," rejoined the caliph; "and I give thee ten dinars."

There are also a great number of occasional passages in the Koran, relating only to particular emergencies. For in the piecemeal method of receiving his revelation, Mahomet had this advantage, that whenever he happened to be particularly perplexed with any thing, he had a certain resource in some new morsel of revelation. It was an admirable contrivance of his to bring down the whole Koran at once only to the lowest heaven, not to earth; since, had the whole been published at once, innumerable objections would have been made, which it would have been impossible for him to solve; but as he received it by parcels, as God saw fit they should be published for the conversion and instruction of the people, he had a sure way to answer all emergencies, and to extricate himself with honour from any difficulty which might occur.

It is the general and orthodox belief among the Mahometans that the Koran is of divine original; nay, that it is eternal and uncreated, remaining, as some express it, in the very essence of God; that the first transcript has been from everlasting by God's throne, written on a table of vast size, called the *preserved table*, in which are also recorded the divine decrees, past and future; that a copy from this table, in one volume, on paper, was, by the ministry of the angel Gabriel, sent down to the lowest heaven, in the month of Ramadan, on the night of *power;* from whence Gabriel revealed it to Mahomet by parcels, some at Mecca, and some at Medina, at different times, during the space of 23 years, as the exigency of affairs required; giving him, however, the consolation to show him the whole (which, they say, was bound in silk, and adorned with gold and precious stones of paradise) once a-year; but that in the last year of his life he had the favour to see it twice. They say that few chapters were delivered entire, the greater part being revealed piecemeal, and written down from time to time by the prophet's amanuensis in such a part of such and such a chapter till they were completed, according to the directions of the angel. The first parcel that was revealed is generally agreed to have been the first five verses of the 46th chapter.

After the new-revealed passages had been from the prophet's mouth taken down in writing by his scribe, they were published to his followers, several of whom took copies for their private use, but the far greater number got them by heart. The originals, when returned, were put promiscuously into a chest, observing no order of time; for which reason it is uncertain when many passages were revealed.

When Mahomet died, he left his revelations in the same disorder, and not digested into the method, such as it is, in which we now find them. This was the work of his successor, Abu Bekr, who, considering that a great number of passages were committed to the memory of Mahomet's followers, many of whom were slain in the wars, ordered the whole to be collected, not only from the palm-leaves and skins on which they had been written, and which were kept between two boards or covers, but also from the mouths of such as had learned them by heart; and this transcript, when completed, he committed to the custody of Hassa, the daughter of Omar, one of the prophet's widows.

From this relation it is generally imagined that Abu Bekr was really the compiler of the Koran, though, for aught that appears to the contrary, Mahomet left the chapters complete as we now have them, excepting such passages as his successor might add or correct from those who had committed them to memory; what Abu Bekr did else being perhaps no more than to range the chapters in their present order, which he seems to have done without any regard to time, having generally placed the longest first.

However, in the 30th year of the Hegira, Othman being then caliph, and observing the great disagreement in the copies of the Koran in the several provinces of the empire, —those of Irak, for example, following the reading of Abu Musa al Ashari, and the Syrians that of Makdad Ebn Aswad, —he, by the advice of the *companions*, ordered a great number of copies to be transcribed from that of Abu Bekr, in Hassa's care, under the inspection of Zeid Ebn Thabet, Abd'allah Ebn Zobair, Said Ebn al As, and Abd'alrahman Ebn al Hareth the Makhzumite; whom he directed, that wherever they disagreed about any word, they should write it in the dialect of the Koreish, in which it was at first delivered. These copies, when made, were dispersed in the several provinces of the empire, and the old ones burnt and suppressed. Though many things in Hassa's copy were corrected by the above-mentioned revisers, yet some few various readings still occur.

"The most prominent feature of the Koran, that point of excellence in which the partiality of its admirers has ever delighted to view it, is the sublime notion it generally impresses of the nature and attributes of God. If its author had really derived these just conceptions from the inspiration of that Being whom they attempt to describe, they would not have been surrounded, as they now are on every side, with error and absurdity. But it might easily be proved, that whatever it justly defines of the Divine attributes, was borrowed from our Holy Scriptures; which even from its first promulgation, but especially from the completion of the New Testament, has extended the views and enlightened the understandings of mankind; and thus furnished them with arms which have too often, though ineffectually, been turned against itself by its ungenerous enemies.

"In this instance particularly, the copy is far below the great original, both in the propriety of its images and the force of its descriptions. Our Holy Scriptures are the only compositions that can enable the dim sight of mortality to penetrate into the invisible world, and to behold a glimpse of the Divine perfections. Accordingly, when they would represent to us the happiness of heaven, they describe it, not by any thing minute and particular, but by something general and great,—something that, without descending to any determinate object, may at once, by its beauty and immensity excite our wishes and elevate our affections. Though in the prophetical and evangelical writings the joys that shall attend us in a future state are often mentioned with ardent admiration, they are expressed rather by allusion than similitude, rather by indefinite and figurative terms than by any thing fixed and determinate. 'Eye hath not seen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love him.' (1 Cor. ii. 9.) What a reverence and astonishment does this passage excite in every hearer of taste and piety! What energy, and at the same time what simplicity, in the expression! How sublime, and at the same time how obscure, is the imagery!

"Different was the conduct of Mahomet in his descriptions of heaven and of paradise. Unassisted by the necessary influence of virtuous intentions and divine inspiration, he was neither desirous, nor indeed able, to exalt the minds of men to sublime conceptions or to rational expectations. By attempting to explain what is inconceivable, to describe what is ineffable, and to materialize what in itself is spiritual, he absurdly and impiously aimed to sensualize the purity of the Divine essence. Thus he fabricated a system of incoherence, a religion of depravity, totally repugnant indeed to the nature of that Being who, as he pretended, was its object; but therefore more likely to accord with the appetites and conceptions of a corrupt and sensual age.

"That we may not appear to exalt our Scriptures thus far above the Koran by an unreasonable preference, we shall produce a part of the second chapter of the latter, which is deservedly admired by the Mahometans, who wear it engraved on their ornaments, and recite it in their prayers. 'God! there is no God but he; the living, the self-susbisting: neither slumber nor sleep seizeth on him: to him belongeth whatsoever is in heaven and on earth. Who is he that can intercede with him but through his good pleasure? He knoweth that which is past, and that which is to come. His throne is extended over heaven and earth, and the preservation of both is to him no burden. He is the high, the mighty.'" (*Sale's Kor.* ii. p. 30, 4to edit.)

ALCORAN is also figuratively applied to certain other books full of impieties and impostures. In this sense we meet with the Alcoran of the Cordeliers, which once made a great noise; wherein St Francis is extravagantly magnified, and put on a level with Jesus Christ. The Alcoran of the Cordeliers is properly an extract of a very scarce book, entitled *The Conformity of the Life of the seraphic father St Francis with the Life of Christ*, published in 1510, 4to; and again at Bologna in folio. Erasmus Albertus, being by the elector of Brandenburg appointed to visit a monastery of Franciscans, found this book; and being struck with the extreme folly and absurdity of it, collected a number of curiosities out of it, and published them under the title of the *Alcoran* of the Franciscans, with a preface by Martin Luther.



ALCOY, one of the most thriving manufacturing cities of Spain, on an elevated site near the river of the same name, in the province of Alicante, and 24 miles north of the town of that name. It manufactures an annual average of 23,000 pieces of cloth, and 200,000 reams of paper. Pop. about 20,000.

ALCUIN, in Latin *Albinus*, surnamed *Flaccus*, an eminent ecclesiastic, and the reviver of learning in the eighth century. He was born, it is supposed, in Yorkshire, about 735. He was educated at York, under the direction of Archbishop Egbert, as we learn from his own letters, in which he frequently calls that great prelate his beloved master, and the clergy of York the companions of his youthful studies. As he survived Bede about 70 years, it is hardly possible that he could have received any part of his education under him, as some writers of literary history have affirmed; and it is worthy of observation, that he never calls that great man his master, though he speaks of him with the highest veneration. It is not well known to what preferments he had attained in the church before he left England, though some say he was abbot of Canterbury. He was sent to Rome by Eanbald, the successor of Ethelbert, and in returning, at Parma he met Charlemagne, who, as Alcuin had already visited the French court, was no stranger to his extraordinary merit. The emperor contracted so great an esteem and friendship for him, that he earnestly solicited, and at length prevailed upon him, to settle in his court and become his preceptor in the sciences. Alcuin accordingly instructed that great prince in rhetoric, logic, mathematics, and divinity, which rendered him one of his greatest favourities. He particularly distinguished himself by his writings in defence of the orthodox faith against the heresiarch Felix D'Urgel; and on more than one occasion was employed in important missions between Charlemagne and Offa king of Mercia. "France," says one of our best writers of literary history, "is indebted to Alcuin for all the polite learning it boasted of in that and the following ages. The universities of Paris, Tours, Fulden, Soissons, and many others, owe to him their origin and increase, those of which he was not the superior and founder being at least enlightened by his doctrine and example, and enriched by the benefits he procured for them from Charlemagne." After Alcuin had spent many years in the most intimate familiarity with the greatest prince of his age, he at length, with great difficulty, obtained leave to retire from court to his abbey of St Martin, at Tours; where he reremained till his death, A.D. 804. In his retirement he kept up a constant correspondence with Charlemagne, from which it appears that both were animated with the most ardent love to learning and religion, and constantly employed in contriving and executing the noblest designs for their advancement. Alcuin composed many treatises on a great variety of subjects, in a style much superior in purity and elegance to that of the generality of writers in the age in which he flourished. His works were collected and published by Du Chesne, in one volume folio, Paris, 1617: a better edition is that of Froben, 2 vols. folio, Ratisbon, 1777. They consist of, 1. Tracts upon Scripture; 2. Tracts upon doctrine, discipline, and morality; 3. Historical treatises, letters, and poems. It is not improbable that Alcuin was the writer of the famous *Caroline Books.*

ALCYONIA, a family of marine animal bodies of the order of Zoophytes, included in the *polypifera.* They are distinct from sponges, but are allied to them. See ZOOLOGY.

ALCYONIUM STAGNUM, in *Ancient Geography,* a lake in the territory of Corinth, whose depth was unfathomable, and in vain attempted to be discovered by Nero. Through this lake Bacchus is said to have descended to hell to bring back Semele. (Pausanias.)

ALCYONIUS, PETER, a learned Italian, born in 1487. He was, for a considerable time, corrector of the press to Aldus Manutius, and afterwards Professor of Greek at Florence. His treatise on banishment entitled *Medices Legatus, sive de Exsilio,* written in imitation of the style of Cicero, brought upon him, though unjustly, the charge of plagiarism. Paulus Manutius, who bore him no goodwill, was the author of this insinuation, and says that Alcyonius made away with the only existing MS. of Cicero's Treatise *De Gloria,* to save detection; but the accusation has been satisfactorily refuted. Alcyonius composed two excellent orations on the taking of Rome, representing very strongly the injustice of Charles V. and the barbarity of his soldiers. There is also an oration ascribed to him, on the knights who died at the siege of Rhodes.

ALDBOROUGH, a small town in the wapentake of Claro, in the West Riding of Yorkshire. It is on the river Ure, and is supposed to be the ancient *Isurium Brigantium.* Near it are some remains of a druidical temple. It formerly returned two members to parliament, but has been disfranchised. Population of parish in 1851, 2438.

ALDEBARAN, in *Astronomy,* a star of the first magnitude, called in English the *bull's eye,* as making the eye of the constellation Taurus. Its longitude is 6. 32. 9. of Gemini, and its latitude 5. 29. 40. south.

ALDEBURGH, a market-town in the hundred of Plomesgate, in the county of Suffolk, chiefly inhabited by fishermen, and now much frequented as a bathing place. It formerly returned two members to parliament, but was disfranchised by the Act of Reform. The poet Crabbe was born here. Population of parish in 1851, 1627.

ALDEGREVER, HEINRICH, an eminent engraver of Westphalia, a pupil of Albert Durer, whom he imitated closely. His works are very numerous, chiefly from his own designs; so that he is considered also as a painter. His works date from 1522 to 1562.

ALDER, *Betula alnus.* The wood of this tree, which thrives in moist soils, is used on account of its durability, when of considerable dimensions, for piles, mill-work, pumps, and sluices. On account of its variegated colour it is occasionally used in turnery; but one of its most important uses is the excellent charcoal it affords for gunpowder. The bark is astringent, and is used in preparing leather; and the plant has also been used as a dye.

ALDERHOLM, an island of Sweden, formed by the three arms of a river running through Gefle, a town of Nordland, in Sweden, 80 miles north from Stockholm. Here is a wharf, a repository for planks and deals, two packing-houses, a large custom-house for taking toll of the ships, an arsenal for cannon, and a granary. Lat. 60. 40. N.

ALDERMAN, a word derived from the Anglo-Saxon *ealdorman,* compounded of the comparative degree of the word *eald* (old), and *man.* The term implies the possession of an office of rank or dignity. Earls and governors of provinces and other persons of distinction received this title among the Anglo-Saxons. Thus we meet with the titles of *aldermannus totius Angliæ, aldermannus regis, comitatis, civitatis, burgi, castelli, hundredi sive wapentachii, et novemdecimorum.* According to Spelman, the *aldermannus totius Angliæ* seems to have been the same officer who was afterwards styled *capitalis justiciarius Angliæ,* or chief justice of England; the *aldermannus regis* seems to have been an occasional magistrate, answering to our justice of assize; and the *aldermannus comitatus,* a magistrate who held a middle rank between what was afterwards called the *earl* and the *sheriff:* he sat at the trial of causes with the bishop; the latter proceeding according to ecclesiastical law, and the former declaring and expounding the common law of the land.



In modern times aldermen are office-bearers in the municipal corporations of England and Wales, and Ireland. Before the passing of the Municipal Corporations Act, their functions varied according to the charters of the different burghs. By the statute 5th and 6th Will. IV. c. 76, and 3d and 4th Vict. c. 118, the aldermen are elected by the councillors from among themselves (in Ireland, by the burgesses), for six years, one-half going out every three years. The number of councillors in each borough varies from 12 to 48, according to its magnitude. One-fourth of the municipal council consists of aldermen, and three-fourths of councillors. In the municipal corporations of Scotland there is no such title as alderman, the office-bearers of corresponding rank there being termed bailies.

The corporation of London was not included in the Burgh Reform Act; and the antiquated system remains there in full force. The court of aldermen consists of twenty-six, including the lord-mayor; the twenty-five aldermen are elected for life by the freemen of the different wards; when one dies or resigns a wardmote is called, who return two persons, one of whom the Court of Aldermen elect to supply the vacancy. The city is divided into twenty-six wards; twenty-four of these send up one alderman each; the other two between them choose a twenty-fifth; the twenty-sixth serves for the independent borough of Southwark, and is appointed by the other aldermen, who generally select the senior from among themselves when a vacancy occurs.

The lord-mayor is elected from such of the aldermen as have served the office of sheriff; from these the Common-hall, which consists of the freemen of the various wards, elect two; and the aldermen select one of these for the mayoralty.

The Court of Aldermen act as magistrates for the city of London, and also possess authority of a judicial nature in the affairs of the corporation. They are constituent members of the Court of Common Council, which is the legislative body of the corporation; but the other members of the Common Council, which consists of 264 members, are elected annually by the freemen.

ALDERNEY, an island in the English channel, subject to the crown of Great Britain. It is about eight miles in compass, and is separated from Cape la Hogue, in Normandy, by a narrow strait, called the *Race of Alderney,* which is a very dangerous passage in stormy weather, when the two currents meet; otherwise it is safe, and has depth of water for the largest ships. Through this strait the French fleet made their escape after their defeat at La Hogue in 1692. It is a healthful island, is fruitful both in corn and pasture, and is remarkable for its fine breed of cows. The town, of the same name, is the seat of the population, amounting in 1851 to 3333. It has but one harbour, called *Crabby,* which is at a good distance from the town, and is only fit for small vessels. To the west lies the range of rocks called the *Caskets,* so dangerous to mariners. Long. 2. 7. W. Lat. 49. 45. N. The extension of the sea-wall of the break-water was commenced in 1850; to be completed in eight years, at the estimated cost of L.620,000.

ALDHELM, or Adelm, St, bishop of Shireburn, in the time of the Saxon Heptarchy. He is said to have been the son of Kenred, brother to Ina, king of the West Saxons; but in the opinion of William of Malmesbury, his father was no more than a distant relation to the king. Having received the first part of his education in the school of one Maldulph, a learned Scot, he travelled into France and Italy for his improvement. On his return home he studied some time under Adrian, abbot of St Augustin's, in Canterbury, the most learned professor of the sciences who had ever been in England. The fame of his learning soon spread, not only in England, but in foreign countries. Learned men sent him their writings for his criticism; among others, Prince Arcivil, a son of the king of Scotland, who sent his compositions to Aldhelm, "entreating him to give them the last polish by rubbing off their Scotch rust." He was the first Englishman who wrote in the Latin language, both in prose and verse; and composed a book for the instruction of his countrymen in the prosody of that language. Bede says that Aldhelm "was a man of universal erudition, having an elegant style, and being wonderfully well acquainted with books, both on philosophical and religious subjects." In fact, considering the cloud of ignorance by which he was surrounded, and the great difficulty of acquiring knowledge without proper instruction, Aldhelm was a very extraordinary man. From one of his letters to Hedda, bishop of Winchester, concerning the nature of his studies whilst at Canterbury, he appears to have been indefatigably determined to acquire every species of learning in his power. For a copy of this curious epistle, see Henry's *History*, vol. ii. p. 320. King Alfred the Great declared that Aldhelm was the best of all the Saxon poets; and that a favourite song, which was universally sung in his time, near 200 years after its author's death, was of his composition. He was a musician as well as a poet, and made his own songs the medium of instruction and refinement to his barbarous countrymen. After having governed the monastery of Malmesbury, of which he was the founder, about thirty years, he was made bishop of Shireburn, where he died A.D. 709.—He wrote, 1. De octo Vitiis principalibus. This treatise is extant in the *Bibliotheca Patrum* of Canisius. 2. Ænigmatum versus mille. This, with several others of his poems, was published by Martin Delrio at Mentz, 1701, 8vo. 3. A book addressed to a certain king of Northumberland, named Alfrid, on various subjects. 4. De Vita Monachorum. 5. De Laude Sanctorum. 7. De Arithmetica. 7. De Astrologia. 8. A book against the mistake of the Britons concerning the celebration of Easter; printed by Sonius, 1576. 9. De Laude Virginitatis; manuscript, in Bennet College, Cambridge; published among Bede's *Opuscula*. Besides these, he wrote many sonnets, epistles, and homilies in the Saxon language.

ALDINE. See Manutius, Aldus.

ALDPORT, an ancient name for Manchester.

ALDRED, abbot of Tavistock, was promoted to the bishopric of Worcester in the year 1046. He had great influence over Edward the Confessor, and procured his reconciliation to Sweyn, the son of Earl Godwin, who had revolted against him. He also restored the union and friendship between King Edward and Griffith, king of Wales. In the year 1050, he went to Jerusalem, which no archbishop or bishop of England had ever done before. On his return to England, he was sent in the year 1054 as ambassador to the emperor Henry II. He staid a whole year in Germany, and was very honourably entertained by Herman, archbishop of Cologne, from whom he learned much relating to ecclesiastical discipline, of which he made use on his return to his own diocese. On the death of Kinsius, archbishop of York, 1060, Aldred was elected in his stead, and was permitted to retain the see of Worcester with the archbishopric of York, as some of his predecessors had done. He was afterwards, however, deprived of it by the pope.



On the death of Edward the Confessor in 1066, Aldred was to have placed the crown on the head of Harold, but before the ceremony could take place, the battle of Hastings intervened. He officiated at the coronation of William the Conqueror, and gained great favour with that monarch, over whose imperious spirit he seems to have exercised a remarkable influence. At the end of a year, however, he broke his allegiance, by escaping into Scotland with Edgar Atheling. He died in September 1069, broken-hearted, according to William of Malmesbury, by the tyranny of the Conqueror. Stubbs, again, ascribes his death to grief at the invasion of the Danes.

ALDRICH, Dr Henry, an eminent English divine and philosopher, born at London in 1647, was educated at Westminster school under the famous Dr Busby, and admitted of Christ-church College, Oxford. He had a great share in the controversy with the Papists in the reign of James II.; and Bishop Burnet ranks him among those who examined all the points of Popery with a solidity of judgment, clearness of argument, depth of learning, and vivacity of writing, far beyond any who had before that time written in our language. He rendered himself so conspicuous, that at the Revolution, when Massey the Popish dean of Christ-church fled, his deanery was conferred on him. In this station he behaved in an exemplary manner, and that fabric owes much of its beauty to his ingenuity. He published, besides some other pieces, a System of Logic, still in use as a text-book in Oxford; and the revising of Clarendon's History of the Rebellion was intrusted to him and Bishop Sprat. Besides his preferments above mentioned, Dr Aldrich was also rector of Wem, in Shropshire. He was chosen prolocutor of the convocation in 1702. He died at Christ-church on the 14th of December 1710. Sir John Hawkins has favoured the public with several particulars relative to Dr Aldrich's skill in music. He composed many services for the church, which are well known; as are also his anthems, nearly twenty in number. He adapted, with great skill and judgment, English words to many of the notes of Palestrina, Carissimi, Victoria, and other Italian composers for the church, some of which are frequently sung in our cathedrals as anthems. By his happy talent of naturalizing the compositions of the old Italian masters, and accommodating them to an English ear, he increased the stores of his own church.

Dr Aldrich is of some note as a Latin poet. In the *Musæ Anglicanæ* we find two elegant copies of verses by him; one on the accession of King William III., and the other on the death of the Duke of Gloucester. Sir John Hawkins has preserved a humorous translation by him of the well-known English ballad,

> A soldier and a sailor,
> A tinker and a tailor, &c.

The following epigram, entitled "Causæ Bibendi," is likewise ascribed to Dr Aldrich:—

> *Sic bene quid memini, Causæ sunt quinque bibendi;*
> *Hospitis Adventus, præsens Sitis, atque futura,*
> *Aut Vini Bonitas, aut quælibet altera Causa.*

The epigram has been thus translated:—

> If on my theme I rightly think,
> There are five reasons why men drink;
> Good wine, a friend, because I'm dry,
> Or lest I should be by and by,
> Or any other reason why.

The translation is not equal to the original. It is evident from the verses cited and referred to, that Dr Aldrich was of a very cheerful and pleasant turn of mind. Having never been married, he appropriated his income to works of hospitality and beneficence, and the encouragement of learning. His modesty and humility prevented him from prefixing his name to the learned tracts which he published during his life. He was buried in the cathedral, according to his own wish, without any memorial.

Aldrich, *Robert*, bishop of Carlisle, was born at Burnham, in Buckinghamshire, about the year 1493, and educated at Eton school, from whence, in 1507, he was elected scholar of King's College, Cambridge, where he took his degree in arts, and was afterwards proctor of the university. In 1525 he was appointed master of Eton school, then became fellow of that college, and finally provost. In 1529 he went to Oxford, where he took his degree of B.D., and in the following year that of D.D. In 1531 he was made archdeacon of Colchester, in 1534 canon of Windsor, and the same year registrar of the order of the Garter. He was consecrated bishop of Carlisle in the year 1537, and died at Horncastle in Lincolnshire in 1556. He wrote, 1. Epistola ad Gul. Hormannum, in Latin verse, printed in Horman's *Antibossicon*, Lond. 1521, of which book Pitts erroneously makes Aldrich the author; 2. Epigrammata varia; 3. Latin verses, and another epistle to Horman, prefixed to the *Vulgaria Puerorum* of that author, Lond. 1519, 4to; 4. Answers to certain queries concerning the abuses of the mass, and the receiving of the sacrament.

ALDROVANDUS, Ulysses, professor of philosophy and physic at Bologna, was born there in 1522. He was a most curious inquirer into natural history, and travelled into the most distant countries on purpose to inform himself of their natural productions. Minerals, metals, plants, and animals, were the objects of his curious researches; but he applied himself chiefly to birds, and was at a great expense to have figures of them drawn from the life. Aubert le Mire says that he gave a certain painter, famous in that art, a yearly salary of 200 crowns, for 30 years and upwards; and that he employed, at his own expense, Lorenzo Bennino and Cornelius Swintus, as well as the famous engraver Christopher Coriolanus. These expenses ruined his fortune, and at length reduced him to the utmost necessity; and it is said that he died blind in an hospital at Bologna, at the age of 85. Mr Bayle observes, that antiquity does not furnish us with an instance of a design so extensive and so laborious as that of Aldrovandus, with regard to natural history; that Pliny has treated of more kinds of subjects, but only touches lightly on them, saying but a little upon any thing, whereas Aldrovandus has collected all he could meet with. His compilation, or that compiled upon his plan, consists of 13 volumes in folio, several of which were printed after his death. He himself published his Ornithology, or History of Birds, in three folio volumes, in 1599; and his seven books of Insects, which make another volume of the same size. The volume of Serpents, three of Quadrupeds, one of Fishes, that of exsanguious Animals, the History of Monsters, with the Supplement to that of Animals, the Treatise of Metals, and the Dendrology, or History of Trees, were published at several times after the death of Aldrovandus, by the care of different persons. He himself is the sole author only of the first six volumes of this work, the rest having been finished and compiled by others upon his plan. In this extensive plan he not only relates what he has read in naturalists, but remarks also what historians have written, legislators ordained, and poets feigned. He explains also the different uses which may be made of the things he treats of, in common life, in medicine, architecture, and other arts; in short, he speaks of morality, proverbs, devices, riddles, hieroglyphics, and many other things which relate to his subject.



ALDSTON-MOOR, a market-town of the Ward of Leath, in the county of Cumberland. It is on the banks of the Tyne, in a picturesque district, abounding in mines of lead, which produce also some silver and copper. The market is held on Saturday. Pop. in 1851, 2005.

ALE, a fermented liquor obtained from an infusion of malt, and differing from beer chiefly in having a less proportion of hops. This liquor, the natural substitute of wine in such countries as could not produce the grape, is said to have originally been made in Egypt, the first planted kingdom, on the dispersion from the East, that was supposed unable to produce grapes. The natives of Spain, the inhabitants of France, and the aborigines of Britain, all used an infusion of barley for their ordinary liquor; and it was called by the various names of *Cœlia* and *Ceria* in the first country, *Cerevisia* in the second, and *Curmi* in the last; all literally importing only *the strong water*.

"All the several nations," says Pliny, "who inhabit the west of Europe, have a liquor with which they intoxicate themselves, made of corn and water. The manner of making this liquor is sometimes different in Gaul, Spain, and other countries, and is called by many various names; but its nature and properties are everywhere the same. The people of Spain, in particular, brew the liquor so well that it will keep good a long time. So exquisite is the cunning of mankind in gratifying their vicious appetites, that they have thus invented a method to make water itself intoxicate." The method in which the ancient Britons and other Celtic nations made their ale is thus described by Isidorus and Orosius:—"The grain is steeped in water, and made to germinate, by which its spirits are excited and set at liberty; it is then dried and ground; after which it is infused in a certain quantity of water; which, being fermented, becomes a pleasant, warming, strengthening, and intoxicating liquor." This ale was most commonly made of barley, but sometimes of wheat, oats, and millet.

Anciently the Welsh and Scots had also two kinds of ale, called *common ale* and *spiced ale;* and their value was thus ascertained by law: "If a farmer had no mead, he shall pay two casks of spiced ale, or four casks of common ale, for one cask of mead." By this law a cask of spiced ale, nine palms in height and eighteen palms in diameter, was valued at a sum of money equal in value to L.7, 10s. of our present money; and a cask of common ale of the same dimensions at a sum equal to L.3, 15s. This is a sufficient proof that even common ale at that period was an article of luxury among the Welsh, which could only be obtained by the great and opulent. Wine seems to have been quite unknown even to the kings of Wales at that period, as it is not so much as once mentioned in their laws; though Giraldus Cambrensis, who flourished about a century after the Conquest, informs us that there was a vineyard in his time at Maenarper, near Pembroke, in South Wales.

Ale was the favourite liquor of the Anglo-Saxons and Danes, as it had been of their ancestors the ancient Germans. Before their conversion to Christianity, they believed that drinking large and frequent draughts of ale was one of the chief felicities which those heroes enjoyed who were admitted into the hall of Odin. Scotland has long been celebrated for the manufacture of ale. The quantity brewed in Edinburgh and Leith for the year ending 10th October 1852, is estimated at 259,982 barrels. For further details see Brewing, Scotland, Edinburgh, &c.

*Ale, Medicated*, that wherein medicinal herbs have been infused or added during the fermentation.

*Ale-Conner*, an officer in London, who inspects the measures used in public houses. There are four ale-conners, who are all chosen by the liverymen in common-hall on Midsummer-day.

*Ale-Silver*, a tax paid annually to the lord-mayor of London by all who sell ale within the city.

ALEA, in *Roman Antiquity*, denotes in general all manner of games of chance, but, in a more restricted sense, was used for a particular game played with dice and tables, not unlike our backgammon.

ALEANDRO, Geromino, cardinal and archbishop of Brindisi, was born in 1480, and distinguished himself by his fiery zeal against the Reformation. Being sent into Germany as the pope's nuncio in 1519, he acted as occasion served, in the character both of ambassador and doctor, and opposed Luther in the diet of Worms with bitter vehemence. His violent conduct alienated him from Erasmus, who had been his early friend. He published several works, and died at Rome in 1542.

Aleandro, *Geromino*, grand-nephew of the former, a jurist, antiquarian, and poet, was born at Motta, near Friuli, in 1574. He was long employed as secretary to Cardinal Ottavio Bandini, and afterwards to Cardinal Barberini, in whose service he died, at Rome, in 1629. He was one of the first members of the Academy of Humourists, wrote a learned treatise in Italian on the device of the society, and displayed his genius on many different subjects. Barberini gave him a magnificent funeral at the Academy of Humourists.

ALECTO, one of the Furies, daughter of Acheron and Night, or, as others would have it, of Pluto and Proserpine.

ALECTORIA, a stone said to be formed in the gall-bladder of old cocks, to which the ancients ascribe many fabulous virtues. This is otherwise called *Alectorius lapis*, sometimes *Alectorolithos*, in English the *cock-stone*. The more modern naturalists hold the *alectorius lapis* to be originally swallowed down, not generated in, the stomach and gizzards of cocks and capons. It is known that many of the fowl kind make a practice of swallowing pebbles, which are supposed to be of service in the business of trituration and digestion.

ALECTOROMANTIA, in *Antiquity*, a species of divination performed by means of a cock. This is otherwise called *Alectryomancy*, of which there appear to have been different species. But that most spoken of by authors was in the following manner: a circle was described on the ground, and divided into twenty-four equal portions; in each of these spaces was written one of the letters of the alphabet, and on each of the letters was laid a grain of wheat; after which, a cock being turned loose in the circle, particular notice was taken of the grains picked up by the cock, because the letters under them, being formed into a word, made the answer desired. It was thus, according to Zonaras, that Libanius and Jamblicus sought who should succeed the emperor Valens; and the cock eating the grains answering to the spaces ΘΕΟΔ, several whose names began with those letters, as Theodotus, Theodistes, Theodulus, &c. were put to death; which, however, did not hinder the succession of Theodosius. But the story, however current, is but ill supported: it has been called in question by some, and refuted by others, from the silence of Marcellinus, Socrates, and other historians of that time.

A-LEE, in the sea-language, a term used when the wind, crossing or flanking the line of a ship's course, presses upon the masts and sails so as to make her incline to what is then called the lee-side. When the helm is moved over to this side, it is said to be *a-lee* or *hard a-lee*.

ALEGAR, acetic acid, produced by fermenting ale, as vinegar is produced from wine.

ALEIUS Campus, from ἄλη, wandering, in *Ancient Geography*, a plain in Cilicia, on this side of the river Pyramus, near the mountain Chimæra. It derived the name from Bellerophon's wandering and perishing there, after being thrown off Pegasus.



ALEMAN, Louis, archbishop of Arles, and cardinal of St Cecilia, was born in 1390, and died in 1452. He presided, along with Cardinal Julian, in the council of Basil, which deposed Eugenius IV. and elected the antipope Felix V. He is much commended by Æneas Sylvius, as a man extremely well formed for presiding in such assemblies,—firm and vigorous, illustrious by his virtue, learned, and of an admirable memory in recapitulating all that the orators and disputants had said. At the request of the canons and Celestine monks of Avignon, and the solicitation of the cardinal of Clermont, legate *a latere* of Clement VII., he was beatified by the pope in the year 1527.

Aleman, *Mateo*, a remarkable Spanish writer, born at Sevilla, about the middle of the sixteenth century; best known to us by his racy and amusing *Adventures of Guzman Alfarache*, published in 1599; a work highly esteemed for the purity and elegance of its Castilian style, though the delineations are often coarse and indelicate. This and several succeeding works of the same kind, under the feigned adventures of rogues and vagabonds, cover a sly satire on the corruption of Spanish manners in the time of Philip II. It was from this, and the novel of Espinèl, entitled *The Life of Squire Mareos Olregon*, that Le Sage borrowed many of the characters and adventures in his admirable *Gil Blas*. Aleman also wrote a *Life of St Antonio de Padona;* and having visited Mexico, he there published an *Ortografia Castellanà* in 1609, which has obtained some reputation. He died in the reign of Philip III.

ALEMANNI, a large German tribe on the Upper Rhine, where they are first mentioned by Dion Cassius in the reign of the Emperor Caracalla, who gained, in A.D. 213, a victory over them on the banks of the Maine, and thence assumed the surname *Alemannicus*. The origin of this tribe, and the country from which they came, are unknown; but we have a distinct statement, which is apparently confirmed by the very name of the people, that they had flocked together from all parts, and were a mixed race. They proved most formidable enemies to the Romans as well as to the Gauls, their western neighbours, who to this day apply the name Alemanni (Allemands) to all the Germans indiscriminately, though the Alemanni, properly so called, occupied only the country between the Maine and the Danube. In the reign of Aurelian, A.D. 270, they attempted to invade Italy, but were repulsed. After the death of that emperor, however, they renewed their attacks by invading Gaul, and ravaging the country at different times. Several undertakings against them were of little avail, until in A.D. 357 the Emperor Julian completely defeated them in the neighbourhood of Strasburg, where all their forces were assembled under seven chiefs. This and other defeats, however, did not break the power of the Alemanni, who being pressed on by other barbarians in the north were forced to advance southward and westward to conquer new countries for themselves. Hence, after the middle of the 5th century, we find them established not only in the country now called Suabia, but also in a part of Switzerland and in Alsace. In these countries the Alemanni have maintained themselves ever since; and the greater part of the modern Suabians and the northern Swiss are descendants of that ancient race. (L. S.)

ALEMBERT, Jean le Rond d', an eminent French philosopher, was born at Paris in 1717. He derived the name of Jean le Rond from that of the church near which, after his birth, he was exposed as a foundling. His father, informed of this circumstance, listened to the voice of nature and duty, took measures for the proper education of his child, and for his future subsistence in a state of ease and independence.

He received his first education in the College of the Four

D'Alembert.

Nations, among the Jansenists, where he gave early marks of capacity and genius. In the first year of his philosophical studies he composed a Commentary on the Epistle of St Paul to the Romans. The Jansenists considered this production as an omen that portended to the party of Port-Royal a restoration to some part of their ancient splendour, and hoped to find one day in M. d'Alembert a second Pascal. To render this resemblance more complete, they engaged their rising pupil in the study of the mathematics; but they soon perceived that his growing attachment to this science was likely to disappoint the hopes they had formed with respect to his future destination: they therefore endeavoured to divert him from this line; but their endeavours were fruitless.

On his leaving college, he found himself alone and unconnected with the world; and sought an asylum in the house of his nurse. He comforted himself with the hope that his fortune, though not ample, would better the condition and subsistence of that family, which was the only one that he could consider as his own. Here, therefore, he took up his residence, resolving to apply himself entirely to the study of geometry; and here he lived, during the space of forty years, with the greatest simplicity, discovering the augmentation of his means only by increasing displays of his beneficence, concealing his growing reputation and celebrity from these honest people, and making their plain and uncouth manners the subject of good-natured pleasantry and philosophical observation. His good nurse perceived his ardent activity, heard him mentioned as the writer of many books, but never took it into her head that he was a great man, and rather beheld him with a kind of compassion. "*You will never*," said she to him one day, "*be any thing but a philosopher—and what is a philosopher?—a fool, who toils and plagues himself during his life, that people may talk of him when* HE IS NO MORE."

As M. d'Alembert's fortune did not far exceed the demands of necessity, his friends advised him to think of a profession that might enable him to augment it. He accordingly turned his views to the law, and took his degrees in that profession; but soon abandoned this plan, and applied to the study of medicine. Geometry, however, was always drawing him back to his former pursuits; and after many ineffectual efforts to resist its attractions, he renounced all views of a lucrative profession, and give himself over entirely to mathematics and poverty.

In the year 1741 he was admitted member of the Academy of Sciences; for which distinguished literary promotion, at such an early age, he had prepared the way by correcting the errors of a celebrated work,[1] which was deemed *classical* in France in the line of geometry. He afterwards set himself to examine, with deep attention and assiduity, what must be the motion of a body which passes from one fluid into another more dense, in a direction not perpendicular to the surface separating the two fluids. Every one knows the phenomenon which happens in this case, and which amuses children under the denomination of *Ducks and Drakes;* but M. d'Alembert was the first who explained it in a satisfactory and philosophical manner.

[1] The *Analyse Démontrée* of F. Beniau.

Two years after his election to a place in the Academy he published his treatise on *Dynamics.* The new principle developed in this treatise consisted in establishing equality at each instant between the changes that the motion of a body has undergone, and the forces or powers which have been employed to produce them; or, to express the thing otherwise, in separating into *two parts* the action of the moving powers, and considered the *one* as producing alone the motion of the body in the second instant, and the *other* as employed to destroy that which it had in the first.

So early as the year 1744, M. d'Alembert had applied this principle to the theory of the equilibrium and the motion of fluids; and all the problems before solved by geometricians became in some measure its corollaries. The discovery of this new principle was followed by that of a new calculus, the first trials of which were published in a *Discourse on the General Theory of the Winds,* to which the prize-medal was adjudged by the Academy of Berlin in the year 1746, and which was a new and brilliant addition to the fame of M. d'Alembert.

He availed himself of the favourable circumstance of the king of Prussia having just terminated a glorious campaign by an honourable peace, and in allusion to this, dedicated his work to that prince in the three following Latin verses:—

*Hæc ego de ventis, dum ventorum ocyor alis*
*Palantes agit Austriacos Fredericus, et orbi,*
*Insignis lauro, ramum prætendit olivæ.*

Swifter than wind, while of the winds I write,
The foes of conquering Frederick speed their flight;
While laurel o'er the hero's temple bends,
To the tir'd world the olive branch he sends.

This flattering dedication procured the philosopher a polite letter from Frederick, and a place among his literary friends.

In the year 1747 D'Alembert applied his new calculus of Partial Differences to the problem of vibrating chords, the solution of which, as well as the theory of the oscillation of the air and the propagation of sound, had been given but incompletely by the geometricians who preceded him, and these his masters or his rivals.

In the year 1749 he furnished a method of applying his principles to the motion of any body of a given figure; and he solved the problem of the precession of the equinoxes, determined its *quantity,* and explained the phenomenon of the nutation of the terrestrial axis, discovered by Dr Bradley.

In 1752 M. d'Alembert published a treatise on the *Resistance of Fluids,* to which he gave the modest title of an *Essay,* but which contains a multitude of original ideas and new observations. About the same time he published, in the Memoirs of the Academy of Berlin, *Researches concerning the Integral Calculus,* which is greatly indebted to him for the rapid progress it has made in the present century.

While the studies of M. d'Alembert were confined to geometry, he was little known or celebrated in his native country. His connections were limited to a small society of select friends: he had never seen any man in high office except Marquis d'Argenson. Satisfied with an income which furnished him with the necessaries of life, he did not aspire after opulence or honours; nor had they been hitherto bestowed upon him, as it is easier to confer them on those who solicit them, than to look out for men who deserve them. His cheerful conversation, his smart and lively sallies, a happy knack at telling a story, a singular mixture of malice of speech with goodness of heart, and of delicacy of wit with simplicity of manners, rendered him a pleasing and interesting companion; and his company, consequently, was much sought after in the fashionable circles. His reputation at length made its way to the throne, and rendered him the object of royal attention and beneficence. He received also a pension from government, which he owed to the friendship of M. d'Argenson.

The tranquillity of M. d'Alembert was abated when his fame grew more extensive, and when it was known beyond the circle of his friends, that a fine and enlightened taste for literature and philosophy accompanied his mathematical genius. Our author's eulogist ascribes to envy, detraction, and to other motives equally ungenerous, all the disapprobation, opposition, and censure that M. d'Alembert met with on account of the publication of the famous Encyclopedical

Dictionary of Arts and Sciences, in conjunction with Diderot. None surely will refuse the well-deserved tribute of applause to the eminent displays of genius, judgment, and true literary taste, with which M. d'Alembert has enriched the great work now mentioned. Among others, the Preliminary Discourse which he has affixed to it, concerning the rise, progress, connections, and affinities of all the branches of human knowledge, is perhaps one of the first productions of which the philosophy of the present age can boast, and will be regarded as a striking specimen of just arrangement and sound criticism, and also as a model of accurate thinking and elegant writing.

Some time after this D'Alembert published his *Philosophical, Historical, and Philological Miscellanies.* These were followed by the *Memoirs of Christina, Queen of Sweden*, in which M. d'Alembert showed that he was acquainted with the natural rights of mankind, and was bold enough to assert them. His *Essay on the Intercourse of Men of Letters with Persons high in Rank and Office* wounded the former to the quick, as it exposed to the eyes of the public the ignominy of those servile chains which they feared to shake off or were proud to wear. A lady of the court hearing one day the author accused of having exaggerated the despotism of the great, and the submission they require, answered slyly, *If he had consulted me, I would have told him still more of the matter.*

M. d'Alembert gave very elegant specimens of his literary abilities in his translations of some select pieces of Tacitus. But these occupations did not divert him from his mathematical studies; for about the same time he enriched the *Encyclopédie* with a multitude of excellent articles in that line, and composed his *Researches on several important points of the System of the World*, in which he carried to a higher degree of perfection the solution of the problem of the perturbations of the planets, that had several years before been presented to the Academy.

In 1759 he published his *Elements of Philosophy;* a work extolled as remarkable for its precision and perspicuity; in which, however, are some tenets, relative both to metaphysics and moral science, that are far from being admissible.

The resentment that was kindled, and the disputes that followed it, by the article *Geneva*, inserted in the *Encyclopédie*, are well known. M. d'Alembert did not leave this field of controversy with flying colours. Voltaire was an auxiliary in the contest; but as, in point of candour and decency, he had no reputation to lose, and as he weakened the blow of his enemies by throwing both them and the spectators into fits of laughter, the issue of the war gave him little uneasiness. It fell more heavily on D'Alembert, and exposed him, even at home, to much contradiction and opposition.

It was on this occasion that the late king of Prussia offered him an honourable asylum at his court, and the place of president of his academy; and was not offended at his refusal of these distinctions, but cultivated an intimate friendship with him during the rest of his life. He had refused, some time before this, a proposal made by the empress of Russia to intrust him with the education of the grand duke; a proposal accompanied with all the flattering offers that could tempt a man ambitious of titles or desirous of making an ample fortune; but the objects of his ambition were tranquillity and study.

In the year 1765 he published his *Dissertation on the Destruction of the Jesuits.* This piece drew upon him a swarm of adversaries, who confirm the merit and credit of his work by their manner of attacking it.

Besides the works already mentioned, he published nine volumes of memoirs and treatises under the title of *Opuscules*, in which he has solved a multitude of problems relative to astronomy, mathematics, and natural philosophy; of which our panegyrist gives a particular account, more especially of those which exhibit new subjects, or new methods of investigation.



He published also *Elements of Music*, and rendered at length the system of Rameau intelligible; but he did not think the mathematical theory of the sonorous body sufficient to account for the rules of that art. He was always fond of music; which, on the one hand, is connected with the most subtile and learned researches of rational mechanics; while, on the other, its power over the senses and the soul exhibits to philosophers phenomena no less singular, and still more inexplicable.

In the year 1772 he was chosen secretary to the French Academy. He formed, soon after this preferment, the design of writing the lives of all the deceased academicians from 1700 to 1772; and in the space of three years he executed this design, by composing 70 *éloges.*

M. d'Alembert died on the 29th of October 1783. There were many amiable lines of candour, modesty, disinterestedness, and beneficence, in his moral character; which are described, with a diffusive detail, in his *éloge*, by M. Condorcet, *Hist. de l'Acad. Royale des Sciences*, 1783.

The scientific works of D'Alembert have never been published in a collected form; the best edition of his literary works is that of 1821 in 5 vols. 8vo, which contains his correspondence with Voltaire and Frederick the Great.

ALEMBIC, a chemical vessel, usually made of glass or copper, formerly used for distillation. The bottom part, which contained the subject for distillation, is called, from its shape, the *cucurbit;* the upper part, which receives and condenses the steam, is called the *head*, the beak of which is fitted into the neck of a receiver. Retorts, and the common *worm still*, are now more generally employed.

ALEMBROTH, in the writings of the alchemists, a word used for a sort of fixed alkaline salt, which had the power of the famous alkahest, in dissolving bodies, and promoting the separation of metals from their ores. It is also used for a compound of corrosive mercury and sal ammoniac.

ALENCON, an arrondissement in the department of the Orne, in the N.W. of France, comprehending an extent of 416 square miles, or 266,240 English acres. It is divided into six cantons, with 72,418 inhabitants. The capital on the river Sarthe bears the same name. It is well built, and contains a cathedral, a church of the 8th century, a court-house, and a theatre. It was the ancient seat of the counts and dukes of Alençon. Its manufactures include tanning, spinning, bleaching, printing calicoes, and lace-making. Pop. 13,533.

ALENIO, Gulioi, a Jesuit missionary, born at Brescia, in 1582. He travelled into the East, and arrived at Macao in 1610. From thence he travelled through the Chinese empire, where he continued to propagate the Christian religion for 36 years. He was the first who planted the faith in the province of Xansi, and he built several churches in the province of Fokien. He died in 1649, leaving behind him several works in the Chinese language.

ALENQUER a fortified town of Portuguese Estremadura, 26 miles N.N.E. of Lisbon, with extensive manufacture of paper, and 3200 inhabitants.

ALENTEJO, one of the provinces into which the kingdom of Portugal is divided, deriving its name from its situation on the banks of the Tagus, in the Portuguese language Tejo. On the north it is bounded by the Portuguese Estremadura and Beira; on the east by Spanish Estremadura and Andalucia; on the south by Algarve; and on the west by the Atlantic Ocean, except in that part where the district or Setubal, which is a port of Portuguese Estremadura, in-

Aleppo. terposes between it and the sea. Its extent is 883 square leagues, and in 1841 the number of its inhabitants was 277,590. It is the largest province in the kingdom. Its surface is very unequal: towards Spanish Estremadura the soil is moderately fruitful, but towards Algarve the country is covered with extensive forests of oak, cork, holm, and other trees, especially on the northern sides of the Sierras de Monchique and Caldeiraon. The climate is considered unhealthy, especially in the summer months, when the waters, which are abundant, become stagnant. The province produces abundance of cattle; it yields more wheat than it consumes, and in part supplies Lisbon with that necessary. It grows sufficient wine for its own consumption, but is deficient in oil, which is occasionally supplied from Spanish Estremadura and Andalucia. The natural boundary, on the side of Spain, is the river Guadiana; but the territory of Olivenza, extending over 110 square leagues, on the eastern side of that river, has, ever since the thirteenth century, been a part of Portugal; and the possession of it has been and still is an object of greater jealousy to the two nations, than its value to either will justify. The only rivers of this province which empty themselves into the ocean are the Tagus and the Odemira: the latter enters it near Villa Nova de Milfontes, and is navigable five leagues from its mouth to the town of its own name. The other streams run, some to the Guadiana, and the others to the Tagus. As this province presents a frontier to Spain, it is most abundantly provided with fortified places, which, if in a good state and well garrisoned, would become formidable auxiliaries in either offensive or defensive warfare; but in the late invasion by the armies of France, they were found to be of little practical benefit. This province is between Lat. 37. 20. and 39. 34. N.

ALEPPO, or Halab, a town of Syria, the capital of a pashalic, of which the limits are not exactly defined, is situated in the vast plain which extends from the Orontes to the Euphrates, and which towards the south terminates in the desert. It is built on eight hills or eminences, and is intersected by the Koeick, which in winter swells into a large stream, overflowing its bridges, and the neighbouring gardens which cover its banks. This river terminates 18 miles beyond Aleppo, in a morass which is haunted by wild boars and pelicans. The city itself is above 3½ miles in circumference, and is surrounded by an ancient strong stone-wall 40 feet high. Including the suburbs, the city is about 7 or 8 miles in compass. The wall is flanked by frequent towers; but the ditch is partly filled up with rubbish or occupied by kitchen-gardens, and the city being commanded by the adjacent heights, is entirely indefensible. The town has seven gates, all known by different names. On one of the hills on which the city is built, and on its north-east corner, is a castle seated on a mount. This mount is of a conic form 200 feet high, and seems in a great measure to be raised with the earth thrown up out of a deep broad ditch which surrounds it. The castle is entered from the south by a bridge of seven lofty narrow arches thrown over the ditch, on which are two gates fortified by turrets, and two more still higher on the hill. Aleppo ranked among the cities of the Ottoman empire, next after Constantinople, Cairo, and Damascus; but was nearly destroyed by the terrible earthquakes of 1822 and 1830. It is gradually recovering from these disasters.

Formerly its commerce placed it in the first rank among the cities of Asia, and it was the grand emporium of Syria, Arabia, Mesopotamia, and Armenia. It is still the emporium of northern Syria, and has extensive commercial relations with Diarbekr, and the upper parts of Anatolia, with Merdin, Mosul, and Baghdad. Since 1832 several British merchants have established houses at Aleppo. The principal manufacture of the city consists of various kinds of cloths, which have been long famous throughout the East, and which are still produced to a considerable amount. Some are woven with gold and silver thread; others with silk and cotton, both flowered and striped; while some consist of striped cotton only. These stuffs employ about 4000 looms. There are besides numerous soap, dyeing, and print works. The chief attractions of Aleppo are its gardens, which extend continuously about 12 miles to the south-east of the city, They are watered by the Koikh, and produce abundance of fruit and culinary vegetables; but their most celebrated product is the pistachio-nut, which is regularly cultivated. The city is supplied with water by an ancient aqueduct, which conveys it from a distance of eight miles.

The air of Aleppo is dry and piercing, but at the same time salubrious for all who are not troubled with asthmatic complaints. The city, however, and the environs, are subject to a singular endemic disorder, which is called the ringworm or pimple of Aleppo: it is in fact a pimple which is at first inflammatory, and at length becomes an ulcer of the size of the nail. The usual duration of this ulcer is one year: it commonly fixes on the face, and leaves a scar, which disfigures almost all the inhabitants. No reason is assigned for this malady; but M. Volney suspects it proceeds from the quality of the water, as it is likewise frequent in the neighbouring villages, in some parts of Diarbekr, and even in certain districts near Damascus, where the soil and the water have the same appearances. But the plague is a more destructive malady, a visitation of which is anticipated by the inhabitants every ten years. Its ravages are most deadly, owing to the blind fatalism of the Turks, who cannot be persuaded to take any precautions against the progress of this dreadful disease. In the plague which immediately preceded the year 1797, about 60,000 inhabitants were swept off. Aleppo is of great antiquity, and is supposed to occupy the site of the ancient Berœa. It was overwhelmed by the flood of Saracen invasion in 638, when it was taken from the emperor Heraclius. In 1260 it was taken possession of and wasted by the Tartars, and in 1401 by Tamerlane, who defeated the Syrians, when it was given up to pillage. The adjacent country is fertile, and yields grain of all sorts, with which the city is plentifully supplied. All the fruits of Europe, as well as those of the East, are cultivated in gardens. Its galls, the produce of *Quercus infectoria*, are highly valued. Aleppo is 70 miles east of Scanderoon, on the seacoast, and 234 north of Damascus. Long. 37. 12. E. Lat. 36. 12. N.

Aleppo once contained 150,000 inhabitants. Colonel Chesney computes them now at 100,000; of whom 66,500 are Turks, 19,000 Greeks, 5000 Maronites, 3000 Armenians, 2000 Syrians of a mixed race, and 4500 Jews. The Christians enjoy not only the most perfect toleration, but have some envied privileges. Their exemption from the Conscription excited in 1850 the indignant jealousy of the Mahometans, and occasioned tumults in which some blood was shed, and property to the amount, it is said, of L.1,000,000 sterling destroyed. The houses amount to 40,000; but the aspect of the town, once the fairest and cleanest of Turkish cities, has been much damaged by the great earthquakes of 1822 and 1830, and by the erection of an irregular suburb, originally intended only for a temporary shelter.

Ales. ALES, Alexander, a celebrated divine of the rigid school of Augsburg, was born at Edinburgh on the 23d April 1500. He soon made considerable progress in school divinity, and entered the lists very early against Luther, this being then the grand field wherein all authors, young and old, used to display their abilities. Soon after he had a share in the dispute which Patrick Hamilton maintained against the ecclesiastics, in favour of the new faith he had imbibed at Marburg. He endeavoured to bring him back to the Catholic religion; but this he could not effect, and even began him-

Alessandri || Alessandria.

self to doubt about his own religion, being much affected by the discourse of Hamilton, and still more by the constancy he showed at the stake. Beginning thus to waver, he was himself persecuted with so much violence, that he was obliged to retire into Germany, where he became at length a perfect convert to the Protestant religion. The change of religion in England after the marriage of Henry VIII. with Anne Boleyn, induced Ales to go to London in 1535. He was highly esteemed by Cranmer, Latimer, and Thomas Cromwell, who were at that time in high favour with the king. Upon the fall of these favourites he was obliged to return to Germany, where the elector of Brandenburg appointed him professor of divinity at Frankfort on the Oder in 1540. Having offended the court of Brandenburg by publicly maintaining the right and duty of the civil magistrate to punish fornication, he underwent a public rebuke from the University of Wittenberg. He left Frankfort in disgust, and returned to Leipsic, where he was chosen professor of divinity, and died in March 1565. He wrote various commentaries on the Scriptures, besides many controversial works against the Roman Catholics.

ALESSANDRI, Alessandro, in Latin, *Alexander ab Alexandro*, a Neapolitan lawyer, of great learning, who flourished toward the end of the 15th and beginning of the 16th century. He followed the profession of the law, first at Naples, afterwards at Rome: but he devoted all the time he could spare to the study of polite literature; and at length he entirely left the bar, that he might lead a more easy and agreeable life with the Muses. The particulars of his life are to gathered from his work entitled *Dies Geniales.* We are there informed that he lodged at Rome, in a house that was haunted; and he relates many surprising particulars about the ghost. He says also, that when he was very young, he went to the lectures of Philelphus, who explained at Rome the Tusculan Questions of Cicero. He was there also when Nicholas Perot and Domitius Calderinus read their lectures upon Martial. He is supposed to have died about the year 1523, aged 62, and was buried in the monastery of the Olivets. Tiraquca wrote a learned commentary upon his work, which was printed at Lyons in 1587, and reprinted at Leyden in 1673, with the notes of Dennis Godfrey, Christopher Colerus, and Nicholas Mercerus.

ALESSANDRIA, a city of Italy, in the Sardinian dominions, situated on the right bank of the Tanaro, capital of the province of the same name. It is the see of a bishop, and, besides the cathedral, contains 12 churches, 2 collegiate churches, with 17 monasteries and nunneries. It has many fine public and private buildings. It was strongly fortified, and in the several successive hostilities in Italy has been attacked and defended with great fury. It has not yet recovered the effects of the obstinate defence of the French against the allies in 1799. Two great fairs are held here, when the city becomes a mart resorted to by merchants from all parts of Italy. It is in Long. 8. 40. E. Lat. 44. 57. N. Pop. 40,000.

Alessandria, a province of the duchy of Piedmont, in the dominions of the king of Sardinia, bounded on the north by Casale, on the east by Mortara, Boghera, and Tortona, on the south-east by Genoa, on the south-west by Aqui, and on the west by Asti. The extent is 343 square miles, or 219,520 acres. It comprehends two cities, 29 towns and villages, and 12 hamlets. The country is a plain, with few elevations, and very fruitful; but suffers from a deficiency of water, though the Po and the Tanaro, with some other rivers, pass through it. The chief productions are wheat, maize, wine, and silk; but besides these, wood, madder, hemp, flax, and fruit, are raised in abundance. The population is very dense, amounting to 117,870 persons, mostly employed in agriculture, which is conducted on the system of garden cultivation.

Alessi || Aleutian Islands.

ALESSI, Galeazzo, an eminent Italian architect, born at Perugia in the beginning of the 16th century. He studied at Rome, where he became intimate with Michael Angelo and the other great men who adorned that period. The Strada Nuova at Genoa, and various works at Bologna, Milan, and Naples, bear testimony to his skill.

ALET, a town of France, in the department of the Aude and district of Limoux, at the foot of the Pyrenees. It is remarkable for its baths, and for the grains of gold and silver found in the stream which runs from the Pyrenean mountains, at the foot of which it stands. It is seated on the river Aude, 15 miles south of Carcassone, and 37 south-west of Narbonne. Long. 2. 15. E. Lat. 42. 59. N.

ALEUROMANCY, the same with what was otherwise called *alphitomantia*, and *crithomantia*, an ancient kind of divination performed by means of meal or flour.

ALEUTIAN, Aleutic, or Aleutsky Islands, so called from the Russian word *aleut*, signifying a bold rock, is the name given by the Russian discoverers to a chain of small islands situated in the Northern Pacific Ocean, and extending in an easterly direction between the peninsula of Kamtschatka, in Asiatic Russia, to the promontory of Alaska, in North America. According to the practice of the most recent Russian geographers, we have comprehended the whole of this archipelago under one general name, although it has been sometimes divided into three several groups; those nearest to the eastern coast of Kamtschatka being properly called Aleutian, the central group the Andreanofskie or Andrenovian, and those nearest to the American promontory the Fox Islands. The Russian geographers usually separate Behring's and Copper Island which are at the western extremity of this chain, from the other parts of it, included by them under the general name of Aleutian Islands; but as there seems no good reason for this exception, it certainly would be better to comprehend the whole under one general denomination.

Progress of Discovery.

The first voyage of discovery in this remote and dangerous archipelago was projected by Peter the Great, whose enterprising mind appears to have been strongly excited by the question, then much agitated, relative to the distance between the Asiatic and American continents; the solution of which seemed to be facilitated by the recent conquest of Kamtschatka. A short time previous to the death of that monarch, which took place in 1725, he drew up instructions, with his own hand, for the conduct of an expedition, which was to be intrusted to the command of an officer named Behring, who had already made several voyages in the sea of Kamtschatka by order of the crown. In 1728 Behring set sail from the mouth of the Kamtschatka River, and coasted the eastern shores of Siberia, as far to the northward as Lat. 67. 18., but made no discovery of the opposite continent. In 1729 he again set sail, for the purpose of prosecuting the same enterprise, but with no better success. A third voyage was undertaken by order of the Empress Anna in 1741, and Behring was again selected as chief of the expedition, another vessel being intrusted to the command of Tschirikoff. This enterprise proved more fortunate, and led the way to all the subsequent important discoveries of the Russians in those seas; although the immediate results of the voyage, upon the whole, were not deemed commensurate with the time and expense employed in fitting out the expedition. The principal object of the undertaking, however, appears to have been accomplished. Tschirikoff discovered the coast of America in the 56th degree of latitude; and Behring, who was separated from his companion in a storm, saw it in Lat. 58. 28. On his voyage back to Kamtschatka, Behring's ship was driven on the island which now bears his name, where he soon afterwards died.

In the year 1768 Captain Krenitzin and Lieutenant Le-

Aleutian Islands.

vashef sailed from the mouth of the Kamtschatka River by order of the Empress Catherine, to examine the chain of the Aleutian Islands. This commission they accordingly executed very carefully, having surveyed the whole of this archipelago, from Behring's Island to the promontory of Alaska; and, after spending the winter among the Fox Islands, they returned to Kamtschatka in the autumn of 1769.

During his third and last voyage, in the year 1778, Captain Cook surveyed the eastern portion of this archipelago, accurately determined the positions of some of the most remarkable islands, and corrected many errors of former navigators.

In the year 1785 a fresh expedition was set on foot by the Russian government, the command of which was intrusted to Captain Billings, an English naval officer in the Russian service, who had accompanied Captain Cook in his last celebrated voyage to the Pacific Ocean. This expedition appears to have been suggested by Mr Coxe, who was at that time at St Petersburg, and whose *Account of the Russian Discoveries between Asia and America* had already attracted the attention of the Russian government. During this voyage, which was not completed until the year 1796, Captains Billings and Sarytschef explored the whole chain of the Aleutian Islands, particularly that part of it which had been visited by Captain Cook, and some parts of the adjacent western coast of America. Ample details of the conduct of this expedition have been published in the narratives of Martin Sauer, who officiated as secretary to Captain Billings, and of Admiral Sarytschef.

With the view of ascertaining the practicability of supplying the Russian settlements in N. America and the adjacent isles by sea, instead of the tedious route by Ochotsk, Captain Krusenstern, an experienced Russian naval officer, who had served for a long period in the British navy, suggested the plan of an expedition from Cronstadt, round Cape Horn, to the Aleutian Islands and the north-west coast of America. This plan was approved of by Count Romanzof, the minister of commerce, and Admiral Mordwinof, minister of the marine, and obtained the sanction of his Imperial Majesty. Two vessels, the Nadeshda and the Neva, under the command of Captain Krusenstern, the original author of the plan, and Captain Lisiansky sailed in company from Cronstadt, in the month of August 1803, and proceeded to the Brazils, from whence they sailed round Cape Horn to the Sandwich Islands. Here they separated, the Nadeshda being ordered on a distinct mission to Japan and China, while Captain Lisiansky, in the Neva, proceeded to Kadyak and the American settlements. Of this voyage very full and interesting accounts have been published by Captains Krusenstern and Lisiansky, and by Dr Langsdorff, who accompanied the expedition in the quality of physician.

By far the most important and best explored portion of this archipelago is the most easterly group, called by the Russians *Lyssie Ostrova*, or the Fox Islands. Of these islands the most considerable are, Umnak, Unalashka or Oonalashka, and Unimak, the last of which is separated by a narrow strait from the promontory of Alaska. Beyond these, to the north-east, lies the large island of Kadyak or Kodiak, which is generally included among the group called Schumagin's Islands.

The whole of the islands composing this chain are bare and mountainous; their coasts are rocky and surrounded by breakers, which renders the navigation of those seas exceedingly dangerous. The land rises immediately from the coasts to steep bald mountains, gradually ascending higher behind each other, and assuming the appearance of chains of mountains, running parallel to the length of the island. Springs take their rise at the bottom of the mountains, and either flow in broad and rapid streams into the neighbouring sea, or, collecting in the rocky vales and glens, form ample lakes, which send off their superfluous waters by natural canals into the adjacent bays. These islands bear evident marks of volcanic formation, and several of them have still active volcanoes, which continually emit smoke, and sometimes flames.

Island of Unalashka.

Unalashka, one of the largest of the Fox Islands, was visited by Captain Cook during his last voyage, and seems to merit particular notice. This island stretches from north-east to south-west and is from 70 to 80 versts in length, but of very unequal breadth. On the north and north-east sides there are many bays and creeks, in some of which are very secure harbours for vessels. A part of the south-west shore consists of very high, steep, inaccessible cliffs, and another part has remained hitherto wholly unexplored. The whole island consists of a mass of rocks, covered only with a very thin coat of earth; the hills are of very unequal height, and are intersected by irregular valleys, the soil of which is commonly argillaceous, or an earth which appears washed down from the hills. In the lower valleys there is great abundance of grass, which would furnish very good food for cattle; indeed, Captain Cook was of opinion that cattle might subsist at Unalashka all the year round without being housed; and the soil, in many places, appeared capable of producing grain, roots, and vegetables. But the Russian traders and the natives seem satisfied with what nature brings forth. No wood grows on this and the neighbouring islands; only low bushes, and shrubs of dwarf birch, willow, and alder. For all the timber used for the purposes of building, &c. they are indebted to the sea, which wafts it to their shores from the adjacent continent of America. The inhabitants are rather low in stature, but plump and well-shaped, with short necks, swarthy chubby faces, black eyes, small beards, and long, straight, black hair, which the men wear loose behind and cut before, but the women tie up in a bunch.

Occupations.

The principal occupations of the Aleutians are fishing and hunting, and preparing the implements necessary for both.

Their *baidars*, *baidarkas*, or boats, resemble the canoes of other savages. They consist of a skeleton of wood over which is stretched a leather covering made of seal-skins. The boats of the Unalashkans are much superior in point of beauty to those of any of the other islands: some of them appear so transparent that one might trace the formation of the inside, and the manner in which the rower sits. In their form they are long and narrow, and commonly hold only one person.

Population and government.

The population of Unalashka and the neighbouring islands appears to have been considerable, amounting to several thousands. In 1790 Sarytcheff reckoned it at 1300. According to the most recent accounts, it does not appear to amount to more than 300. This rapid depopulation is ascribed partly to the practice of sending the best hunters to a distance, to chace the large sea-otters, few of them ever returning to their families; and partly to the state of oppression under which the natives live, and the change which has taken place in their modes of living. Captain Cook seems to consider the natives of these islands as originally of the same extraction with the Greenlanders and Esquimaux. When first discovered by the Russians they were under the government of *Toigons*, or chiefs, who, however, possessed little superior distinction or dignity, and had no revenue. At present they are all subject to the government of the Russian settlers. Population of the whole group is now estimated at 8000.

Russian settlements and commerce.

Throughout the whole of the Aleutian Islands, on the island of Kadyak, and the western coast of America, the Russians have formed settlements, for the purpose of hunting and collecting furs, with which they carry on a lucrative commerce, particularly with the Chinese. The most

Alexander. valuable fur is that of the sea-otter; an animal which has now become rare on these islands, in consequence of the extreme eagerness with which they have been hunted and killed. Besides the sea-otter, there are numbers of foxes, especially on the Fox Islands, which from that circumstance derive their name. The black foxes found on these islands are not so valuable as those of Siberia. The Arctic or ice fox, called also the rock fox, and the blue fox, from the natural colour of the fur, which is of a bluish-gray, is very common.

See Müller's *Samlung Russicher Geschichte*, particularly the third volume. *Neue Nachrichten von denen neuentdeckten Insuln in der See zwischen Asia und America*, &c. *verfasset von J. L. S.*—Hamburg and Leipsic, 1776. Coxe's *Account of the Russian Discoveries*. Tooke's *View of the Russian Empire*. The *Voyages* and *Travels* of Billings; Sarytcheff; Cooke; Meares; Dixon; Vancouver; La Perouse; Mackenzie; Krusenstern; Lisiansky; and Dr Langsdorff.

ALEXANDER THE GREAT. See MACEDONIA.

ALEXANDER of Aphrodisias, the most celebrated of the Greek commentators on Aristotle, and styled by way of pre-eminence, ὁ ἐξηγητής, *the expositor*. He was a native of Aphrodisias, in Caria, and flourished between the 2d and 3d centuries. His first and principal work, *On Fate*, written in opposition to the stoical doctrine of necessity, was dedicated to Severus and his son Caracalla. It has been edited by Orelli, Zurich, 1824. His other works, which are very voluminous, consist chiefly of commentaries on treatises of Aristotle. They were greatly esteemed among the Arabians, who translated many of them. A list of his works, with an account of his life, will be found in the *Bibl. Arab. Hisp. Escur.* of Casiri, vol. i. p. 243.

ALEXANDER of Hales, *Alexander Halensis*, surnamed *the irrefragable Doctor*, a celebrated English theologian of the thirteenth century. Like most of the scholars of his time, he studied at Paris, where he took his degree of Doctor, and publicly taught philosophy and theology. Among his numerous disciples were the famous Bonaventura, Aquinas, and Duns Scotus. His great work is the system of theology known as his *Summa*, being a commentary on the *Sentences* of Peter Lombard, composed by the express orders of Pope Innocent IV., and approved after being submitted to the examination of 70 doctors, as a system of instruction for all the schools of Christendom. Of the private history of this famous man little is known. He died in 1245, and was buried in the convent of the Cordeliers at Paris, where he had spent the 23 last years of his life.

ALEXANDER of Tralles. See TRALLIANUS.

ALEXANDER, surnamed BALAS, a personage who figures in the history of the Maccabees and in Josephus. He professed to be the natural son of Antiochus Epiphanes, and as such, out of opposition to Demetrius Soter, he was recognised as king of Syria by the king of Egypt, by the Romans, and eventually by Jonathan Maccabæus, on the part of the Jews. Demetrius was not long after slain in battle, and Balas obtained possession of the kingdom; but abandoning himself to voluptuousness and debauchery, he soon rendered his reign odious. This encouraged Demetrius Nicator, the eldest son of Demetrius Soter, to claim his father's crown. Alexander took the field against him, but was defeated in a pitched battle, and fled with 500 cavalry to Abæ in Arabia, and sought refuge with the emir Zabdieh, who murdered his confiding guest in the fifth year of his reign over Syria. (1 Macc. xi. 13–18; Joseph. *Antiq.* xiii. 4.)

ALEXANDER JANNÆUS, second king of Judea of the Asmolæan family, but who disgraced the blood of the heroic Maccabees by most barbarous cruelties. He succeeded his brother Aristobulus in 104 B.C., and died in 81 B.C.—*Josephus, Ant. Jud.* xiii.

ALEXANDER SEVERUS, a Roman emperor who reigned from A.D. 222 till A.D. 235. He was born about A.D. 205, in Phœnicia, being the son of Julia Mammæa, by her husband Gessius Marcianus, a Syrian, or, according to others, by Caracalla. When his cousin Elagabalus was raised to the imperial throne, he accompanied him to Rome, where after some time he was adopted by his cousin, and elevated to the rank of Cæsar. On his adoption by Elagabalus he received the name Alexander (he had before been called Bassianus), to which subsequently that of Severus was added. As the young Cæsar refused to take part in the brutal amusements of the emperor, he drew upon himself hatred and persecution, which were only increased by the circumstance that he was a favourite with the soldiers. This gave rise to more than one outbreak among the prætorians, who in March 222, murdered Elagabalus and raised Alexander Severus to the throne. The senate and people readily acquiesced in this decision of the prætorian guards, and conferred upon the new emperor the highest titles and honours. He had been carefully educated by his mother and Mæsa his grandmother, who had procured for him the ablest instructors of the time. While on the throne he was guided by the counsels of these two ladies, and was ever ready to listen to the advice of men of wisdom and experience, among whom we find the illustrious lawyers Ulpian and Paullus. It was on the suggestion of his mother that Alexander excluded women from the senate, and formed a privy-council of sixteen of the wisest and most virtuous senators, of which Ulpian became the president. Notwithstanding her jealousy and some disposition to cruelty, Mammæa exercised a most salutary influence over the emperor and the affairs of the empire. Alexander himself was not wanting either in ability or in zeal: he devoted the greater part of the day to public business; and in his leisure hours refreshed himself by the study of Virgil, Horace, Plato, and Cicero. He did away with the superstitious abominations which had been introduced at Rome by his predecessor, but at the same time appears to have had a peculiar religion of his own, for we are informed that in the chapel of his palace (the Lararium) he paid divine honours to Abraham, Orpheus, Apollonius of Tyana, and Jesus Christ, of all of whom images were set up there. His reign is indeed praised on account of his great mildness, but at the same time he always allowed the law to take its course unimpeded, and endeavoured by all means to check the immorality which pervaded all classes. His attempts, however, to reform the legions and prætorians were unsuccessful; and as the latter regarded the wise Ulpian as the author of the measures adopted by the emperor, they mutinied and compelled Alexander to give up that most faithful friend and adviser to be murdered before his own eyes, in A.D. 228. In the mean time commotions had taken place in Asia, where the empire of the Parthians and the kingdom of the Arsacidæ had been overturned by the Persians. The conquerors, under their king Artaxerxes, even marched across the frontiers of the Roman empire, in consequence of which Alexander was obliged, in A.D. 232, to undertake an expedition against the Persians. According to some accounts he was successful, while according to others the whole undertaking was not carried out in a very creditable manner. It is certain, however, that the Persians after this time for some years abstained from making inroads into the Roman dominion. On his return from Asia, Alexander found that the northern barbarians were threatening the frontier in another part. He accordingly hastened to the Rhine. While he was there encamped in a place called Sicila, the soldiers, instigated by their commander Maximinus, murdered both him and his mother, and proclaimed the Thracian Maximinus his successor, A.D. 235. Compare Gibbon, chap. vi.; Niebuhr, *Lect. on Rom. Hist.* iii. p. 273, fol. (L. S.)

Alexander.

Alexander V., raised to the papal see in 1409, was born in the island of Candia, of parents so poor that he begged from door to door. He is praised by historians for the purity of his morals. He died at Bologna aged 70, after a pontificate of about ten months.

Alexander VI., *Pope*, Rodrigo Lenzuoli, was born of a noble Spanish family at Valencia, in 1429, and assumed the name of Borgia, on the elevation of his maternal uncle, Calixtus III., to the chair of St Peter, who made Rodrigo a cardinal at the age of 25. His private life had always been a disgrace to his ecclesiastical profession; and before his election to the papacy, he had four natural children by Vanozza, his Roman mistress, who long possessed the chief place in his affections. That he was a man of talent has never been denied; but his open profligacy and contempt for decency even after he became pope, were such that his reign is compared by Gibbon to that of Tiberius in ancient Rome. While cardinal, he was employed in several important negotiations, during which he contrived to amass great wealth, and to lay the foundations of the future power of his family. On his return from one of these embassies to Spain and Portugal, he was shipwrecked, and was one of the few survivors of a catastrophe in which 180 persons perished; among whom were three bishops, and many other men of rank and learning. His wealth, unscrupulously used, enabled him to attain the papacy in 1492, on the demise of Innocent III.

We shall not dwell on the impurities and crimes that stained the court of Alexander, which the concurrent testimony of Italian writers, represent as flagitious in the highest degree; but give his character in the words of Guicciardini. "In Alexander VI. were singular degrees of prudence and sagacity, a sound understanding, a wonderful power of persuasion, and an incredible vigilance and dexterity in all he undertook. But these qualities were more than counterbalanced by his vices. In his manners he was most shameless; wholly divested of sincerity, of decency, and of truth; without fidelity, without religion; in his avarice immoderate; in his ambition insatiable; in his cruelty more than barbarous; with a passionate desire of elevating his numerous children by whatever means this could be accomplished." His pontificate was the signal for the recommencement of those troubles and jealousies among the Italian potentates that had slumbered for some time, and which paved the way for a succession of foreign oppressions under which that fine country long groaned, commencing with the unprincipled irruption of the French King Charles VIII. "No sooner," says Roscoe, "was the new pontiff firmly seated in the chair of St Peter, than those jealousies, intrigues, and disputes among the potentates of Italy which had for some time ceased to agitate that country, began again to revive, and prepared the way not only for a long series of bloodshed and misery, but for events which overturned in a great degree the political fabric of Italy, and materially affected the rest of Europe." The pontificate of Alexander VI. must be considered, from the intrigues and crimes of him and his family, as disastrous and disgraceful to Italy. His violence and misrule for a while interrupted the progress of reviving literature, which had begun to spread from Italy as a centre over Europe.

The audacious villanies, however, of the pontiff's son Cæsar Borgia, throw those of the father into the shade. The equivocal character of his only daughter Lucrezia, has found a chivalrous defender in the elegant historian of the Medici. (See *Appendix I. Life of Leo. X.*) Lucrezia was first married to Gio. Sforza, lord of Pesaro, but divorced from him by her father, who soon after united her to Alfonso of Aragon, a natural son of Alfonso II. of Naples; but two years afterwards her unfortunate husband was assassinated before the great door of the church of St Peter, as is alleged with probability by the instrumentality of her brother Cæsar, who is alleged also to have murdered his own brother Giovanni in the streets of Rome. In the following year, 1501, she was finally married to Alfonso d'Este, the son of the reigning Duke of Ferrara. From this time, whatever may have been her previous character, Lucrezia became the ornament of the court of Ferrara, the patroness of learning, and was entrusted by her husband with the principal administration of his affairs during his military expeditions, in which she acquitted herself with ability and dignity.

After a life of profligacy and crime, in which he had cut off the principal members of the Colonna, Orsini, and Savelli families, the noblest of the Roman nobility, and had concentrated wealth on his own family, Alexander died Aug. 18. 1503, in the 74th year of his age, by poison prepared by himself for the destruction of the cardinal of Corneto. (T.S.T.)

Alexander VII., *Pope*. See Chigi.

Alexander, *St*, whom St Irenæus reckons the fifth bishop of Rome, succeeded St Everistus in the year 109, and died in the year 119. There is no account of his life, and the epistles attributed to him are supposititious.

Alexander I., king of Scotland, youngest son of Malcolm Canmore, succeeded his elder brother Edgar in 1107. His kingdom was turbulent; but he contrived by energy and valour to overcome all opposition. His most formidable competitor was Angus, grandson of Lulach, son of Macbeth's queen; but the dangerous insurrection was put down by the vigour of Alexander. He was no less determined in resisting all attempts on the independence of his crown by foreign princes. He died childless at Stirling in 1124, and was succeeded by his brother, David I. See Scotland.

Alexander II., king of Scotland, succeeded his father William in 1213, at 16 years of age. He made an expedition into England, to oppose the tyranny of King John, who returned the visit, and was offered battle by Alexander, but refused it. He took the city of Carlisle from Henry III., which was afterwards exchanged for Berwick. Alexander died in 1249, in the 51st year of his age and 35th of his reign, and left for his successor his son,

Alexander III., who was crowned king of Scotland in 1249. The Comyns, a powerful family, took arms against him, and, taking him prisoner, confined him at Stirling; but he was afterwards released by his subjects. He first married the daughter of Henry III., king of England; and next the daughter of the Count de Dreux; but was at length killed by a fall from his horse, on the 10th of April 1290, after having reigned 42, or, according to others, 37 years.

Alexander, *Noel*, an indefatigable writer of the 17th century, born at Rouen, in Normandy, 1639. After finishing his studies at Rouen, he entered into the order of Dominican friars, and was professed there in 1655. Soon after he went to Paris, to go through a course of philosophy and divinity in the great convent, where he distinguished himself so greatly, that he was appointed professor of philosophy there, which office he held for twelve years. M. Colbert showed him many marks of his esteem; and being determined to omit nothing to perfect the education of his son, afterwards archbishop of Rouen, he formed an assembly of the most learned persons, whose conferences upon ecclesiastical history might be of advantage to him. Father Alexander was invited to this assembly, where he exerted himself with so much genius and ability, that he gained the particular friendship of young Colbert, who showed him the utmost regard as long as he lived. These conferences gave rise to Alexander's design of writing an ecclesiastical history; for being desired to reduce what was material in these conferences to writing, he did it with so much accuracy, Alexander. that the learned men who composed this assembly advised him to undertake a complete body of church history. This he executed with great assiduity, collecting and digesting the materials himself, and writing even the tables with his own hand. He at last completed his work in 1686. Towards the latter part of his life he was afflicted with the loss of his sight; a misfortune which he bore with great patience and resignation. He died in 1724, in the 86th year of his age.

ALEXANDER, *William*, earl of Stirling, an eminent Scottish statesman and poet in the reigns of James VI. and Charles I., who, after travelling with the Duke of Argyll as his tutor or companion, wrote a poetical work, with the view of alleviating the sorrows of unsuccessful love, under the title of *Aurora*. He then removed to the court of James VI., where he cultivated poetry upon the plan of the Greek and Roman tragedians. In 1607 he published some dramatic performances, entitled *Monarchic Tragedies* dedicated to King James. After this, he is said to have written *A Supplement* to complete the third part of Sir Philip Sidney's *Arcadia*. He also wrote a poetical piece, entitled *A Parænesis to the Prince;* and in 1614 he published his last poem, *Doomsday*, or *the Great Day of Judgment*. His poetical works were published by himself, in a folio volume, under the title of *Recreations with the Muses*. He was made gentleman-usher to Prince Charles, and master of the requests; was knighted; and obtained a grant of Nova Scotia, where he projected the settlement of a colony, but afterwards sold it to the French. In 1626 he was made secretary of state for Scotland, was created first viscount and then earl of Stirling, and died in 1640.

ALEXANDER, *Paulovich*, emperor of Russia, was born on 28th December 1777. He was the son of Paul, afterwards emperor, by Maria, daughter of Prince Eugene of Würtemberg. His early education was conducted under his excellent mother, and afterwards was carefully directed by his grandmother, the Empress Catherine II., who confided its general superintendence to Laharpe, of whom Alexander ever afterwards retained a grateful recollection. The death of Catherine, in 1796, made room for the accession of her son Paul, whose wild eccentricities were so extravagant and prejudicial to his country, that they ended in his assassination in 1801; and Alexander was immediately placed on the Russian throne.

The policy of the young emperor was indicated by his concluding a peace with Britain, against which his father had declared war; and after the recommencement of hostilities between us and France in 1803, Alexander joined Austria and Sweden in a coalition with Great Britain against the pretensions of France in 1805. This war was very disastrous to the allies. The armies of Austria were totally defeated in a succession of battles between the 6th and 13th of October of that year; and the combined Austrian and Russian armies, under the two emperors, were defeated by Napoleon in the great battle of Austerlitz on the 2d of December. Austria concluded a separate treaty of peace, and Alexander led the remains of his army into his own dominions. Britain thus left single-handed to contend with the increased power of France, was probably saved from the worst consequences of the contest, by the annihilation of the combined navies of France and Spain, in the battle of Trafalgar, on 21st of October, on the very day on which General Mack surrendered a fine Austrian army of 36,000 men at Ulm to Napoleon.

Prussia, which had injudiciously stood neutral while France was humbling Austria and Russia, rashly engaged in hostilities with Napoleon in 1806, while her allies, the Russians, were still beyond the Vistula; but the defeats at Auerstadt and Jena laid Prussia prostrate; and in the succeeding year, the battles of Eylau and Friedland, in which the Russians were fairly beaten, led to the dismemberment of Prussia, and the treaty of Tilsit with Russia. A few days after the last battle, Alexander and Napoleon met on a raft anchored in the river Niemen, and agreed to the articles of a treaty which was signed at Tilsit, on July 7. Napoleon gained so on Alexander, as to obtain his consent to a secret article of the treaty, by which Alexander was not only to withdraw from his connection with Britain, but to become her enemy; and he declared war against her on the 26th of October. Alexander.

For nearly five years, Alexander appeared attached to the alliance of France; but the privations of his subjects by the interruption of the commerce with England, and the intolerable load of Napoleon's "Continental System," at length induced him to return to his old alliance, and to declare war against France on March 19. 1812. On the 24th April, he left St Petersburg, to join his armies on the west frontier of Lithuania. Napoleon assembled the most numerous and magnificent army that had ever been brought together in modern times, augmented by the unwilling levies of Prussia and Austria, and entered Russia on the 25th of June 1812. The first encounter was at Borodino, where there was a well-contested action, in which each army suffered the loss of 25,000 men. Kutusoff made a skilful retreat; and as the French advanced, they found a deserted wasted country to the confines of Moscow, which Napoleon entered on the 14th September; but in a few hours the city was in flames, supplies of every kind intercepted, and the approach of winter compelled Napoleon to leave its smoking ruins. The enterprising generals, Kutusoff, Wittzenstein, and Tschichagoff, hung on his retreat like thunderclouds; and the destruction of his gallant army at the passage of the Berizina, and the firmness of Alexander through the mighty contest, gave the first blow to Napoleon's colossal power, which had well nigh annihilated the independence of Continental Europe.

In 1813, the advancing Russians were successively joined by the forces of Prussia, Austria, and Sweden. Alexander continued with the allied armies, and he was especially present in the battles of Dresden and Leipsic. The extraordinary military genius of Napoleon had made wonderful exertions to repair his losses in the early part of 1814; but the victories of Wellington in Spain, and his advance into the heart of France, favoured the progress of the allies; and on March 30. 1814, 150,000 men of the allied armies took possession of Paris, which was entered next day by Alexander and the king of Prussia.

After the deposition of Napoleon, the allied sovereigns visited England. By the treaty of Vienna, Alexander was acknowledged king of Poland; but before the Congress of Vienna had separated, Napoleon had escaped from Elba, and was enthusiastically received at Paris. The two eastern emperors and the king of Prussia remained together, until the battle of Waterloo gave peace to Europe.

On the advance of the British and Prussians to Paris, the three allied sovereigns again made their entry into Paris, where they concluded, on September 26, that treaty which has been miscalled *the Holy Alliance*.

After that period, Alexander was chiefly occupied in the internal administration of his vast dominions, which certainly advanced in every kind of improvement during the twenty-five years of his reign, more than under any of his predecessors from the time of Peter I. The gradual abolition of the feudal servitude of the peasantry, begun by the most enlightened of his predecessors, was continued under Alexander. Education, agriculture, manufactures, commerce, were also greatly extended; while literature and the fine arts were liberally encouraged. His disposition has been represented by his subjects as mild and merciful; yet his influence in the affairs of Europe was not exerted in the cause of public liberty. But this could hardly be expected from the autocrat of an unmitigated despotism in his own territories. He will, however, bear a very favourable comparison with any Russian sovereign, or even with his European contemporary princes.

Early in the winter of 1825, he left St Petersburg for the last time on a tour of inspection of his southern provinces. About the middle of November, he was attacked by a violent intermittent fever, which is endemical in those countries; and when he reached Taganrog, on the Gulf of Azof, he was alarmingly ill from reiterated accessions of the disease, which carried him off on December 1. 1825. In foreign countries his death has been attributed to poison; but this is refuted by the history of his disease, and is very improbable, from his great popularity with his countrymen. He was married in 1793, to Louisa Maria Augusta, princess of Baden, but left no issue, and was succeeded by his second brother Nicolas, the present emperor. (T. S. T.)

ALEXANDRETTA. See SCANDEROON.

ALEXANDRIA, called ISKANDERIA by the Turks, an ancient city of Lower Egypt, and for a long time its capital. This city was built by Alexander the Great, soon after the overthrow of Tyre, about 333 years before Christ. It is situated on the Mediterranean, twelve miles west of that mouth of the Nile anciently called *Canopicum*, and lies in Long. 29. 54. E. Lat. 31. 10. N.

Alexander is said to have been induced to build this city on account of its affording a fine port, and being advantageously situated for trade. It realised his expectations; for it soon became the emporium, not only for merchandise, but also for all the arts and sciences of the Greeks. Alexandria, according to Strabo, was 30 stadia in length from east to west, and 7 or 8 stadia in breadth where narrowest. The circumference was about 70 stadia, or 9 miles; but Pliny, including no doubt the suburbs, reckons the circumference 15 miles. Lake Mareotis bathed its walls on the south, and the Mediterranean on the north. It was intersected lengthwise by straight parallel streets. This direction left a free passage to the northern wind, which alone conveys coolness and salubrity into Egypt. A street of 100 feet wide began at the gate of the sea, and terminated at the gate of Canopus. It was decorated with magnificent houses, temples, and public buildings. In its extensive range, the eye wandered with admiration over the marble, the porphyry, and the obelisks, which were destined at some future day to embellish Rome and Constantinople. The great street, the handsomest in the world, was intersected by another of the same breadth. From the middle of this place were to be seen at once vessels arriving under full sail from the north and from the south.

An artificial mole, called the *Heptastadium*, nearly a mile in length, stretched from the continent to the isle of Pharos, and divided the great harbour into two. That which is to the northward preserved its name. A dike drawn from the island to the rock on which the watch-tower was built, secured it from the westerly winds. The other was called *Eunostos*, or the Safe Return. The former is called at present the new, the latter the old harbour: they were connected with each other by two breaks in the mole, crossed by two bridges, which could be raised at pleasure. The palace, which advanced beyond the promontory of *Lochias*, extended as far as the dike, and occupied more than a quarter of the city. Each of the Ptolemies added to its magnificence. It contained within its inclosure, the museum, an asylum for learned men, groves, and buildings worthy of royal majesty, and a temple where the body of Alexander was deposited in a golden coffin. Ptolemy Soter II. violated this monument, carried off the golden coffin, and put a glass one in its place. In the great harbour was the little island of Anti-Rhodes, where stood a theatre and a royal place of residence. Within the harbour of Eunostos was a smaller one called *Kibotos*, dug by the hand of man, which communicated with Lake Mareotis by a canal. Between this canal and the palace was the grand temple of Serapis, while that of Neptune stood near the great market place. Alexandria extended likewise along the northern banks of the lake. Its eastern part presented to view the gymnasium, with its porticoes of more than 600 feet long, supported by several rows of marble pillars. Without the gate of Canopus was a spacious circus for the chariot races. Beyond that the suburb of Nicopolis ran along the sea-shore, and seemed a second Alexandria. A superb amphitheatre was built there, with a race-ground, for the celebration of the quinquennalia.

Such is the description of Alexandria left us by the ancients, and above all by Strabo.

The architect employed by Alexander in this undertaking was the celebrated Dinocrates, who had acquired so much reputation by rebuilding the temple of Diana at Ephesus. The city was first rendered populous by Ptolemy Soter, the son of Lagus, one of Alexander's captains, who, after the death of the Macedonian monarch, being appointed governor of Egypt, soon assumed the title of king, and took up his residence at Alexandria, about 304 years before Christ.

In the 30th year of Ptolemy's reign he took his son Ptolemy Philadelphus as his partner in the empire; and by this prince the city of Alexandria was much embellished. In the first year of his reign the famous watch-tower of Pharos was finished. It had been begun several years before by his father; and, when finished, was looked upon as one of the wonders of the world. The same year, the islet of Pharos itself, originally seven furlongs distant from the peninsula, was joined to it by a causeway. This was the work of Dexiphanes, who completed it at the same time that his son put the last hand to the tower. The tower was a large square structure of white marble, on the top of which fires were kept constantly burning for the direction of sailors. The building cost 800 talents; which, if Attic, amounted to L.155,000; if Alexandrian, to L.248,000. This is reckoning the Attic talent at 60, and the Alexandrian at 96 minæ, and each mina equal to L.3, 4s. 7d.

The architect employed in this famous structure is said to have fallen upon the following contrivance to usurp the whole glory to himself. Being ordered to engrave upon it the following inscription,—"King PTOLEMY to the Gods the Saviours, for the benefit of Sailors,"—instead of the king's name he substituted his own, and then filling up the hollow of the marble with mortar, wrote upon it the above-mentioned inscription. In process of time, the mortar being worn off, the following inscription appeared: "SOSTRATUS the CNIDIAN, the son of DEXIPHANES, to the Gods the Saviours, for the benefit of Sailors."

This year also was remarkable for the bringing of the image of Serapis from Pontus to Alexandria. It was set up in one of the suburbs of the city, called *Rhacotis*, where a temple was afterwards erected to his honour, suitable to the greatness of that stately metropolis, and called, from the god worshipped there, *Serapeion*. This structure, according to Ammianus Marcellinus, surpassed in beauty and magnificence all others in the world, except the Capitol at Rome. Within the verge of this temple was the famous Alexandrian library. It was founded by Ptolemy Soter, for the use of an academy he instituted in this city; and, by continual additions by his successors, became at last the finest library in the world, containing no fewer than 700,000 volumes. The method followed in collecting books for this library was to seize all those which were brought into Egypt by Greeks or other foreigners. The books were transcribed in the museum by persons appointed for that purpose: the copies were then delivered to the proprietors, and the originals laid up in the library. Ptolemy Euergetes, having borrowed from the Athenians the works of Sophocles, Euripides, and Æschylus, returned them only the copies, which he caused to be transcribed in as beautiful a manner as possible; presenting them at the same time with fifteen talents (equal to L.2906, 5s., reckoning by the smaller talent) for the exchange.

As the museum was at first in that quarter of the city called *Brucheion*, near the royal palace, the library was placed there likewise; but when it came to contain 400,000 volumes, another library, within the Serapeion, was erected by way of supplement to it, and on that account called the *daughter* of the former. In this second library 300,000 volumes in process of time were deposited; making in all 700,000. In the war carried on by Julius Cæsar against the inhabitants of this city, the library in the Brucheion, with all its contents, was reduced to ashes. The library in the Serapeion, however, still remained; and here Cleopatra deposited 200,000 volumes of the Pergamencan library, which Mark Antony presented to her. These, and others added from time to time, rendered the new library at Alexandria more numerous and considerable than the former; but when the temple of Serapis was demolished under the archiepiscopate of Theophilus A.D. 389, the valuable library was pillaged or destroyed, and twenty years afterwards the empty shelves excited the regret and indignation of every intelligent spectator. Afterwards the church and seat of the patriarchs may have been enriched with considerable collections of books, consisting chiefly of theological controversy, but the library no longer contained the 400,000 or 700,000 volumes collected by the curiosity and magnificence of the Ptolemies. For 293 years Alexandria was the capital of the kingdom of the Ptolemies.

This city, as we have already observed, soon became extremely populous, and was embellished both by its own princes and the Romans; but, like most other noted cities of antiquity, it has been the seat of terrible massacres. About 141 years before Christ it was almost totally depopulated by Ptolemy Physcon. That barbarous monster, without the least provocation, gave free liberty to his guards to plunder his metropolis, and murder the inhabitants at their pleasure. The cruelties practised on this occasion cannot be expressed, and the few who escaped were so terrified that they fled into other countries. Upon this, Physcon, that he might not reign over empty houses, invited strangers from the neighbouring countries; by whom the city was repeopled, and soon recovered its former splendour. On this occasion many learned men, having been obliged to fly, proved the means of reviving learning in Greece, Asia Minor, and the islands of the Archipelago, and other places where it was almost totally lost.

The new inhabitants were not treated with much more kindness by Physcon than the old ones had been; for, on their complaining of his tyrannical behaviour, he resolved on a general massacre of the young men. Accordingly, when they were one day assembled in the gymnasium, or place of public exercise, he ordered it to be set on fire; so that they all perished, either in the flames, or by the swords of the tyrant's mercenaries, whom he had posted at all the avenues.

Though Julius Cæsar was obliged to carry on a war for some time against this city, it seems not to have suffered much damage, except the burning of the library already mentioned. Before Cæsar left Alexandria, in acknowledgment of the assistance he had received from the Jews he confirmed all their privileges there, and even engraved his decree on a pillar of brass. This, however, did not prevent the massacre of 50,000 of them in this city, about the year of Christ 67.

The city of Alexandria seems to have fallen into decay soon after this, and to have forfeited many of its ancient privileges, though for what offence is not known; but when Hadrian visited Egypt, about the year 122, it was almost totally ruined. He repaired both the public and private buildings, not only restoring the inhabitants to their ancient privileges, but heaping new favours upon them; for which they returned him their solemn thanks, and conferred upon him what honours they could while he was present; though as soon as he was gone they published the most bitter lampoons against him.

The fickle and satirical humour of the Alexandrians was highly offensive to Hadrian, though he visited it with no punishment. Caracalla, however, did not let it pass so easily. That tyrant, when he visited their city in the year 215, having become the subject of their foolish satires, ordered a general massacre by his numerous troops, who were dispersed all over the city. The inhuman order being given, all were murdered, without distinction of age or sex; so that in one night's time the whole city floated in blood, and every house was filled with carcasses. The monster who occasioned this had retired during the night to the temple of Serapis, to implore the protection of that deity; and, not yet satiated with slaughter, commanded the massacre to be continued all the next day; so that very few of the inhabitants remained. As if even this had not been sufficient, he stripped the city of all its ancient privileges; suppressed the academy; ordered all strangers who lived there to depart; and that the few who remained might not have the satisfaction of seeing one another, he cut off all communication of one street with another, by walls built for that purpose, and guarded by troops.

Notwithstanding this terrible disaster, Alexandria soon recovered its former splendour after the death of Caracalla. It was long esteemed the first city in the world, next to Rome; and we may judge of its magnificence, and the multitude of people contained in it, from the account of Diodorus Siculus, who relates that in his time (B.C. 44) Alexandria had on its rolls 300,000 free inhabitants. Mannert, a learned German writer, thinks the slaves must have been at least equally numerous; and thus the city, in its flourishing periods, had contained not less than 600,000 inhabitants. According to Eutychius, it was on the 22d December A.D. 640, that Amrou, Omar's general, took it by storm after a siege of 14 months, and with the loss of 23,000 men. Heraclius, then emperor of Constantinople, did not send a single ship to its assistance. This prince affords an example very rare in history: he had displayed some vigour in the beginning of his reign, and then suffered himself to be lulled into idleness and effeminacy. Awakened suddenly from his lethargy by the noise of the conquests of Chosroes, that scourge of the East, he put himself at the head of his armies, distinguished himself as a great captain from his very first campaign, laid waste Persia for seven years, and returned to his capital covered with laurels: he then became a theologian on the throne, lost all his energy, and amused himself the rest of his life with disputing upon monotheism, whilst the Arabs were robbing him of the finest provinces of the empire. Deaf to the cries of the unfortunate inhabitants of Alexandria, as he had been to those of the people of Jerusalem, who defended themselves for two years, he left them a sacrifice to the rising fortune of the indefatigable Amrou. All their intrepid youth perished with their arms in their hands.

The victor, astonished at his conquest, wrote to the caliph, "I have taken the city of the west. It is of an immense extent. I cannot describe to you how many wonders it contains. There are 4000 palaces, 4000 baths, 12,000 dealers in fresh oil, 12,000 gardeners, 40,000 Jews who pay tribute, 400 theatres or places of amusement."

At this time, according to the Arabian historians, Alexandria consisted of three cities, viz. *Menna*, or the port, which includes Pharos and the neighbouring parts; *Alexandria*, properly so called, where the modern Alexandria now stands; and *Nekita*, probably the Necropolis of Josephus and Strabo.

The following story relating to the destruction of the famous library is told by Abulfaragius, whose account, however, is utterly irreconcileable with the silence of all historians of the period.—See Gibbon, *Decline and Fall, &c.* c. 51.

At that time John, surnamed *the Grammarian*, a famous Peripatetic philosopher, being in the city, and in high favour with Amrou Ebn al Aas, the Saracen general, begged of him the royal library. Amrou replied that it was not in his power to grant such a request; but that he would write to the caliph on that head, since, without knowing his pleasure, he dared not to dispose of a single book. He accordingly wrote to Omar, who was then caliph, acquainting him with the request of his friend; to which he is said to have replied, That if those books contained the same doctrine with the Koran, they could be of no use, since the Koran contained all necessary truths; but if they contained anything contrary to that book, they ought not to be suffered; and, therefore, whatever their contents were, he ordered them to be destroyed. Pursuant to this order, they were distributed among the public baths, where, for the space of six months, they served to supply the fires of those places, of which there was an incredible number in Alexandria. See Amrou.

After the city was taken, Amrou thought proper to pursue the Greeks who had fled farther up the country; and therefore marched out of Alexandria, leaving but a very slender garrison in the place. The Greeks, who had before fled on board their ships, being apprised of this, returned on a sudden, surprised the town, and put all the Arabs they met with to the sword; but Amrou, receiving advice of what had happened, suddenly returned, and drove them out of it with great slaughter; after which the Greeks were so intimidated, that he had nothing further to fear from them.—A few years after, however, Amrou being deprived of his government by the caliph Othman, the Egyptians were so much displeased with his dismission that they showed a tendency to revolt. Constantine, the Greek emperor, having received intelligence of their disaffection, determined on the reduction of Alexandria. For this purpose he sent the eunuch Manuel, his general, with a powerful army, to retake that place; which, by the assistance of the Greeks in the city, who kept a secret correspondence with the imperial forces while at sea, and joined them as soon as they had made a descent, he effected with inconsiderable loss. The caliph, now perceiving his mistake, immediately restored Amrou to his former dignity. This step was very agreeable to the natives, who, having had experience of the military skill and bravery of this renowned general, and apprehending that they should be called to an account by the Greeks for their former perfidious conduct, had petitioned Othman to send him again into Egypt.—Upon Amrou's arrival, therefore, at Alexandria, the Copts or natives, with the traitor Al-Mokawkas (who had formerly betrayed to Amrou the fortress of Mesr) at their head, not only joined him, but supplied him with all kinds of provisions, exciting him to attack the Greeks without delay. This he did; and after a most obstinate struggle, which lasted several days, drove them into the town, where, for some time, they defended themselves with great bravery, and repelled the utmost efforts of the besiegers. This so exasperated Amrou that he swore, if God enabled him to conquer the Greeks, he would throw down the walls of the city, and make it as easy of access as the house of a prostitute. Nor did he fail to execute his threat; for, having taken the town by storm, he quite dismantled it, entirely demolishing the walls and fortifications. The lives of the citizens, however, were spared, at least as far as lay in the general's power; but many of them were put to the sword by the soldiers on their first entrance. In one quarter particularly, Amrou found them butchering the Alexandrians with unrelenting barbarity; to which, however, by his seasonable interposition, he put a stop, and on that spot erected a mosque, which he called the *mosque of mercy*.

From this time Alexandria never recovered its former splendour. It continued under the dominion of the caliphs till the year 924, when it was taken by the Magrebians, two years after its great church had been destroyed by fire. This church was called by the Arabs *Al Kaisaria* or *Cæsarea*, and had formerly been a pagan temple, erected in honour of Saturn by Cleopatra.

The city was soon after abandoned by the Magrebians; but in 928 they again made themselves masters of it. Their fleet being afterwards defeated by that of the caliph, Abul Kâsem the Magrebian general retired from Alexandria, leaving there only a garrison of 300 men; of which Thamaâl, the caliph's admiral, being apprised, he in a few days appeared before the town, and carried off the remainder of the inhabitants to an island of the Nile called Aboukir. This was done to prevent Abul Kâsem from meeting with any entertainment at Alexandria, in case he should think proper to return. According to Eutychius, above 200,000 of the miserable inhabitants perished this year.

What contributed to raise Alexandria to the extraordinary height of splendour it enjoyed for a long time, was its being the centre of commerce between the eastern and western parts of the world. It was with the view of becoming master of this lucrative trade that Alexander built this city, after having extirpated the Tyrians, who formerly engrossed all the traffic of the East. Of the immense riches which that trade afforded, we may form an idea from considering that the Romans accounted it a point of policy to oppress the Egyptians, especially the Alexandrians. Extravagant accounts have been given of the wealth of Alexandria; but according to Strabo, the revenue of all Egypt under the last and most indolent of the Ptolemies, amounted only to 12,500 talents, or about two millions and a half of our money. This was afterwards considerably increased by the more exact economy of the Romans, and the increase of the trade of Ethiopia and India.

Though the revolutions which happened in the government of Egypt after it fell into the hands of the Mahometans frequently affected this city to a very great degree, yet still the excellence of its port, and the innumerable conveniences resulting from the East India trade to the possessors of Egypt, preserved it from total destruction, even when in the hands of the most barbarous nations. Thus, in the 13th century, when the European nations began to acquire a taste for the elegancies of life, the old mart of Alexandria began to revive; and the port, though far from recovering its former magnificence, grew once more famous by becoming the centre of commerce: but having fallen under the dominion of the Turks, and the passage round the Cape of Good Hope being discovered by the Portuguese in 1497, a fatal blow was given to the Alexandrian commerce, and the city thenceforward rapidly declined.

Alexandria, *Modern*, is built upon a neck of land between the two ports. That to the westward, the ancient *Eunostos*, now *the old port*, is by far the best. It stretches from the town westward to Marabout, nearly six miles, is about a mile and a half wide, and has three entrances. The first, or that nearest the city, has seventeen feet of water, and is about two miles south-west from the large building situated a little to the westward of the town, called the palace. The entrance, however, is difficult. The eastern side of the second or middle entrance is marked by buoys, which lie about two miles and three quarters south-west from the palace: it is about a quarter of a mile wide, and has, where shallowest, twenty-seven feet of water. The third or western entrance, which is the best, has its western boundary about three eighths of a mile from the east end of Marabout Island, is about half a mile wide, and has at its shallowest part from twenty-five to twenty-seven feet of water. The new or Asiatic harbour is on the eastern side of the town. The space for anchorage in it is very limited; and being exposed to the north winds, with a foul and rocky bottom, the cables of vessels soon chafe and part, by which serious accidents sometimes happen, from the violent collision of the vessels thus driven from their moorings.

The country around Alexandria is entirely destitute of water. That necessary is supplied from the Nile by the kalidj, a canal of 12 leagues, which conveys it every year at the time of the inundation. It fills the vaults or reservoirs dug under the ancient city; and this provision serves till the next year. It is evident, therefore, that were a foreign power to take possession, the canal would be shut, and all supplies of water cut off. It is this canal alone which connects Alexandria with Egypt; for, from its situation without the Delta, and the nature of the soil, it really belongs to the deserts of Africa. Its environs on the western and southern side are sandy, flat, and sterile, without trees or houses; on the eastern side the country is broken and undulating, and adorned in the vicinity of the town with well-cultivated gardens. The famous tower of Pharos has long since been demolished, and a castle, called Pharillon, built in its place. The causeway which joined the island to the continent is broken down, and its place supplied by a strong bridge of several arches.

Some parts of the Saracenic walls of the city are yet standing, and present a fine specimen of ancient masonry. They were flanked with large towers, about 200 paces distant from each other, with small towers in the middle. Below were some extensive casemates, which might serve for galleries to walk in. In the lower part of one of the towers was a large square hall, the roof of which was supported by thick columns of Thebaic syenite. Above were several rooms, over which were platforms more than 20 paces square. The ancient reservoirs, vaulted with so much art, which extend under the whole town, remain almost entire at the end of 2000 years.

Of Cæsar's palace there remain only a few porphyry pillars, and the front, which is almost entire, and very beautiful. The palace of Cleopatra was built upon the walls facing the port, with a gallery on the outside, supported by several fine columns. Not far from this palace are two obelisks, vulgarly called Cleopatra's Needles. They are of Thebaic stone, and covered with hieroglyphics. One is overturned, defaced, and lying under the sand; the other is on its plinth. These two obelisks, each of which is a single stone, measured 70 feet high, by 7 feet 7 inches at the base. Denon, who went to Egypt along with the French army in 1798, supposed that these columns decorated the entrance of the palace of the Ptolemies, the ruins of which still exist at no great distance from the place of the obelisks. Towards the gate of Rosetta are five columns of marble, on the place formerly occupied by the porticoes of the gymnasium. The rest of the colonnade, the design of which was discoverable 150 years ago by Maillet, has since been destroyed by the barbarism of the Turks.

But what most engages the attention of travellers is the pillar of Pompey, as it is commonly called, situated at a quarter of a league from the southern gate. It is composed of red granite. The capital, which is Corinthian, with palm leaves, and not indented, is nine feet high. The shaft and the upper member of the base are of one piece of nearly 90 feet long and 9 in diameter. The base is a square of about 15 feet on each side. This block of marble, 60 feet in circumference, rests on two layers of stone bound together with lead; which, however, has not prevented the Arabs from forcing out several of them, to search for an imaginary treasure. The whole column is 98 feet 9 inches high; 29 feet 8 inches in circumference; and the diameter at the top of the capital measures 16 feet 6 inches. It is perfectly polished, and only a little shivered on the eastern side. Nothing can equal the majesty of this monument: seen from a distance, it overtops the town, and serves as a signal for vessels. On a nearer approach, it produces an astonishment mixed with awe. One can never be tired with admiring this beautiful column, the length of the shaft, or the extraordinary simplicity of the pedestal. This last has been somewhat damaged by the instruments of travellers, who are curious to possess a relic of this antiquity. The column was considered inaccessible, till it was scaled about half a century ago by the wild frolic of a party of English sailors, who conceived the project of emptying a bowel of punch on the top of this celebrated monument. Dexterously availing themselves of the movements of a paper kite, they succeeded in fastening a rope to the summit, by which they ascended, and performed this great achievement. They discovered a foot and ankle, the only remnant of a gigantic statue which had originally adorned it. It was ascended by Captain W. H. Smyth, R.N. in 1822, for the purpose of ascertaining, by a series of angles taken from its summit, whether, as he had imagined, it had been erected as a mark at the north end of the degree of the meridian measured by Eratosthenes. At that time it was ascended by many persons; and Mr Madden mentions an English lady who breakfasted and wrote a letter from this elevated position. At the base, on the west side of the pedestal, some English officers found a Greek inscription, from which it would appear to have been erected in the time, and to the honour, of the emperor Diocletian; although the monolithic shaft appears of far greater antiquity.

The island of the Pharos, called by the Arabs, Rondahel-Tyn, or the Garden of Fig-trees, lies in a N.E. and S.W. direction, to the N. of the city, and consists of a dry saline soil, and dazzling white calcareous rocks, bordered with reefs, especially on the S.W. side. At its north-eastern extremity is situate the castle, a large and lofty square building, which, previous to 1842 was surmounted by a lighthouse in the form of a minaret, a substitute for the ancient magnificent structure, which stood on a rock in the eastern harbour. The castle has been strongly fortified, and occupies a small island joined to the larger one by a dike, constructed in part of ancient granite columns laid crosswise. A new lighthouse was erected in 1842, on the most westerly point of the island. It has a fixed light, 180 feet above the level of the sea, which in clear weather is visible at a distance of nearly 20 miles. The high coasts of the island shelter the old harbour from the violent winds that blow between N.W. and N.E. At its south-western extremity, called Ras-el-Tyn, or Fig-tree point, there is a naval hospital, capable of holding 300 beds, with spacious, lofty, and well-aired apartments. The foundations of the ancient Pharos are to be seen in a calm day below water.

On the south-west side of the city, at a mile's distance, are situate the catacombs, the ancient burial-place of Alexandria; a remarkable object, although they cannot be compared to those of the ancient Thebes. The Baron de Tott, in describing these, observes "that Nature not having furnished this part of Egypt with a ridge of rocks, like that which runs parallel with the Nile above Delta, the ancient inhabitants of Alexandria could only have an imitation by

Alexandria.

digging into a bed of solid rock; and thus they formed a *Necropolis*, or City of the Dead. The excavation is from 30 to 40 feet wide, 200 long, and 25 deep, and is terminated by gentle declivities at each end. The two sides, cut perpendicularly, contain several openings, about 10 or 12 feet in width and height, hollowed horizontally; and which form, by their different branches, subterranean streets. One of these, which curiosity has disencumbered from the ruins and sands that render the entrance of others difficult or impossible, contains no mummies, but only the places they occupied. The order in which they were ranged is still to be seen. Niches, 20 inches square, sunk six feet horizontally, narrowed at the bottom, and separated from each other by partitions in the rock seven or eight inches thick, divided into checkers the two walls of this subterranean vault. It is natural to suppose, from this disposition, that each mummy was introduced with the feet foremost into the cell intended for its reception; and that new streets were opened, in proportion as these dead inhabitants of Necropolis increased." This observation, he adds, which throws a light on the catacombs of Memphis, may perhaps likewise explain the vast size and multitude, as well as the different elevations, of the pyramids in Upper and Lower Egypt.

About seventy paces from Pompey's pillar is the canal of the Nile, which was dug by the ancient Egyptians, to convey the water of the Nile to Alexandria, and fill the cisterns under the city. This canal had ceased altogether to be navigable, till Mahommed Ali spent immense labour and cost in restoring it. The work was begun in 1819, and completed within a year, at a melancholy sacrifice of human life. Unfortunately, the Italian engineers whom he employed were entirely destitute of the skill necessary to conduct so great and arduous an undertaking. They took no measures to protect the canal against the fresh influx of mud from the Nile, so that it was soon choked up, and still requires frequent cleaning out. It now forms the regular line of communication between Alexandria and the Nile for the overland passage to India. The distance between Alexandria and Atfeh, where passengers embark on the Nile, is 48 English miles.

Alexandria, in modern times, until its complete fortification by Mahommed Ali, has never ranked as a place of strength. Accordingly, when attacked by Bonaparte in 1798, it surrendered almost without a blow. The French were very industrious in forming the place, if not into a regular fortress, yet into a very strong entrenched position. They appear to have succeeded. In 1801 Sir Ralph Abercromby undertook his memorable expedition. On the 13th and 21st March he gained, in the plain before Alexandria, two successive victories, of which the last was most complete and signal, though purchased by the life of the distinguished commander. Yet it was still not considered possible to carry Alexandria, unless by regular siege; the conclusion of which, on the 2d September, was accompanied by a general convention for the evacuation of Egypt by the French armies.

In 1807 a British force under the command of General Frazer landed and took possession of Alexandria without resistance; but being repulsed in two successive attempts upon Rosetta, they finally evacuated it on the 23d September of the same year.

It has recently begun to recover some degree of prosperity, from its being an important station on the overland route to India, by which the distance is shortened more than a half, and rendered comparatively safe and expeditious. Steamers from England, Marseilles, Trieste, and Constantinople sail regularly to and from Alexandria; and the goods, mails, and passengers which they convey, pass by the Mahmoodëeh canal and the Nile, through Cairo and the desert, to and from Suez, which communicates with India by the Red Sea steamers. The consequence has been a rapid increase of population, and enlargement of the town. In the Turkish quarter, however, the streets are still narrow and irregular, and the greater part of the houses very humble and poor. In the Frank or European quarter, the houses are clean and whitewashed, generally elegant and well-built, in wide, airy streets, and it contains a large new square, where are found the principal hotels and most of the consulates. The houses are built of brick or of stone, dug from the ruins of the ancient city. In the environs there are a number of handsome villas, with well-inclosed gardens. Its exports are chiefly corn, cotton, flax, wool, rice, opium, senna, and other African products; and its imports are cotton, woollen, and silk goods, hardware, iron, machinery, coals, &c. In the year 1847, 2019 vessels of the united burden of 409,516 tons entered its port; of which 465 vessels, of 136,499 tons, were British; and in 1849, 1651 vessels, of which 336 were British. In 1843 the value of its imports was L.1,005,412, and of its exports, L.1,321,268. It has a new palace, a custom-house, and two theatres; a naval arsenal, a marine hospital, a dry dock, a military and a naval school, several mosques, synagogues, and Christian churches; and since 1840 a Protestant church. Its population amounts to about 60,000 exclusive of the military, and is of a very mixed character, consisting of Turks, Copts, Armenians, Greeks, Syrians, Jews, and Europeans.

Alexandria is about forty leagues north-west of Cairo. A railway is at present (1853) in the course of construction between these two places. Long. 30. 10. E. Lat. 31. 12. N.

Alexandria, a city of Virginia, in N. America, capital of the county of the same name, and lately in the district of Columbia. It is beautifully situated on the right bank of the river Potomac, six miles south of Washington. It is neat and well-built, has a good harbour, and a considerable trade in flour. The Chesapeake and Ohio Canal begins here, which must tend to increase the prosperity of the town. In 1850 the population amounted to 8795; and that of the county to 10,216.

Alexandria, a city of Russia, capital of the circle of that name in the province of Cherson. It is situated on the river Inguletz, and contains 270 houses and 1200 inhabitants. Great quantities of maize are grown in the neighbourhood; and the sheep are of the broad-tailed kind, like those of the Cape of Good Hope. Long. 33. 3. E. Lat. 48. 22. N.

Alexandria, in *Ancient Geography*, a city of Arachosia, called also *Alexandropolis*, on the river Arachotus (Stephanus, Isidorus Characenus).—Another *Alexandria* in Gedrosia, built by Leonnatus by order of Alexander (Pliny).—A third *Alexandria* in Aria, situated at the lake Arias (Ptolemy); but, according to Pliny, built by Alexander on the river Arius.—A fourth in Bactriana (Pliny).—A fifth *Alexandria*, an inland town of Caramania (Pliny, Ptolemy, Ammian).—A sixth *Alexandria*, or *Alexandropolis*, in Sogdiana (Isidorus Characenus).—A seventh in India, at the confluence of the Acesines and Indus (Arrian).—An eighth, called also *Alexandretta*, near the Sinus Issicus, on the confines of Syria and Cilicia, now *Scanderoon*, the port town to Aleppo.—A ninth *Alexandria* of Margiana, which being demolished by the barbarians, was rebuilt by Antiochus the son of Seleucus, and called *Antiochia* of Syria (Pliny); watered by the river Margus, which is divided into several channels, for the purpose of watering the country which was called *Zotale*. The city was seventy stadia in circuit, according to Pliny; who adds, that after the defeat of Crassus, the captives were conveyed to this place by Orodes, the king of the Parthians.—A tenth, of the Oxiana, built on the Oxus by Alexander, on the confines of Bactria (Pliny).—An eleventh, built by Alexander at the foot of Mount Paropamisus, which was called *Caucasus* (Pliny, Arrian).—A twelfth *Alexandria* in Troas, called also *Troas* and *Antigonia* (Pliny).—A thirteenth on the Jaxartes, the boundary of Alexander's victories towards Scythia, and the last that he built on that side.

ALEXANDRIAN MS., *Codex Alexandrinus*, the appellation given to a manuscript of the Sacred Scriptures of the Old and New Testaments now in the British Museum. This venerable Greek MS. was presented to our Charles I., through the hands of his ambassador to the Porte, Sir Thomas Rowe, by Cyrillus Lucaris, patriarch of Constantinople, in 1628. The donor had then recently brought it from Alexandria, whence its name. It remained in the royal library of our sovereigns, until transferred to the Museum in 1753. It is contained in four small folio volumes, written on vellum in double columns; the first three containing the Old Testament, the last the New Testament. The *Old*, however, is more perfect than the *New*: for the beginning of the Gospel of St Matthew is lost, the MS. commencing with the 6th verse of chapter xxv. There are several *lacunæ* in the Gospel of St John, as vi. 50, viii. 52; and a still larger one in 2d Epistle to Corinthians, from chap. iv. 13. to xii. 6. (See Woide's *Prolegomena*.) Occasionally too, single letters have disappeared, from the operations of the bookbinder. The characters are *uncial*, well rounded, and carefully written. There are no interspaces dividing words, no aspirates, nor accents, few contractions; and no instances of *Stichometry*, or division into lines to be read without pauses, an improvement introduced by *Euthalius*, about the year 462; from which last circumstance Woide and many other critics believe this MS. to be at least older than that period. An Arabic inscription on the reverse of the leaf containing a list of the books of both Testaments, states that it was written by the martyred Thekla. Whether this be true or not, the manuscript bears marks of an Egyptian origin, from Egyptian orthography, the confusion of vowels with nearly similar sounds, and Alexandrian forms of inflection of some tenses, as of the 2d Aorist. That the MS. is very ancient is undoubted, though able critics are divided whether it ought to be referred to the early part of the fourth or beginning of the sixth century; but it seems most probably written before the middle of the fifth. Besides the books of the Old Testament which we regard as *canonical*, it contains the Apocryphal books, with the exception of the story of Susannah, and of Bel and the Dragon; but it contains the 3d and 4th books of Maccabees. These books are somewhat differently arranged from that of our version, or of the Vulgate of St Jerome. The psalms are divided into 151, with 15 hymns. As an introduction to them, the MS. contains the Epistle of Athanasius to Marcellinus, contained in 1277 lines; with the hypothesis of Eusebius on the Psalms. These three volumes, with very valuable prolegomena and notes, have been printed in *fac-simile* of the MS. at the expense of the British Museum, by the Rev. H. H. Baber, lately librarian to that institution. Half of the third volume is occupied with Baber's most valuable notes. The *fac-simile* of the New Testament published by Woide, in 1786, contains very excellent prolegomena and critical remarks on the MS., the general accuracy of which are admitted, though his deductions as to the age of the transcript have been much canvassed. This publication renders a collation of the MS. of the New Testament unnecessary; and his volume is now considered as completing this important work. In the 4th volume of the MS. we have the books of the New Testament in nearly the order usually adopted; except that the Epistle of Paul to the Hebrews immediately follows 2d Thessalonians; and that the Epistle of James, the two of Peter, the three of John, and that of Jude, are included under the *Catholicæ* placed between the Acts and the Epistles of Paul. The MS. contains also the whole of the 1st and part of the 2d Epistle of Clement to the Corinthians, which follow the Apocalypse, and are succeeded by the 8 Psalms of Solomon. We may remark that the well-known verses about the *three witnesses* in the 5th chapter of the 1st Epistle of St John, are not in this MS., nor indeed in almost any of the very ancient Codices; whence its genuineness is doubted by most critics. See Burnet's *Travels, Letter I.*

To those who desire a more minute account of the Alexandrian manuscript, we must refer them to the prolegomena and notes of Baber and Woide, while we shall add the table of contents of the four volumes (as given in the first volume), with the corresponding designations in the English Bible.

Tom. I.

| | |
|---|---|
| *Γενεσις Κοσμου* | Genesis. |
| *'Εξοδος 'Αιγοπτου* | Exodus. |
| *Λευιτικὸν* | Leviticus. |
| *'Αριθμοι* | Numbers. |
| *Δευτερονόμια* | Deuteronomy. |
| *'Ιησούς Ναυῆ* | Joshua, son of Nun. |
| *Κριται* | Judges. |
| *Ρυθ* | Ruth. |
| *Βασιλεῶν ά* | Samuel I. or Kings I. |
| *Βασιλεῶν β'* | Samuel II. or Kings II. |
| *Βασιλεῶν γ'* | Kings I. or Kings III. |
| *Βασιλεῶν δ'* | Kings II. or Kings IV. |
| *Παραλειπομένα ά* | Chronicles I. |
| *Παραλειπομένα β'* | Chronicles II. |

Tom. II.

*Προφῆται ις* (16 Prophets).

| | |
|---|---|
| *'Ωσηε* | Hosea. |
| *'Αμὼς* | Amos. |
| *Μιχαίας* | Micah. |
| *'Ιωηλ* | Joel. |
| *'Αβδαιου* | Obadiah. |
| *'Ιωνας* | Jonah. |
| *Ναουμ* | Nahum. |
| *'Αμβακουμ* | Habakkuk. |
| *Σοφονὶας* | Zephaniah. |
| *'Αγγαιος* | Haggai. |
| *Ζαχαραιας* | Zachariah. |
| *Μαλαχιας* | Malachi. |
| *'Ησαιας* | Isaiah. |
| *'Ιερεμιας* | Jeremiah. |
| *Θρηνηματα* | Lamentations. |
| *'Ιεζεκιηλ* | Ezekiel. |
| *Δανιελ* | Daniel. |
| *'Εσθηρ* | Esther. |
| *Τωβιτ* | Tobit. |
| *'Ιυδειθ* | Judith. |
| *'Εσζρας ά* | Esdras I. |
| *Εσζρας β'* | Esdras II., including *Νεεμια*, and part of the canonical Book of Ezra. |
| *Μακκαβιων ά* | Maccabees I. |
| *Μακκαβιων β'* | Maccabees II. |
| *Μακκαβιων γ'* | Maccabees III. |
| *Μακκαβιων δ'* | Maccabees IV. |

Tom. III.

| | |
|---|---|
| *'Αθανασιου 'Επιστολη* | Epistle of Athanasius to Marcellinus on the Psalms. |
| *'Ευσεβιου 'Υποθεσις* | Hypothesis of Eusebius on the Psalms. |
| *Ψαλτεριον μετ' 'Αδων* | Psalms 151, Hymns 15. |

Alexandrian School.

| | |
|---|---|
| Ἰωβ | Job. |
| Παροιμιαι | Proverbs. |
| Ἐκκλησιαστης | Ecclesiastes. |
| Ἀσματα Ἀσματων | Canticles. |
| Σοφια ἡ Παναρητος | Wisdom prayed for, or Wisdom of Solomon. |
| Σοφια Ἰησου υἱου Ζιραχ | Ecclesiasticus, or Wisdom of Jesus, son of Sirach. |

*Notæ* H. H. Baber fill 264 pages, or about half this volume.

Tom. IV.

| | |
|---|---|
| Ἐυαγγελιων κατα Ματθαιον | Matthew. |
| Ἐυαγγελιων κατα Μαρκον | Mark. |
| Ἐυαγγελιων κατα Λουκαν | Luke. |
| Ἐυαγγελιων κατα Ἰωαννην | John. |
| Πραξις Ἀποστολων | Acts of the Apostles. |
| Ἐπιστολαι Καθολικαι ζ' | Seven Catholic Epistles, comprehending those of James, 2 of Peter, 3 of John, and 1 of Jude. |
| Ἐπιστολαι Παυλου ιδ' | Fourteen Epistles of Paul. |
| Ἀποκαλυψις Ἰωαννου | Revelation of John. |
| Κλημεντος Ἐπιστολη α' | 1st Epistle of Clement to the Corinthians. |
| Κλημεντος Ἐπιστολη β' | 2d Epistle of Clement to the Corinthians. |
| Ψαλμοι Σολομοντος η' | Eight Psalms of Solomon. |

(T. S. T.)

Alexandrian School. At the time when Greece, by a series of disasters, was deprived of her ancient independence, the glorious era of her poetry was already past; and that intellectual pre-eminence which she had enjoyed for so long a period, was now to find a powerful rival in the city of Alexandria, which, under the Græco-Egyptian dynasty of the Lagidæ, was destined to attain a high celebrity as the seat of letters. At the end of the fourth century before Christ, Ptolemy Soter drew around him at Alexandria many philosophers and men of letters from different parts of Greece; and the work thus commenced by the son of Lagus, was continued after him by Ptolemy Philadelphus, and Ptolemy Euergetes, in succession. Ptolemy Soter, animated with a laudable ambition, founded the *Museum*, a vast establishment in connection with the royal residence, and thither the learned of all countries were welcomed. That every facility might be afforded them for cultivating the several branches of science and literature, this prince collected from all parts of the world the most celebrated literary productions, and thus laid the foundation of that famous library, which excited the admiration of the ancients, and of which the destruction has given rise to so many contradictory reports. The office of librarian was first held by Demetrius Phalereus. The library and museum, with its theatre for lectures and public assemblies, were connected with the palace by long colonnades of marble, and magnificently adorned by obelisks, sphinxes, and other trophies from the Pharaonic cities. The museum was provided with private apartments for the accommodation of the members, and contained a great saloon in which they took their repasts in common. To this establishment was attached a botanic garden enriched with tropical flora; and also a menagerie of the rarest animals. The museum was governed by a president who was nominated by the Ptolemies, and afterwards by the Cæsars. An exterior peristyle or corridor was devoted to exercise and ambulatory lectures. Ptolemy Philadelphus instituted, in honour of Apollo, those literary contests called *Ludi Musarum et Apollinis*, at which public prizes were adjudged to the successful competitors. This prince also made very considerable additions to the library, of which an account has already been given. See Alexandria.

Alexandria and its school appear to have soon recovered from the disasters of civil war; for in the second century of our era the learned assembled there in great numbers; and a new school of philosophy arose, which, from the third down to the close of the fifth century, attempted to supply the human intellect with a standing ground between the scepticism that followed the decline of Grecian philosophy on the one hand, and the rapidly spreading, and finally victorious, influence of Christianity on the other. The term "Alexandrian School" is applied in a loose sense to the whole body of eminent men who, in all the departments of knowledge, conferred lustre on the capital of the Ptolemies; but as a characteristic designation, it is more strictly confined to that particular section of its philosophers known as the Neo-Platonists. This philosophy, as the name implies, was a new development of Platonism, in a form and combination suited to the exigency of the time, and is specially remarkable as an advance from the more purely rational point of view of the Greeks towards the sphere of religious ideas—as a transition stage between the grossness of pagan superstition, and the spiritual reign of Christianity. Setting out from the higher doctrines of Plato, which formed at once its starting point and its unifying centre, it sought by a broad electicism to harmonize, 1*st*, All philosophy; 2*d*, All religion. Its first step was the reconciliation, in a higher unity, of Platonism and Aristotelianism; it next set itself to harmonise all the old religious beliefs, by bringing in the mysticism of the East to interpret their higher meaning; and thus it presented the new and peculiar phenomenon of Grecian dialectics applied to oriental theosophy, of philosophy and religion for the first time in alliance. To Christianity its relation was one of direct hostility; while at the same time, it approached it on the side of its higher mysteries, and represented itself as possessed of all that was true in the new religion. Neo-Platonism and Christianity (so far at least as the Alexandrian theology is concerned) exercised on each other a mutually modifying influence.

The first beginning of this remarkable electicism dates with the Jew Philo in the first century; but it does not appear as a distinct and influential movement till the opening of the school of Ammonius Saccas (A.D. 193), followed by the more decided and comprehensive development of Neo-Platonism by his disciple Plotinus (A.D. 200-270). In the next generation it was represented by Porphyry and Iamblichus; somewhat later by Hierocles; and it finally attained its culmination with Proclus (A.D. 412-485), in whose person the philosophy of Alexandria, and of the Old World, became extinct. Neo-Platonism thus presents three periods or stages of development: its metaphysics are chiefly represented by Plotinus; its logic and theosophy by Porphyry and Iamblichus; and the systematic combination of its parts gave employment to the genius of Proclus.

For a more particular account of their doctrines, see Ammonius, Plotinus, &c.

But Alexandria was not distinguished alone by its philosophical school. At the same period also arose those new systems of cosmography which prepared the way for the geography of the moderns, and gave a fresh impulse to research and discovery. Under the infamous Caracalla the museum was suppressed, and from A.D. 257 to 267, pestilence, conflagrations, and civil wars, gave a blow to this seat of learning, from which it recovered with difficulty. The library, however, still subsisted, and continued to augment, until fanaticism completed its ruin. In 391 a bloody struggle took place between the Pagans and the Christians, the priests on either side fomenting the division; and during this contest the magnificent Serapeion was terribly devastated.

Whether any part of the library was preserved cannot now be ascertained, but in the sixth century Alexandria became famous for its medical school, and doubtless a new library must have been formed. The story of its destruction by the command of Omar has been already mentioned.

The system of instruction pursued at Alexandria must not be confounded with the modern, nor yet with the ancient academical course, for the promulgation of a systematic doctrine, or a positive science. There was not at any given period a regular school for the teaching of fixed general principles. The views of the Greeks differed from those of the Christian philosophers as well as from those of the Jews. Nor were mental philosophy and letters the sole objects of study with the Alexandrians; they also engaged in the natural and exact sciences, in philology, medicine, and anatomy. The latter science, indeed, may be said to have been created by them, notwithstanding that the dissection of the human body was repugnant to the religious prejudices of the Greeks. In short, at this school every branch of knowledge was represented, and some of its learned men may truly be styled encyclopædists, whose studies embraced the whole circle of the sciences, and who drew their information from the literature of all countries. If the productions of Greece chiefly occupied the shelves of the library, it is certain that native works, and the written documents of other countries, existed in great numbers at Alexandria. These works were sometimes translated into the Greek tongue; as, for example, the version of the Hebrew Scriptures known as the Septuagint. Alexandria, in its earlier period, was almost exclusively a school of grammar and criticism, to which sciences the learned devoted themselves with unwearied assiduity. Hence the Alexandrians soon became the arbiters of the Greek language; and by devoting their labours to the writings of the ancients, they became the restorers of learning, producing correct editions of their works, often accompanied with learned commentaries of great value, though occasionally they are chargeable with prolixity and excessive refinement. The name of Aristarchus of Samothrace is proverbial in literary criticism; and in the same category must be placed Zenodotus of Ephesus, Eratosthenes of Cyrene the celebrated geometer and astronomer, Aristophanes of Byzantium, Crates of Mallos, Dionysius of Thrace, Apollonius the sophist, Didymus, and Zoilus. In the same department must also be noticed the learned dictionaries and laborious lucubrations of Harpocration, of Julius Pollux, Hephæstion, Hesychius, and Ammonius. The studies of these men comprehended not only grammar, but likewise criticism, the science of the scholiast, the drama, metrical verse, and archæology. Though occasionally heavy, their erudition was real and profound; and to this class of men we are indebted for elaborate editions of Thucydides, Plato, Aristotle, and other ancient classics. Admirably fitted as they were for the task, they omitted nothing that could serve to elucidate the ancient text. The natural result, however, of this incessant application to the study of the ancients, was to limit the original productions of the Alexandrians. With the exceptions of the curious chronicles of Manetho, and the Chronographia of Eratosthenes (of which works the fragments which remain have acquired deep interest by the hieroglyphical discoveries of Young and Champollion), the Alexandrians have bequeathed to us no valuable work on Egyptian history; their researches being chiefly directed to the traditional histories of the several Greek states, and the obscure question of their origin. In poetry they devoted themselves rather to the niceties of style and artifices of combination than to the nobler part of that art. With those works of unapproachable excellence ever before their eyes, they laboured to become original inventors, and in default of genius, they fell into exaggeration and affectation. It would be erroneous, however, to include in this censure all the poets of the Alexandrian school, or to ascribe an equal degree of merit to the names of Apollonius Rhodius, Lycophron, Aratus, Nicander, Euphorion, Callimachus, Theocritus, Philetas, Phanocles, Scymnus, and Dionysius. Besides these poets, Alexandria possessed a *Pleiad* of seven tragedians, famous in their day; but there appears to be little reason to regret the loss of their works.



The natural sciences were cultivated at Alexandria with great success. Herophilus and Erasistratus were distinguished anatomists: Demosthenes Philalethes wrote the first work on diseases of the eye: Zopyrus and Cratevas were the improvers of pharmacy, especially of that branch known as rhizotomy: and here also Asclepiades, Soranus, and the celebrated Galen, received instruction in the healing art. But yet greater was its fame as a mathematical school. Among its scholars were Euclid, the father of scientific geometry; Apollonius of Perga, whose work on the conic sections still exists; Nicomachus, the first scientific arithmetician; and it is well known that at Alexandria were made those improvements in the theory of the calendar which were afterwards adopted into the Julian calendar. Here also Claudius Ptolemy (whose system of geography and astronomy was followed until the time of Copernicus) composed his *Magna Syntaxis*, Aratus his *Phænomena*, Menelaus his *Sphærica*; and to these must be added the names of Eratosthenes, Hipparchus, and Aristyllus. The studies of some of these philosophers embraced every variety of human learning. Their knowledge was frequently profound on subjects of the most opposite nature,—as, for example, we find Eratosthenes celebrated not only as a geometer and astronomer, but also as a geographer, philosopher, historian, and grammarian; and the *Deipnosophistæ* of Athenæus is an inexhaustible mine of learning on subjects the most widely diversified, in philology, poetry, history, and archæology. Among the interpreters of Sacred Writ were the (Hellenizing) Jews, Aristobulus and Philo, while the Christian school of Theology flourished under the successive care of Pantænus, Clement, and Origen. At a later period, the Christian school of Alexandria was adorned by the talents of Athanasius, Gregory of Nazianzen, Julius Africanus, Hesychius, Cyril, Synesius, and a host of others.—*Essai Historique sur l'Ecole d'Alexandrie, par M. Jacob Matter*, Paris, 1820, 2 vols. 8vo.

ALEXANDRIAN, or *Alexandrine*, in *Poetry*, a kind of verse consisting of 12, or of 12 and 13 syllables alternately; so called from a poem on the life of Alexander, written in this kind of verse by a French poet of the 12th century. Alexandrines are sometimes used by most nations of Europe, but chiefly by the French, whose tragedies are generally composed of Alexandrines. A well known example of an Alexandrian verse is given in Pope's *Essay on Criticism*:—

> A needless Alexandrine ends the song,
> That like a wounded snake drags its slow length along.

ALEXICACUS, the *averter of evil*, an epithet of Jupiter, Apollo, and Neptune.

ALEXIN, a circle of the province of Tula, in Russia in Europe, to the south of Moscow and east of Kaluga. It is a level district, watered by the river Oka and its tributary streams, of moderate fertility, and abundantly supplied with wood. It comprehends one city and 74 parishes, containing 241 villages and about 90,000 inhabitants. The capital of the circle, of the same name, is built on the river Oka, has four churches, with 2000 inhabitants, some of whom manufacture hats and soap. It is in Long. 36. 30. E. and Lat. 54. 42. N.

ALEXIS, an ancient comic poet, born about B.C. 390 at Thurii in Magna Græcia, the uncle and instructor of

Menander. He lived 106 years, and wrote 245 plays, the fragments extant bearing testimony to their wit and elegance. They were frequently translated by the Latin comic writers. —See Meineke, *Fragm. Com.* vol. 1.

ALEXIS, a Piedmontese (whose real name, according to Haller, was Hieronimo Rosello), the reputed author of the *Book of Secrets*. It was printed at Basil in 1536, in 8vo, and translated from Italian into Latin by Wecher. It has also been translated into most European languages; and in an abridged form was long a popular book. There is a preface to the piece, wherein Alexis informs us that he was born of a noble family; that he had from his most early years applied himself to study; that he had learned many languages; that having an extreme curiosity to be acquainted with the secrets of nature, he had collected as much as he could during his travels for 57 years; that he piqued himself upon not communicating his secrets to any person; but that when he was 82 years of age, having seen a poor man who had died of a sickness which might have been cured had he communicated his secret to the surgeon who took care of him, he was touched with such a remorse of conscience, that he lived almost like a hermit; and it was in this solitude that he arranged his secrets in such order as to make them fit to be published.

ALEXIS, or *Alexei Michailowitz*, Czar of Russia, the second sovereign of the house of Romanoff, father of Peter I., was one of the most eminent princes of that country. He was born at Moscow in 1630, and died in 1674. See RUSSIA.

ALEXIUS I., the nephew of Isaac Comnenus, the first Byzantine emperor of the family of which Alexius was the most distinguished member. In early life he signalised himself in arms against the enemies of his country; but the mean jealousies of the ministers of the emperor Nicolas III., surnamed Botaniates, drove him to take up arms against a sovereign whose throne he had thrice gallantly defended against powerful insurgent leaders; and he ascended the throne of Constantinople in 1081. His character has been too partially drawn by the pen of his favourite daughter Anna Comnena, who has, however, justly remarked that the disorders of the times were both the misfortune and glory of Alexius, and that he paid the penalty of the judgments of heaven on the vices of his predecessors. In his reign the conquering Turks extended their desolating career from Persia to the Hellespont; on the north the empire was pressed upon by the hordes of barbarians from the Danube; on the west it was assailed by the daring valour of the Normans; while Europe precipitated itself on Asia through the route of Constantinople, in the madness of the first crusade. Amid these storms Alexius steered the reeling vessel of the state with a dexterous and courageous hand, though his policy was by the Latins ascribed to cowardice or treachery. His was undoubtedly a very difficult game, which it required no common ability to bring to a safe conclusion; and he had the policy to derive solid advantages from the wild valour of the crusaders. Yet Alexius outlived the love of his subjects, and their patience was well-nigh exhausted in the latter part of his long reign. The noble families were irritated by the profusion of his numerous relations; the people by his severity and exactions; while the clergy murmured at his unscrupulous application of the wealth of the church to the defence of the state, though they applauded his defence of religion by his eloquence, his pen, and his sword. Alexius died on the 15th of August 1118. (T. S. T.)

ALEYN, CHARLES, an English poet in the reign of Charles I. He published two poems, entitled *The Battailes of Cressy and Poictiers*, and several other pieces and translations. He succeeded his father as clerk of the ordnance, and was commissary-general of the artillery to the king at the battle of Edgehill. He died in 1640.



ALFAQUES, a seaport in the province of Catalonia, in Spain. It is on a peninsula formed by the river Ebro, near its mouth. The government has expended vast sums on its improvement, but without correspondent success, chiefly owing to the insalubrity of the situation.

ALFAQUES, among the Moors, the name generally used for their clergy, or those who teach the Mahometan religion; in opposition to the Morabites, who answer to monks among Christians.

ALFARABIUS, a celebrated eastern philosopher of the tenth century, was born at Farab, now called Othrar, a city of Asia Minor. The date of his birth is unknown. He studied for some time at Baghdad, then the chief seat of learning; and afterwards travelled, in order to form an acquaintance with the learned of other countries.

A great revolution of sentiment in regard to letters had taken place, in the preceding century, among the followers of Mahomet. Under the caliphs of the house of Abbas, men of learning were raised to a degree of favour and consequence which has never been enjoyed by that class, under the sovereigns of any other country, in any age of the world. Every little court, too, had its circle of men of letters, who were always admitted to the society of the prince, and for the most part liberally supported by his bounty. Thus, when Alfarabius, after he had finished his travels, settled at Damascus, he was received with open arms by its sovereign, who bestowed upon him a pension, which he continued to enjoy till his death, in the year 950.

But to gain the notice of princes, or to acquire wealth, formed none of the aims of this philosopher. He is said to have led a very retired and ascetic life, rather contemning than seeking after the good things of the world. "He constantly slept, even during winter, upon straw; his countenance was always sorrowful, and he found no consolation in anything but philosophy." (Enfield's *History of Philosophy*, b. v. c. 1.) His works were numerous, and very various in their subjects: his speculations seem, indeed, from the list of his writings, to have embraced the whole circle of the sciences. He is particularly deserving of notice, as having been perhaps the first compiler of an *Encyclopædia*. Such is the title of one of his works, of which there is a copy in manuscript in the library of the Escurial. It contains, according to the brief notice of it given in Casiri's valuable account of the Arabic manuscripts in that collection, a clear and comprehensive definition and compendium of all the arts and sciences; and it appears to have been regarded in the East as the most valuable of Alfarabius's compositions. It would have been agreeable to the lovers of literary history to have possessed some more detailed view of the extent, plan, and contents of an Encyclopædia written by an Arabian so many centuries before any work of that description was thought of in Europe.

Next to this in estimation appears to have been his treatise on *Music*, in which he is said to have applied the principles of physics to correct the errors of musical theorists, and to regulate the construction of musical instruments. (*Biog. Universelle*, tom. i.) Casiri gives a complete list of his writings, but it is too long to be copied in this place. (See *Bibl. Arabico-Hispana Escurialensis*, tom. i.) Some of his pieces were published in Latin at Paris in 1633, under the title of *Opuscula Varia* Alfarabii.

ALFARO, a town of Spain, at the confluence of the Alhama, with the Ebro, in the province of Logroño. It is surrounded with walls, and has four gates, one church, and four monasteries. It manufactures cloth, saltpetre, brandy, &c. Pop. 6450.

ALFERGAN, or ALFRAGAN, an Arabian astronomer, who lived under the reign of the caliph Almamoun, and who, on account of his skill in calculation, was surnamed *the Cal-*

*culator.* He wrote an *Introduction to Astronomy*, which contains little that is original, being chiefly compiled from the *Almagest* of Ptolemy. He was also the author of a treatise on *Dials*, and of an account of the construction and use of the *Astrolabe.* These two pieces still remain in manuscript; but there have been three different Latin translations of his astronomical work published. The first, by Joannes Hispalensis, appeared at Ferrara in 1493, and was afterwards reprinted at Nuremberg in 1537, with a preface by Melanchthon. The second, by John Christman, was published at Frankfort in 1590. The third, and the best, by Golius, professor of mathematics and oriental languages at Leyden, was published at Amsterdam in 1669, with the Arabic text, and notes by the translator, which are extremely curious: but these notes extend no farther than the ninth chapter, as the author did not live to complete this part of his undertaking. The work itself contains thirty short chapters.

ALFET, an ancient ordeal, in which the accused person plunged his arm up to the elbow into a caldron of boiling water.

ALFIERI, Vittorio, chiefly celebrated as the author who raised the Italian tragic drama from its previous state of degradation, was born on the 17th January 1749, at the town of Asti, in Piedmont. He lost his father in early infancy; but he continued to reside with his mother, who married a second time, till his tenth year, when he was placed at the academy of Turin. After he had passed a twelvemonth at the academy, he went on a short visit to a relation who dwelt at Coni; and during his stay there he made his first poetical attempt, in a sonnet chiefly borrowed from lines in Ariosto and Metastasio, the only poets he had at that time read. When thirteen years of age, he was induced to commence the study of civil and canonical law; but the attempt only served to disgust him with every species of application, and to increase his relish for the perusal of French romances.

By the death of his uncle, who had hitherto taken some charge of his education and conduct, he was left, at the age of fourteen, to enjoy without control his vast paternal inheritance, augmented by the recent accession of his uncle's fortune. He now began to attend the riding-school, where he acquired that rage for horses and equestrian exercise which continued to be one of his strongest passions till the close of his existence.

After some time spent in alternate fits of extravagant dissipation and ill-directed study, he was seized with a desire of travelling; and having obtained permission from the king, he departed, in 1766, under the care of an English preceptor. Restless and unquiet, he posted with the utmost rapidity through the towns of Italy; and his improvement was such as was to be expected from his mode of travelling and his previous habits. Dissatisfied with himself, he felt as little relish for spectacles or entertainments as for literature; and was as little amused by the gaiety of a carnival at Naples, as he was impressed by the remains of antiquity at Rome, or the exhibitions of modern art at Florence and Bologna. This indifference and insensibility did not, however, arise from defect of talent or the natural powers of taste, but from the want of some serious passion, or some ennobling or praiseworthy pursuit. Hoping to find in foreign countries some relief from the tedium and *ennui* with which he was oppressed, and being anxious to become acquainted with the French theatre, he proceeded to Paris; but his feelings were only those of disgust or indifference for the dramas which he saw represented in that capital. He seems, indeed, to have been completely dissatisfied with every thing he witnessed in France, and contracted a dislike to its people, which his intercourse in future years rather contributed to augment than diminish. In Holland he became deeply enamoured of a married lady, who returned his attachment, but who was soon obliged to accompany her husband to Switzerland. Alfieri whose feelings were of the most impetuous description, was in despair at this separation, and returned to his own country in the utmost anguish and despondency of mind. While under this depression of spirits, he was induced to seek alleviation from works of literature; and the perusal of Plutarch's Lives, which he read with profound emotion, inspired him with an enthusiastic passion for freedom and independence. Under the influence of this rage for liberty he recommenced his travels; and his only gratification, in the absence of freedom among the Continental states, appears to have been derived from contemplating the wild and sterile regions of the north of Sweden, where gloomy forests, lakes, and precipices, conspired to excite those sublime and melancholy ideas which were congenial to his disposition. Human manners and human institutions he seems invariably to have surveyed with an eye of passion or prejudice, instead of viewing them with the calmness of a philosopher, who meditates how they may be rectified, or what lessons may be drawn from them. In every country his soul felt as if confined by the bonds of society: he everywhere panted for something more free in governments, more elevated in sentiment, more devoted in love, and more perfect in friendship. In search of this ideal world he posted through various countries, more with the rapidity of a courier than of one who travels for amusement or instruction. During a journey to London, he engaged in an intrigue with a married lady of high rank; and having been detected, the publicity of a rencounter with the injured husband, and of a divorce, which followed, united to the knowledge he now acquired of the abandoned character of the woman to whom he was ardently attached, rendered it expedient and desirable for him to quit England. He then visited Spain and Portugal, where he became acquainted with the Abbé Caluso, who remained through life the most attached and estimable friend he ever possessed. In 1772 Alfieri returned to Turin, where he again became enamoured of a lady, whom he loved with his usual ardour, and who seems to have been as undeserving of a sincere attachment as those he had hitherto adored. In the course of a long attendance on his mistress, during a malady with which she was afflicted, he one day wrote a dialogue, or scene of a drama, which he left at this lady's house. About a year after, on a difference taking place between them, this piece was returned to him. Having then retouched and extended it to five acts, it was performed at Turin in 1775, under the title of *Cleopatra*, whose amours had always been a favourite subject with Italian dramatists.

From this moment Alfieri was seized with an immeasurable thirst of theatrical fame, and the remainder of his life was devoted to its attainment. His first two tragedies, *Filippo* and *Polinice*, were originally written in French prose; and when he came to versify them in Italian, he found that, from his Lombard origin, and long intercourse with foreigners, he expressed himself with feebleness and inaccuracy. Accordingly, with the view of improving his Italian style, he went to Tuscany, and, during an alternate residence at Florence and Sienna, he completed his *Filippo* and *Polinice*, and conceived the plan of various other dramas. While thus employed, he became acquainted with the countess of Albany, who then resided with her husband at Florence. For her he formed an attachment which, if less violent than his former loves, appears to have been more permanent. With this motive to remain at Florence, he could not endure the chains by which his vast possessions bound him to Piedmont. He therefore resigned his whole property to his sister, the Countess Cumiana, reserving an annuity which scarcely amounted to a half of his original revenues. At this period the Countess of Albany, urged by the ill treatment she received from her husband, sought refuge in Rome, where she at length received permission from the pope to live apart from her tormentor. Alfieri followed the countess to that capital, where he completed fourteen tragedies, four of which were now for the first time printed at Sienna.

At length, however, it was thought proper that, by leaving Rome, he should remove the aspersions which had been thrown on the object of his affections. During the year 1783 he therefore travelled through different states of Italy, and published six additional tragedies. The interests of his love and literary glory had not diminished his rage for horses, which seems to have been at least the third passion of his soul. He came to England solely for the purpose of purchasing a number of these animals, which he carried with him to Italy. On his return he learned that the Countess of Albany had gone to Colmar in Alsace, where he joined her, and resided with her under the same roof during the rest of his life. They chiefly passed their time between Alsace and Paris, but at length took up their abode entirely in that metropolis. While here, Alfieri made arrangements with Didot for an edition of his tragedies; but was soon after forced to quit Paris by the storms of the Revolution. He recrossed the Alps with the countess, and finally settled at Florence. The last ten years of his life, which he spent in that city, seem to have been the happiest of his existence. During that long period his tranquillity was only interrupted by the entrance of the revolutionary armies into Florence in 1799. Though an enemy of kings, the aristocratic feelings of Alfieri rendered him also a decided foe to the principles and leaders of the French Revolution; and he rejected, with the utmost contempt, those advances which were made with a view to bring him over to their cause. The concluding years of his life were laudably employed in the study of the Greek literature, and in perfecting a series of comedies. His assiduous labour on this subject, which he pursued with his characteristic impetuosity, exhausted his strength, and brought on a malady, for which he would not adopt the prescriptions of his physicians, but obstinately persisted in employing remedies of his own. Under this regimen his disorder rapidly increased, and at length terminated his life on the 8th October 1803, in the fifty-fifth year of his age.

The character of Alfieri may be best appreciated from the portrait which he has drawn of himself in his own *Memoirs of his Life.* He was evidently of an irritable, impetuous, and almost ungovernable temper. Pride, which seems to have been a ruling sentiment, may account for many apparent inconsistencies of his character. While it made him abhor kings, because superior to himself, it led him to detest those republicans who, by too near an approach, contaminated aristocratic dignity; and it induced him, while yet undistinguished himself, and panting for literary fame, to decline a proffered introduction to Metastasio and Rousseau. But as all his bad qualities were greatly softened by the cultivation of literature, it may be presumed that a better education, and an earlier employment of his faculties, would have rendered him a much more amiable character. His application to study gradually tranquillized his temper and softened his manners, leaving him at the same time in perfect possession of those good qualities which he had inherited from nature,—a warm and disinterested attachment to his family and friends, united to a generosity, vigour, and elevation of character, which rendered him not unworthy to embody in his dramas the actions and sentiments of Grecian heroes.

To these dramas Alfieri is chiefly indebted for the high reputation to which he has attained. Before his time the Italian language, so harmonious in the *Sonnets* of Petrarch, and so energetic in the *Commedia* of Dante, had been invariably languid and prosaic in dramatic dialogue. The pedantic and inanimate tragedies of the sixteenth century were followed, during the iron age of Italian literature, by dramas, of which extravagance in the sentiments and improbability in the action were the chief characteristics. The prodigious success of the *Merope* of Maffei, which appeared in the commencement of the last century, may be attributed more to a comparison with such productions, than to intrinsic merit. In this degradation of tragic taste, the appearance of the tragedies of Alfieri was perhaps the most important literary event that had occurred in Italy during the eighteenth century. On these tragedies it is difficult to pronounce a judgment, as the taste and system of the author underwent considerable change and modification during the intervals which elapsed between the three periods of their publication. An excessive harshness of style, an asperity of sentiment, and total want of poetical ornament, are the characteristics of his first four tragedies, *Filippo, Polinice, Antigone*, and *Virginia.* These faults were in some measure corrected in the six tragedies which he gave to the world some years after, and in those which he published along with *Saul*, the drama which enjoyed the greatest success of all his productions; a popularity which may be partly attributed to the severe and unadorned manner of Alfieri being well adapted to the patriarchal simplicity of the age in which the scene of the tragedy is placed. But though there be a considerable difference in his dramas, there are certain observations applicable to them all. None of the plots are of his own invention. They are founded either on mythological fable or history; most of them had been previously treated by the Greek dramatists, or by Seneca. *Rosmunda*, the only one which could be supposed of his own contrivance, and which is certainly the least happy effusion of his genius, is partly founded on the eighteenth novel of the third part of Bandello, and partly on Prevost's *Mémoires d'un Homme de Qualité.* But whatever subjects he chooses, his dramas are always formed on the Grecian model, and breathe a freedom and independence worthy of an Athenian poet. Indeed, his *Agide* and *Bruto* may rather be considered oratorical declamations and dialogues on liberty, than tragedies. The unities of time and place are not so scrupulously observed in his as in the ancient dramas; but he has rigidly adhered to a unity of action and interest. He occupies his scene with one great action and one ruling passion, and removes from it every accessary event or feeling. In this excessive zeal for the observance of unity, he seems to have forgotton that its charm consists in producing a common relation between multiplied feelings, and not in the bare exhibition of one, divested of those various accompaniments which give harmony to the whole. Consistently with that austere and simple manner which he considered the chief excellence of dramatic composition, he excluded from his scene all *coups de théâtre*, all philosophical reflections, and that highly ornamented versification which had been so assiduously cultivated by his predecessors. In his anxiety, however, to avoid all superfluous ornament, he has stripped his dramas of the embellishments of imagination; and for the harmony and flow of poetical language he has substituted, even in his best performances, a style which, though correct and pure, is generally harsh, elaborate, and abrupt; often strained into unnatural energy, or condensed into factitious conciseness. The chief excellence of Alfieri consists in powerful delineation of dramatic character. In his *Filippo* he has represented, almost with the masterly touches of Tacitus, the sombre character, the dark mysterious counsels, the *suspensa semper et obscura verba*, of the modern Tiberius. In *Polinice*, the characters of the rival brothers are beautifully contrasted; in *Maria Stuarda*, that unfortunate queen is represented unsuspicious, impatient of contradiction, and violent in her attachments. In *Mirra*, the character of *Ciniro* is perfect as a father and king, and *Ceeri* is a model of the virtues of a wife and mother. In the representation of that species of mental alienation where the judgment has perished, but traces of character still remain, he is peculiarly happy. The insanity of Saul is skilfully managed; and the horrid joy of Orestes in killing Ægisthus rises finely and naturally to madness, in finding that, at the same time, he had inadvertently slain his mother.

Whatever may be the merits or defects of Alfieri, he may be considered as the founder of a new school in the Italian drama. His country hailed him as her sole tragic poet; and his successors in the same path of literature have regarded his bold, austere, and rapid manner, as the genuine model of tragic composition.

Besides his tragedies, Alfieri published during his life many sonnets, five odes on American independence, and the poem of *Etruria*, founded on the assassination of Alexander I. duke of Florence. Of his prose works the most distinguished for animation and eloquence is the *Panegyrie on Trajan*, composed in a transport of indignation at the supposed feebleness of Pliny's eulogium. The two books entitled *La Tirannide* and the *Essays on Literature and Government*, are remarkable for elegance and vigour of style, but are too evidently imitations of the manner of Machiavel. His *Antigallican*, which was written at the same time with his *Defence of Louis XVI.*, comprehends an historical and satirical view of the French Revolution. The posthumous works of Alfieri consist of satires, six political comedies, and the *Memoirs of his Life*—a work which will always be read with interest, in spite of the cold and languid gravity with which he delineates the most interesting adventures and the strongest passions of his agitated life.—See *Mem. di. Vit. Alfieri;* Sismondi *de la Lit. du Midi de l'Europe;* Walker's *Memoir on Italian Tragedy; Giorn. de Pisa.* tom. lviii. (J. C. D.)

ALFORD, a town in Lincolnshire, 24 miles N.N.E. of Boston. It has a free grammar school, founded in 1576, with fellowships in Magdalen College, Cambridge: and some breweries, tanneries, and rope-works. In the vicinity is the medicinal spring called Holy Well, discovered in 1670. Pop. in 1851, 2262.

Alford, *Michael*, an English Jesuit, whose real name was Griffiths, was born at London in 1587. This work entitled *Annales Ecclesiastiei et Civiles Britannorum, Saxonum et Anglorum*, is valuable to the student of early English history.

ALFRED, or Ælfred, the Great, king of England, was the fifth and youngest son of Æthelwolf, king of the West Saxons, and was born at Wantage, in Berkshire, in 849 He distinguished himself during the reign of his brother Ethelred in several engagements against the Danes, and upon his death succeeded to the crown, in the year 871, and the 22d of his age. On his accession to the throne he found himself involved in a dangerous war with the Danes, and placed in circumstances fitted to call forth all the great qualities by which he was distinguished. The Danes had already penetrated into the heart of his kingdom; and before he had been a month upon the throne, he was obliged to take the field against those formidable enemies. After many battles gained on both sides, he was at length reduced to the greatest distress, and was entirely abandoned by his subjects. In this situation Alfred, laying aside the useless insignia of royalty, took shelter in the house of one of his own herdsmen. He afterwards retired to Æthelingey, in Somersetshire, the modern Athelney, where he built a fort for the security of himself and family, and his few faithful followers. When he had been about a year in this retreat, having been informed that some of his subjects had routed a great army of the Danes, killed their chief, and taken their magical standard, he issued his letters, giving notice where he was, and inviting his nobility to come and consult with him. Before they came to a final determination, Alfred, putting on the habit of a harper, went into the enemy's camp, where, without suspicion, he was everywhere admitted, and introduced to play before their chief. Having thus acquired an exact knowledge of their situation, he returned in great secrecy to his nobility, whom he ordered to their respective homes, there to draw together each man as great a force as he could; appointing a day for a general rendezvous at the forest of *Selwood* in Wiltshire. This affair was transacted so secretly and expeditiously, that the king, at the head of his army, was close upon the Danes before they had the least intelligence of his design. Alfred, taking advantage of their surprise and terror, fell upon them, and totally defeated them at Æthendune, now Eddington. Those who escaped fled to a neighbouring castle, where they were soon besieged, and obliged to surrender at discretion. Alfred granted them better terms than they had reason to expect. He agreed to give up the whole kingdom of the East Angles to such as would embrace the Christian religion, on condition that they would oblige the rest of their countrymen to quit the island, and, as much as was in their power, prevent the landing of any more foreigners. For the performance of this treaty he took hostages; and when, in pursuance of the stipulation, Godrun the Danish chief came, with thirty of his chief officers, to be baptized, Alfred answered for him at the font, and gave him the name of *Æthelstane;* and certain laws were drawn up betwixt the king and Godrun for the regulation and government of the Danes settled in England. In 884 a fresh swarm of Danes landed in Kent and laid siege to Rochester; but the king coming to the relief of that city, they were obliged to abandon their design. Alfred had now great success, which was chiefly owing to his fleet, an advantage of his own creating. Having secured the sea-coasts, he fortified the rest of the kingdom with castles and walled towns; and he besieged and recovered from the Danes the city of London, which he resolved to repair, and to keep as a frontier.



After some years' respite, Alfred was again called into the field; for a body of Danes, being worsted in the west of France, came with a fleet of 250 sail on the coast of Kent, and having landed, fixed themselves at Appuldre. Shortly after, another fleet of eighty vessels coming up the Thames, the men landed, and built a fort at Milton. Before Alfred marched against the enemy, he obliged the Danes settled in Northumberland and Essex to give him hostages for their good behaviour. He then moved towards the invaders, and pitched his camp between their armies, to prevent their junction. A great body, however, moved off to Essex, and crossing the river, came to Farnham in Surrey, where they were defeated by the king's forces. Meanwhile the Danes settled in Northumberland, in breach of treaty, and notwithstanding the hostages given, equipped two fleets, and after plundering the northern and southern coasts, sailed to Exeter and besieged it. The king, as soon as he received the intelligence, marched against them; but before he reached Exeter they had got possession of it. He kept them, however, blocked up on all sides, and reduced them at last to such extremities that they were obliged to eat their horses, and were even ready to devour each other. Being at length rendered desperate, they made a general sally on the besiegers; but were defeated, though with great loss on the king's side. The remainder of this body of Danes fled into Essex, to the fort they had built there, and to their ships. Before Alfred had time to recruit himself, Laf, another Danish leader, came with a great army out of Northumberland, and ravaged all before him, marching on to the city of Werheal in the west (supposed to be Chester), where they remained the rest of the year. The year following they invaded North Wales; and after having plundered and destroyed every thing, they divided, one body returning to Northumberland, another into the territories of the East Angles, from whence they proceeded to Essex, and took possession of a small island called *Meresig*. Here they did not long remain; for having separated, some sailed up the river Thames, and others up the Lea road, where, drawing up their ships, they built a fort not far from London, which proved a great check upon the citizens, who went in a body and attacked it, but were repulsed with great loss. At harvest-time the king himself was obliged to encamp with a body of troops in the neighbourhood of the city, in order to cover the reapers from the excursions of the Danes. As he was one day riding by the side of the river Lea, after some observations he began to think that the Danish ships might be laid quite dry. This he attempted; and having succeeded, the Danes were forced to desert their fort and ships, and march away to the banks of the Severn, where they built a fort, and wintered at a place called *Quatbrig*.[1] Such of the Danish ships as could be got off, the Londoners carried into their own road; the rest they burned and destroyed.

Alfred enjoyed a profound peace during the last three years of his reign, which he chiefly employed in establishing and regulating his government, for the security of himself and his successors, as well as the ease and benefit of his subjects in general. After a troubled reign of 28 years, he died on the 28th of October A.D. 900, and was buried at Winchester, in Hyde Abbey. A monument of porphyry was erected over his tomb.

All our historians agree in characterising him as perhaps the wisest, best, and greatest king that ever reigned in England; and it is also generally allowed, that he not only digested several particular laws still in existence, but that he laid the first foundation of our present constitution. There is great reason to believe that we are indebted to this prince for trial by jury; and the Doomsday Book, which is preserved in the Exchequer, is thought to be no more than another edition of Alfred's book of Winchester, which contained a survey of the kingdom. It is said also that he was the first who divided the kingdom into shires. What is ascribed to him is not a bare division of the country, but the settling of a new form of judicature; for after having divided his dominions into shires, he subdivided each shire into three parts, called *trythings*. There are some remains of these ancient divisions in the ridings of Yorkshire, the laths of Kent, and the three parts of Lincolnshire. Each trything was divided into *hundreds* or *wapentakes;* and these again into *tythings* or dwellings of ten householders. Each of these householders stood engaged to the king as a pledge for the good behaviour of his family, and all the ten were mutually pledges for each other; so that if any one of the tythings was suspected of an offence, if the head boroughs or chiefs of the tythings would not be security for him, he was imprisoned; and, if he made his escape, the tything and hundred were fined to the king. Each shire was under the government of an *earl*, under whom was the *rieve*, his deputy, since, from his office, called *shire-rieve*, or sheriff. And so effectual were these regulations, that it is said he caused bracelets of gold to be hung up in the highways, as a challenge to robbers; and that they remained untouched.

In private life Alfred was singularly amiable; of so equal a temper, that he never suffered either sadness or unbecoming gaiety to disturb his mind; but appeared always of a calm yet cheerful disposition, familiar to his friends, just even to his enemies, kind and tender to all. He was a remarkable economist of his time; and Asser has given us an account of the method he took for dividing and keeping an account of it. He caused six wax-candles to be made, each of 12 inches long, and of as many ounces weight; on the candles the inches were regularly marked, and having found that one of them burned just four hours, he committed them to the care of the keepers of his chapel, who from time to time gave him notice how the hours went.



This prince, we are told, was 12 years of age before a master could be procured in the western kingdom to teach him the alphabet; such was the state of learning when Alfred began to reign. He had felt the misery of ignorance, and determined even to rival his contemporary Charlemagne in the encouragement of literature. He is supposed to have appointed persons to read lectures at Oxford, and is thence considered as the founder of that university. By other suitable measures and by his general encouragement of learning and abilities, he did everything in his power to diffuse knowledge throughout his dominions. Nor was this end promoted more by his countenance and encouragement than by his own example and his writings; for notwithstanding the lateness of his education he had acquired extraordinary erudition; and, had he not been illustrious as a king, he would have been famous as an author. His works are, 1. *Breviarium quoddam collectum ex Legibus Trojanorum*, &c. lib. i.; a Breviary collected out of the Laws of the Trojans, Greeks, Britons, Saxons, and Danes. Leland saw this book in the Saxon tongue, at Christ Church, in Hampshire. 2. *Visi-Saxonum Leges*, lib. i. Pitts tells us that it is in Bennet College library, at Cambridge. 3. *Institutu quædam*, lib. i. This is mentioned by Pitts, and seems to be the second capitulation with Godrun. 4. *Contra Judices Iniquos*, lib. i. 5. *Acta Magistratuum suorum*, lib. i. This is supposed to be the Book of Judgments mentioned by Horne, and was in all probability a kind of Reports intended for the use of succeeding ages. 6. *Regum Fortunæ variæ*, lib. i. 7. *Dicta Sapientum*, lib. i. 8. *Parabolæ et Sales*, lib. i. 9. *Collectiones Chronicorum*. 10. *Epistolæ ad Wulfsigium Episcopum*, lib. i. 11. *Manuale Meditationum*. Besides those original works, he translated many authors from the Latin, &c., into the Saxon language, viz., 1. Bede's History of England. 2. Paulus Orosius's History of the Pagans. 3. St Gregory's Pastoral, &c. The first of these, with his prefaces to the others, together with his laws, were printed at Cambridge, 1644. His laws are likewise inserted in Spelman's Councils. 4. Boethius's Consolations of Philosophy. Dr Plot tells us King Alfred translated it at Woodstock, as he found in a MS. in the Cotton Library. 5. Æsop's Fables; which he is said to have translated from the Greek both into Latin and Saxon. 6. The Psalms of David. This was the last work the king attempted, and was unfinished at the time of his death. It was, however, completed by another hand, and published at London in 1640, in quarto, by Sir John Spelman. Several others are mentioned by Malmsbury, and the old history of Ely asserts that he translated the Old and New Testaments.

ALFRETON, a small town in Derbyshire, 13 miles from Derby. The inhabitants are chiefly engaged in the manufacture of earthenware and stockings. In the vicinity are ironworks and collieries.

ALGÆ. See Cryptogamia.

ALGAIOLA, a small seaport town in the island of Corsica, fortified with walls and bastions. It was almost destroyed

[1] The king's contrivance is thought to have produced the meadow between Hertford and Bow; for at Hertford was the Danish fort, and from thence they made frequent excursions on the inhabitants of London. Authors are not agreed as to the method the king pursued in laying dry the Danish ships. Dugdale supposes that he did it by straightening the channels; but Henry of Huntingdon alleges that he cut several canals, which exhausted its water.

by the malcontents in 1731, but has since been repaired. Long. 8. 52. E. Lat. 42. 37. N.

ALGARDI, Alessandro, a painter and excellent sculptor of Bologna, was born, according to some accounts, in 1602; and died in 1654. His best sculptures are in St Peter's at Rome, and in his native city.

ALGAROTH, in *Chemistry*, is a white oxide of antimony, which is obtained by washing the butter or chloride with pure water.

ALGAROTTI, Francesco, *Count*, was born at Venice in 1712. Led by curiosity, as well as a desire of improvement, he travelled early into foreign countries; and in 1733 visited Paris. Here he composed his Newtonian Philosophy for the Ladies, as Fontenelle had done his Cartesian Astronomy, in the work entitled The Plurality of Worlds. He was much honoured by Frederick the Great, who, when crowned at Königsberg in 1740, created Algarotti a count of Prussia. He died at Pisa the 23d of May 1764, and ordered his own mausoleum, with this inscription, *Hic jacet Algarottus, sed non omnis.* He is allowed to have been a very great connoisseur in painting, sculpture, and architecture; and he contributed much to the reformation of the Italian opera. His works, which are numerous, and upon a variety of subjects, abound with vivacity, elegance, and wit. They were printed at Leghorn in 1764, in 6 vols. 12mo.

ALGARVE, a province of Portugal, the most southern of the kingdom. It is divided from the Spanish province of Andalucia by the river Guadiana. On the north it is bounded by the province of Alentejo, and on the south and west by the Atlantic Ocean. It is one of the smallest divisions of Portugal, and very thinly peopled; its extent being 232 square leagues, and the number of inhabitants 130,329. On the northern part, towards Alentejo, the Sierras de Caldeyraron and Monchique rise to a great height. The roads are very bad, the soil unfruitful, and the inhabitants few in those districts. Numerous flocks of goats are bred, and some other cattle are pastured. The country on the coast is more fruitful, and produces abundant harvests of grapes, figs, oranges, lemons, olives, and almonds, considerable quantities of which are shipped from the seaport to the different countries in the north of Europe. Very little wheat or other corn is grown in this province, but the inhabitants draw their principal supply from the adjoining provinces of Spain. On the coasts the people derive their subsistence in a great measure from the fisheries; and both the tunny and sardines are caught in very considerable quantities. The rivers are of short course, running from north to south, and at their mouths vessels may enter at high tide; but the harbours on the whole coast are bad, though near Tavira, the principal city, some islands afford shelter, and allow of good anchorage for large vessels behind them. The whole of the foreign trade from the various ports in Algarve is carried on by the vessels of other countries, as there are scarcely any other than fishing boats owned by the inhabitants of the ports. The name Algarve is derived from an Arabic word which signifies westward. The province is designated by the name of kingdom, and gives one of the titles to the Portuguese monarch. This province contains 4 cities, 14 towns, 63 villages, 71 parishes, and 25,503 houses. It is situated between Lat. 36. 56. and 37. 30. N.



ALGAZEL. See Alghazzali.

ALGAZI, the name of several learned rabbis. *Chajim Algazi*, who lived about the beginning of the seventeenth century, wrote a book entitled *Neshiboth Mishpat*, or *The Paths of Judgment*, printed at Constantinople in 1669. *Samuel-ben-Isaac Algazi* was a native of Candia, and lived about the middle of the sixteenth century. His principal work was a chronology, *Toledoth Adam*, or *the Generations of Adam*, printed at Venice in 1587. *Solomon-ben-Abraham Algazi* was a native of the Levant, and died in 1683. He was for some time chief rabbi at Mentz, and wrote a large number of works on the Talmud.

# ALGEBRA.

## INTRODUCTION.

ALGEBRA is a branch of the mathematics, which has for its object whatever can be expressed by number, either exactly or by approximation.

In this respect, and also in its employing arbitrary signs to denote the things of which it treats, it agrees with arithmetic. The analogy between the two sciences induced Sir Isaac Newton to denominate it *Universal Arithmetic;* but by the application of algebra to geometry, the science has acquired a new character and new powers, which render this appellation too limited, and not sufficiently descriptive of its nature. In its present state it is nearly alike related to arithmetic and geometry. In its application to both sciences, the reasoning is carried on by general symbols: its true character consists in this, that the results of its operations do not exhibit the individual values of the quantities which are the subject of investigation, such as we obtain in arithmetical calculations or geometrical constructions. They only indicate the operations, whether arithmetical or geometrical, which ought to be performed on the given quantities, to obtain the value of the quantities sought.

It has been a question much agitated, at what period and in what country was algebra invented? Who were the earliest writers on the subject? What was the progress of its improvement? And lastly, by what means, and at what period, was the science diffused over Europe?

It was a common opinion in the 17th century, that the ancient Greek mathematicians must have possessed an analysis of the nature of modern algebra, by which they discovered the theorems and solutions of the problems which we so much admire in their writings; but that they carefully concealed their instruments of investigation, and gave only the results, with synthetic demonstrations.

This opinion is, however, now exploded. A more intimate acquaintance with the writings of the ancient geometers has shown that they had an analysis, but that it was purely geometrical, and essentially different from our algebra.

Although there be no reason to suppose that the great geometers of antiquity derived any aid in their discoveries from the algebraic analysis, yet we find, that at a considerably later period it was known to a certain extent among the Greeks.

About the middle of the 4th century of the Christian era, a period when the mathematical sciences were on the decline, and their cultivators, instead of producing original works of genius, contented themselves with commentaries on the works of their more illustrious predecessors, there was a valuable addition made to the fabric of ancient learning.

This was the treatise of Diophantus on arithmetic, which originally consisted of thirteen books, but of which only the first six, and an incomplete book on polygonal numbers, supposed to be the thirteenth, have descended to our times.

This precious fragment does not exhibit any thing like a complete treatise on algebra. It rather is an application of its doctrines to a peculiar class of arithmetical questions, which belong to what is now called the indeterminate analysis.

Diophantus may have been the inventor of the Greek algebra, but it is more likely that its principles were not unknown before his time; and that, taking the science in the state he found it as the basis of his labours, he enriched it with new applications. The elegant solutions of Diophantus show that he possessed great address in the particular branch of which he treated, and that he was able to resolve determinate equations of the second degree. Probably this was the greatest extent to which the science had been carried among the Greeks. Indeed, in no country did it pass this limit, until it had been transplanted into Italy on the revival of learning.

The celebrated Hypatia, the daughter of Theon, composed a commentary on the work of Diophantus. This, however, is now lost, as well as a similar labour of this illustrious and ill-fated lady on the Conics of Apollonius. It is commonly known that she fell a sacrifice to the fury of a fanatical mob about the beginning of the 5th century.

About the middle of the 16th century, the work of Diophantus, written in the Greek language, was discovered at Rome in the Vatican library, where probably it had been carried from Greece when the Turks possessed themselves of Constantinople. A Latin translation, without the original text, was given to the world by Xylander in 1575; and a more complete translation, by Bachet de Mezeriac (one of the oldest members of the French academy), accompanied by a commentary, appeared in 1621. Bachet was eminently skilful in the indeterminate analysis, and therefore well qualified for the work he had undertaken; but the text of Diophantus was so much injured, that he was frequently obliged to divine the meaning of the author, or supply the deficiency. At a later period, the celebrated French mathematician Fermat, in addition to the commentary of Bachet, added notes of his own on the writings of the Greek algebraist. These are extremely valuable, on account of Fermat's profound knowledge of this particular branch of analysis. This edition, the best which exists, appeared in 1670.

Although the revival of the writings of Diophantus was an important event in the history of the mathematics, yet it was not from them that algebra became first known in Europe. This important invention, as well as the numeral characters and decimal arithmetic, was received from the Arabians. That ingenious people fully appreciated the value of the sciences; for at a period when all Europe was enveloped in the darkness of ignorance, they preserved from extinction the lamp of knowledge. They carefully collected the writings of the Greek mathematicians; they translated them into their language, and illustrated them with commentaries. It was through the medium of the Arabic tongue that the elements of Euclid were first introduced into Europe; and a part of the writings of Apollonius are only known at the present day by a translation from the Arabic, the Greek original being probably irrecoverably lost. The Arabians ascribe the invention of their algebra to one of their mathematicians, Mahommed-Ben-Musa, or Moses, called also Mahommed of Buziana, who flourished about the middle of the 9th century, in the reign of the Caliph Almamon.

It is certain that this person composed a treatise on this subject, because an Italian translation was known at one time to have existed in Europe, although it be now lost. Fortunately, however, a copy of the Arabic original is preserved in the Bodleian Library at Oxford, bearing a date of transcription corresponding to the year 1342. The title-page identifies its author with the ancient Arabian. A marginal note concurs in this testimony, and farther declares the work to be the first treatise composed on algebra among the faithful; and the preface, besides indicating the author, intimates that he was encouraged by Almamon, commander of the faithful, to compile a compendious treatise of calculation by algebra.

The circumstance of this treatise professing to be only a compilation, and, moreover, the first Arabian work of the kind, has led to an opinion that it was collected from books in some other language. As the author was intimately acquainted with the astronomy and computations of the Hindoos, he may have derived his knowledge of algebra from the same quarter. Hence we may conclude, with some probability, that the Arabian algebra was originally derived from India.

The algebraic analysis having been once introduced among the Arabians, it was cultivated by their own writers. One of these, Mahommed Abulwafa, who flourished in the last forty years of the 10th century, composed commentaries on the writers who had preceded him. He also translated the writings of Diophantus. Probably this was the first translation that was made of the Greek algebraist into the Arabian tongue.

It is remarkable, that although the mathematical sciences were received with avidity, and sedulously cultivated during a long period, by the Arabians, yet in their hands they received hardly any improvement. It might have been expected that an acquaintance with the writings of Diophantus would have produced some change in their algebra. This, however, did not happen: their algebra continued nearly in the same state, from their earliest writer on the subject, to one of their latest, Behaudin, who lived between the years 953 and 1031.

Writers on the history of algebra were long under a mistake as to the time and manner of its introduction into Europe. It has now, however, been ascertained that the science was brought into Italy by Leonardo, a merchant of Pisa. This ingenious man resided in his youth in Barbary, and there learned the Indian method of accounting by the nine numeral characters. Commercial affairs led him to travel into Egypt, Syria, Greece, and Sicily, where we may suppose he made himself acquainted with every thing known respecting numbers. The Indian mode of computation appeared to him to be by far the best. He accordingly studied it carefully; and, with this knowledge, and some additions of his own, and also taking some things from Euclid's Geometry, he composed a treatise on arithmetic. At that period algebra was regarded only as a part of arithmetic. It was indeed the sublime doctrine of that science; and under this view the two branches were handled in Leonardo's treatise, which was originally written in 1202, and again brought forward under a revised form in 1228. When it is considered that this work was composed two centuries before the invention of printing, and that the subject was not such as generally to interest mankind, we need not wonder that it was but little known; hence it has always remained in manuscript, as well as some others by the same author. Indeed it was not known to exist from an early period until the middle of the last century, when it was discovered in the Magliabecchian library at Florence.

The extent of Leonardo's knowledge was pretty much the same as that of the preceding Arabian writers. He could resolve equations of the first and second degree, and he was particularly skilful in the Diophantine analysis. He was well acquainted with geometry, and he employed its doctrines in demonstrating his algebraic rules. Like the Arabian writers, his reasoning was expressed in words at length; a mode highly unfavourable to the progress of the art. The use of symbols, and the method of combining them so as to convey to the mind at a single glance a long process of reasoning, was an invention considerably later than Leonardo's time.

Considerable attention was given to the cultivation of algebra between the time of Leonardo and the invention of printing. It was publicly taught by professors. Treatises were composed on the subject; and two works of the oriental algebraists were translated from the Arabian language into Italian. One was entitled *the Rule of Algebra*, and the other was the oldest of all the Arabian treatises, that of Mahommed-Ben-Musa of Corasan.

The earliest printed book on algebra was composed by Lucas Paciolus, or Lucas de Burgo, a minorite friar. It was first printed in 1494, and again in 1523. The title is *Summa de Arithmetica, Geometria, Proportioni, et Proportionalita*.

This is a very complete treatise on arithmetic, algebra, and geometry, for the time in which it appeared. The author followed close on the steps of Leonardo; and, indeed, it is from this work that one of his lost treatises has been restored.

Lucas de Burgo's work is interesting, inasmuch as it shows the state of algebra in Europe about the year 1500: probably the state of the science was nearly the same in Arabia and Africa, from which it had been received.

The power of algebra as an instrument of research is in a very great degree derived from its notation, by which all the quantities under consideration are kept constantly in view; but in respect of convenience and brevity of expression, the algebraic analysis in the days of Lucas de Burgo was very imperfect: the only symbols employed were a few abbreviations of the words or names which occurred in the processes of calculation, a kind of short-hand, which formed a very imperfect substitute for that compactness of expression which has been attained by the modern notation.

The application of algebra was also at this period very limited; it was confined almost entirely to the resolution of certain questions of no great interest about numbers. No idea was then entertained of that extensive application which it has received in modern times.

The knowledge which the early algebraists had of their science was also circumscribed; it extended only to the resolution of equations of the first and second degree; and they divided the last into cases, each of which was resolved by its own particular rule. The important analytical fact, that the resolution of all the cases of a problem may be comprehended in a single formula, which may be obtained from the solution of one of its cases, merely by a change of the signs, was not then known: indeed it was long before this principle was fully comprehended. Dr Halley expresses surprise, that a formula in optics which he had found, should by a mere change of the signs give the focus of both converging and diverging rays, whether reflected or refracted by convex or concave specula or lenses; and Molyneux speaks of the universality of Halley's formula as something that resembled magic.

The rules of algebra may be investigated by its own principles, without any aid from geometry; and although in some cases the two sciences may serve to illustrate the doctrines of each other, there is now not the least necessity in the more elementary parts to call in the aid of the latter to the former. It was otherwise in former times. Lucas de Burgo found it to be convenient, after the example of Leonardo, to employ geometrical constructions to prove the truth of his rules for resolving quadratic equations, the nature of which he did not completely comprehend; and he was induced by the imperfect nature of his notation to express his rules in Latin verses, which will not now be read with the satisfaction we receive from the perusal of the well-known poem, "the Loves of the Triangles."



As it was in Italy that algebra became first known in Europe, so it was there that it received its earliest improvements. The science had been nearly stationary from the days of Leonardo to the time of Paciolus, a period of three centuries; but the invention of printing soon excited a spirit of improvement in all the mathematical sciences. Hitherto an imperfect theory of quadratic equations was all the extent to which it had been carried. At last this boundary was passed, and about the year 1505 a particular case of equations of the third degree was resolved by Scipio Ferreus, a professor of mathematics in Bononia. This was an important step, because it showed that the difficulty of resolving equations of the higher orders, at least in the case of the third degree, was not insurmountable, and a new field was opened for discovery. It was then the practice among the cultivators of algebra, when they advanced a step, to conceal it carefully from their contemporaries, and to challenge them to resolve arithmetical questions, so framed as to require for their solution a knowledge of their own new-found rules. In this spirit did Ferreus make a secret of his discovery: he communicated it, however, to a favourite scholar, a Venetian named Florido. About the year 1535 this person, having taken up his residence at Venice, challenged Tartalea of Brescia, a man of great ingenuity, to a trial of skill in the resolution of problems by algebra. Florido framed his questions so as to require for their solution a knowledge of the rule which he had learned from his preceptor Ferreus; but Tartalea had, five years before this time, advanced farther than Ferreus, and was more than a match for Florido. He therefore accepted the challenge, and a day was appointed when each was to propose to the other thirty questions. Before the time came, Tartalea had resumed the study of cubic equations, and had discovered the solution of two cases in addition to two which he knew before. Florido's questions were such as could be resolved by the single rule of Ferreus; while, on the contrary, those of Tartalea could only be resolved by one or other of three rules, which he himself had found, but which could not be resolved by the remaining rule, which was also that known to Florido. The issue of the contest is easily anticipated; Tartalea resolved all his adversary's questions in two hours, without receiving one answer from him in return.

The celebrated Cardan was a contemporary of Tartalea. This remarkable person was a professor of mathematics at Milan, and a physician. He had studied algebra with great assiduity, and had nearly finished the printing of a book on arithmetic, algebra, and geometry; but being desirous of enriching his work with the discoveries of Tartalea, which at that period must have been the object of considerable attention among literary men in Italy, he endeavoured to draw from him a disclosure of his rules. Tartalea resisted for a time Cardan's entreaties. At last, overcome by his importunity, and his offer to swear on the holy Evangelists, and by the honour of a gentleman, never to publish them, and on his promising on the faith of a Christian to commit them to cypher, so that even after his death they would be unintelligible to any one, he ventured with much hesitation to reveal to him his practical rules, which were expressed by some very bad Italian verses, themselves in no small degree enigmatical. He reserved, however, the demonstrations. Cardan was not long in discovering the reason of the rules, and he even greatly improved them, so as to make them in a manner his own. From the imperfect essays of Tartalea, he deduced an ingenious and systematic method of resolving all cubic equations whatsoever; but with a remarkable disregard for the principles of honour, and the oath he had taken, he published, in 1545, Tartalea's discoveries, combined with his own, as a supplement to a treatise on arithmetic and algebra, which he had published six years before. This work is remarkable for being the second printed book on algebra known to have existed.

In the following year Tartalea also published a work on algebra, which he dedicated to Henry VIII. king of England.

It is to be regretted that in many instances the authors of important discoveries have been overlooked, while the honours due to them have been transferred to others having only secondary pretensions. The formulæ for the resolution of cubic equations are now called Cardan's rules, notwithstanding the prior claim of Tartalea. It must be confessed, however, that he evinced considerable selfishness in concealing his discovery; and although Cardan cannot be absolved from the charge of bad faith, yet it must be recollected that by his improvements in what Tartalea communicated to him, he made the discovery in some measure his own; and he had moreover the high merit of being the first to publish this important improvement in algebra to the world.

The next step in the progress of algebra was the discovery of a method of resolving equations of the fourth order. An Italian algebraist had proposed a question which could not be resolved by the newly invented rules, because it produced a biquadratic equation. Some supposed that it could not be at all resolved; but Cardan was of a different opinion: he had a pupil named Lewis Ferrari, a young man of great genius, and an ardent student in the algebraic analysis: to him Cardan committed the solution of this difficult question, and he was not disappointed. Ferrari not only resolved the question, but he also found a general method of resolving equations of the fourth degree, by making them depend on the solution of equations of the third degree.

This was another great improvement; and although the precise nature of an equation was not then fully understood, nor was it indeed until half a century later, yet, in the general resolution of equations, a point of progress was then reached which the utmost efforts of modern analyses have never been able to pass.

There was another Italian mathematician of that period who contributed somewhat to the improvement of algebra. This was Bombelli. He published a valuable work on the subject in 1572, in which he brought into one view what had been done by his predecessors. He explained the nature of the *irreducible case* of cubic equations, which had greatly perplexed Cardan, who could not resolve it by his rule; he showed that the rule would apply sometimes to particular examples, and that all equations of this case admitted of a real solution; and he made the important remark, that the algebraic problem to be resolved in this case corresponds to the ancient problem of the trisection of an angle.

There were two German mathematicians contemporary with Cardan and Tartalea, viz. Stifelius and Scheubelius. Their writings appeared about the middle of the 16th century, before they knew what had been done by the Italians. Their improvements were chiefly in the notation. Stifelius, in particular, introduced for the first time the characters which indicate addition and subtraction, and the symbol for the square root.



The first treatise on algebra in the English language was written by Robert Recorde, teacher of mathematics and practitioner in physic at Cambridge. At this period it was common for physicians to unite with the healing art the studies of mathematics, astrology, alchemy, and chemistry. This custom was derived from the Moors, who were equally celebrated for their skill in medicine and calculation. In Spain, where algebra was early known, the title of physician and algebraist were nearly synonymous. Accordingly, in the romance of Don Quixotte, when the bachelor Samson Carasco was grievously wounded in his rencounter with the knight, an *algebrista* was called in to heal his bruises.

Recorde published a treatise on arithmetic, which was dedicated to Edward VI.; and another on algebra, with this title, "The Whetstone of Wit," &c. Here, for the first time, the modern sign for equality was introduced.

By such gradual steps did algebra advance in improvement from its first introduction by Leonardo, each succeeding writer making some change for the better; but with the exception of Tartalea, Cardan, and Ferrari, hardly any one rose to the rank of an inventor. At length came Vieta, to whom this branch of mathematical learning, as well as others, is highly indebted. His improvements in algebra were very considerable; and some of his inventions, although not then fully developed, have yet been the germs of later discoveries. He was the first that employed general characters to represent known as well as unknown quantities. Simple as this step may appear, it has yet led to important consequences. He must also be regarded as the first that applied algebra to the improvement of geometry. The older algebraists had indeed resolved geometrical problems, but each solution was particular; whereas Vieta, by introducing general symbols, produced general formulæ, which were applicable to all problems of the same kind, without the trouble of going over the same process of analysis for each.

This happy application of algebra to geometry has produced great improvements: it led Vieta to the doctrine of angular sections, one of the most important of his discoveries, which is now expanded into the arithmetic or calculus of sines. He also improved the theory of algebraic equations, and he was the first that gave a general method of resolving them by approximation. As he lived between the years 1540 and 1603, his writings belong to the latter period of the 16th century. He printed them at his own expense, and liberally bestowed them on men of science.

The Flemish mathematician Albert Girard was one of the improvers of algebra. He extended the theory of equations somewhat farther than Vieta, but he did not completely unfold their composition; he was the first that showed the use of the negative sign in the resolution of geometrical problems, and he also first spoke of *imaginary* quantities, a subject not yet completely cleared up; and he inferred by induction that every equation has precisely as many roots as there are units in the number that expresses its degree. His algebra appeared in 1629.

The next great improver of algebra was Thomas Harriot, an Englishman. As an inventor he has been the boast of this country. The French mathematicians have accused the British of giving discoveries to him which were really due to Vieta. It is probable that some of these may be justly claimed for both, because each may have made the discovery for himself, without knowing what had been done by the other. Harriot's principal discovery, and indeed the most important ever made in algebra, was, that every equation may be regarded as formed by the product of as many simple equations as there are units in the number expressing its order. This important doctrine, now familiar to every student of algebra, was yet slowly developed: it was quite within the reach of Vieta, who unfolded it in part, but left its complete discovery to Harriot.

We have seen the very inartificial form in which algebra first appeared in Europe. The improvements of almost 400 years had not given its notation that compactness and elegance of which it is susceptible. Harriot made several changes in the notation, and added some new signs: he thus gave to algebra greater symmetry of form. Indeed, as it came from his hands, it differed but little from its state at the present time.

Oughtreed, another early English algebraist, was a contemporary with Harriot, but lived long after him. He wrote a treatise on the subject, which was long taught in the universities.

In tracing the history of algebra, we have seen, that in the form under which it was received from the Arabs, it was hardly distinguishable as a peculiar mode of reasoning, because of the want of a suitable notation; and that, poor in its resources, its applicability was limited to the resolution of a small number of uninteresting numeral questions. We have followed it through different stages of improvement, and we are now arrived at a period when it was to acquire additional power as an instrument of analysis, and to admit of new and more extended applications. Vieta saw the great advantage that might be derived from the application of algebra to geometry. The essay he made in his theory of angular sections, and the rich mine of discovery thus opened, proved the importance of his labours. He did not fully explore it, but it has seldom happened that one man began and completed a discovery. He had, however, an able and illustrious successor in Descartes, who, employing in the study of algebra that high power of intellect with which he was endowed, not only improved it as an abstract science, but, more especially by its application to geometry, he laid the foundation of the great discoveries which have since so much engaged mathematicians, and made the last two centuries ever memorable in the history of the progress of the human mind.

Descartes's grand improvement was the application of algebra to the doctrine of curve lines. As in geography we refer every place on the earth's surface to the equator, and to a determinate meridian, so he referred every point of a curve to some line given by position. For example, in a circle, every point in the circumference might be referred to the diameter. The perpendicular from any point in the curve, and the distance of that perpendicular from the centre or from the extremity of a diameter, were lines which, although varying with every change of position in the point from which the perpendicular was drawn, yet had a determinate relation to each other, which was the same for all points in the curve, which depended on its nature, and which, therefore, served as a characteristic to distinguish it from all other curves.

The relations of lines drawn in this way could be readily expressed in algebraic symbols; and the combination of these constituted what is called the *equation* of the curve. This might serve as its definition; and from the equation by the processes of algebra, all the properties of the curve could be investigated.

Descartes's geometry (or, as it might have been named, the application of algebra to geometry) appeared first in 1637. This was six years after the publication of Harriot's discoveries, which was a posthumous work. Descartes availed himself of some of Harriot's views, particularly the manner of generating an equation without acknowledgement; and on this account Dr Wallis, in his algebra, has reflected with considerable severity on the French algebraist.

This spirit has engendered a corresponding eagerness in the French mathematicians to defend him. Montucla, in his history of the mathematics, has evinced a strong national prejudice in his favour; and, as usually happens, in order to exalt him, he hardly does justice to Harriot, the idol of his adversaries.

In treating of the claims of algebra and geometry to be considered as kindred sciences, a question arises, why was this relation not sooner perceived and appreciated? The sciences of geometry and algebra have each had a distinct origin. The former is the more ancient, and no doubt for this reason, that its principles are less removed from the ordinary affairs of men. The subjects of geometry, extension, and figure are continually presented to attention; and the elements of the science are to a certain extent employed in the most ordinary arts of life. We cannot sufficiently admire the ingenuity with which the natural geometry of the early times had been wrought up into a system more than two thousand years ago; but when we consider that its assistance was wanted in the partition of land, in the erection of houses and temples, and numberless other cases, we need not wonder at the early progress of the science among such an ingenious people as the ancient Greeks.

Algebra, however, is a more refined speculation. Its first object was number; but the properties of number are more recondite than those of extension and figure.

In geometry, the objects of our attention are the very figures themselves; but in algebra, the subjects of our reasonings are represented by symbols, which have no resemblance to the things they represent; hence it is not wonderful that algebra should have a later origin, and that it should have been slower in its progress towards perfection.

Notwithstanding the different origin of geometry and algebra, and their long-continued separate existence, like some chemical substances of different natures, they have a strong affinity; and, when united, their new properties are entirely different from those which belong to each apart. By their union, a new science was created, and new instruments of invention furnished, vastly more powerful than any possessed by the sciences apart.

The new views which the labours of Vieta, Harriot, and Descartes opened in geometry and algebra were seized with avidity by the powerful minds of men eager in the pursuit of real knowledge. Accordingly, we find in the seventeenth century a whole host of writers on algebra, or algebra combined with geometry.

Our limits will not allow us to enter minutely into the claims which each has on the gratitude of posterity. Indeed, in pure algebra the new inventions were not so conspicuous as the discoveries made by its applications to geometry, and the new theories which were suggested by their union. The refined speculations of Kepler concerning the solids formed by the revolutions of curvilinear figures, the Geometry of Indivisibles by Cavalerius, the Arithmetic of Infinites of Wallis, and, above all, the Method of Fluxions of Newton, and the Differential and Integral Calculus of Leibnitz, are fruits of the happy union. All these were agitated incessantly by their inventors and contemporaries; such men as Barrow, James Gregory, Wren, Cotes, Taylor, Halley, De Moivre, Maclaurin, Stirling, and others, in this country; and abroad by Roberval, Fermat, Huygens, the two Bernoullis, Herman, Pascal, and many others.

It is at this period, then, that our sketch of the history of algebra, at least in Europe, must terminate, because of the great number of writers who have in one way or other elucidated or improved different parts of the subject, either directly, or when treating of collateral theories.

We have been as copious as our limits would permit on the early history, because it presents the interesting spectacle of the progress of a science from an almost imperceptible beginning, until it has attained a magnitude too great to be fully grasped by the human mind.

### *Of the Indian Algebra.*

The attention of the learned has, within the last thirty years, been called to a branch of the history of algebra, in no small degree interesting; we mean the cultivation of the science to a considerable extent, and at a remote period, in India.

We are indebted, we believe, to Mr Reuben Burrow for some of the earliest notices which reached Europe on this very curious subject. His eagerness to illustrate the history of the mathematical sciences led him to collect oriental manuscripts, some of which, in the Persian language, with partial translations, were bequeathed to his friend Mr Dalby of the Royal Military College, who communicated them to such as took an interest in the subject, about the year 1800.

In the year 1813 Mr Edward Strachey published in this country a translation from the Persian of the Bija Ganita (or Vija Ganita), a Hindoo treatise on algebra; and in 1816 Dr John Taylor published at Bombay a translation of Lilawati (or Lilavati), from the Sanscrit original. This last is a treatise on arithmetic and geometry, and both are the production of an oriental algebraist, Bhascara Acharya. Lastly, in 1817 there came out a work entitled *Algebra, Arithmetic, and Mensuration, from the Sanscrit of Brahmegupta and Bhascara*, translated by Henry Thomas Colebrooke, Esq. This contains four different treatises, originally written in Sanscrit verse, viz. the *Vija Ganita* and *Lilavati* of Bhascara Acharya, and the *Ganitad'haya* and *Cuttacad'hyaya* of Brahmegupta. The first two form the preliminary portion of Bhascara's Course of Astronomy, entitled *Sidd'hanta Siromani*, and the last two are the twelfth and eighteenth chapters of a similar course of astronomy, entitled *Brahma-sidd'hanta.*

The time when Bhascara wrote is fixed with great precision, by his own testimony and other circumstances, to a date that answers to about the year 1150 of the Christian era. The works of Brahmegupta are extremely rare, and the age in which he lived is less certain. Mr Davis, an oriental scholar, who first gave the public a correct view of the astronomical computations of the Hindoos, is of opinion that he lived in the 7th century; and Dr William Hunter, another diligent inquirer into Indian science, assigns the year 628 of the Christian era as about the time he flourished. From various arguments, Mr Colebrooke concludes that the age of Brahmegupta was antecedent to the earliest dawn of the culture of the sciences among the Arabians, so that the Hindoos must have possessed algebra before it was known to that nation.

Brahmegupta's treatise is not, however, the earliest work known to have been written on this subject. Ganessa, a distinguished astronomer and mathematician, and the most eminent scholiast of Bhascara, quotes a passage from a much older writer, Arya-Bhatta, specifying algebra under the designation of *Vija*, and making separate mention of *Cuttaca*, a problem subservient to the resolution of indeterminate problems of the first degree. He is understood by another of Bhascara's commentators to be at the head of the older writers. They appear to have been able to resolve quadratic equations, by the process of completing the square; and hence Mr Colebrooke presumes that the treatise of Arya-Bhatta then extant extended to quadratic equations in the determinate analysis, and to indeterminate equations of the first degree, if not to those of the second likewise, as most probably it did.

Considering the proficiency of Arya-Bhatta in astronomical science, and adverting to the fact of his having written on algebra, and being placed at the head of algebraists when the commentators of extant treatises have occasion to mention the early and original writers on this branch of science, he may be regarded as the great improver of the analytic art in India, and likely to have been the person by whom it was carried to the pitch it was found to have attained among the Hindoos, and at which it was observed to be nearly stationary through the long lapse of ages which have since passed; the later additions being few and unessential in the writings of Brahmegupta, of Bhascara, and of Jnyanaraja, though they lived at intervals of centuries from each other.

The exact period when Arya-Bhatta lived cannot be determined with certainty; but Mr Colebrooke thinks it probable that this earliest of known Hindoo algebraists wrote as far back as the fifth century of the Christian era, and perhaps earlier. He was therefore nearly as ancient as the Grecian algebraist Diophantus, who is reckoned to have flourished in the time of the emperor Julian, or about A. D. 360. Supposing then the Hindoo and Greek algebraists to be nearly of the same antiquity, it must be conceded in favour of the former, that he was farthest advanced in the science, since he knew how to resolve equations containing several unknown quantities: now it does not appear that Diophantus could do this. He also had a general method for indeterminate equations, of at least the first degree, to a knowledge of which the Grecian algebraist had certainly not attained.

It appears from the Hindoo treatises on algebra, that they understood well the arithmetic of surd roots; that they were aware of the infinite quotient resulting from the division of finite quantity by cypher; that they knew the general resolution of equations of the second degree, and had touched on those of higher denomination, resolving them in particular cases, and in those in which the solution may be effected in the manner of quadratics; that they had found a general solution of indeterminate equations of the first degree, and a method for deriving a multitude of answers to problems of the second degree, when one solution was obtained by trials: now this is as near an approach to a general solution of such problems as was made until the time of Lagrange. The Hindoos had also attempted to solve indeterminate equations of higher orders, but, as might be expected, with very little success.

We have seen how long it was before algebra was applied to geometry in Europe: but the Hindoos not only applied algebra both to astronomy and geometry, but conversely applied geometry to the demonstration of algebraic rules; and indeed they cultivated algebra much more and with greater success than geometry, as appears by the low state of their knowledge of the one and the high pitch of their attainments in the other.

Mr Colebrooke has instituted a comparison between the Indian algebraist and Diophantus, and found reason to conclude, that in the whole science the latter is very far behind the former. He says, the points in which the

Hindoo algebra appears particularly distinguished from the Greek are, besides a better and more convenient algorithm, 1*st*, the management of equations of more than one unknown quantity; 2*d*, the resolution of equations of a higher order, in which, it they achieved little, they had at least the merit of the attempt, and anticipated a modern discovery in the resolution of biquadratics; 3*d*, general methods for the resolution of indeterminate problems of the first and second degrees, in which they went far indeed beyond Diophantus, and anticipated discoveries of modern algebraists; 4*th*, the application of algebra to astronomical investigations and geometrical demonstration, in which also they hit upon some matters which have been re-invented in modern times.

When we consider that algebra made little or no progress among the Arabians, a most ingenious people, and particularly devoted to the study of the sciences, and that centuries elapsed from its first introduction into Europe until it reached any considerable degree of perfection, we may reasonably conjecture, that it may have existed in one shape or other in India long before the time of Arya-Bhatta: indeed, from its close connection with their doctrines of astronomy, it may be supposed to have descended from a very remote period, along with that science. The late learned Professor Playfair took a great interest in this curious and interesting subject; and, adopting the opinion of Bailly, the eloquent author of the *Astronomie Indienne*, he with great ingenuity attempted to prove, in a *Memoir on the Astronomy of the Brahmins*, that the observations on which the Indian astronomy is founded were of great antiquity, indeed more than 3000 years before the Christian era. Again, in a later memoir, *On the Trigonometry of the Brahmins*, he endeavoured to establish, that the origin of the mathematical sciences in Hindostan must be referred to an equally remote period. The same judicious writer has further considered this most curious subject in a Review of Strachey's Translation of Bija Gannita (*Edinburgh Review*, No. 42), and again, in a Review of Colebrooke's work on the Indian algebra, to which we have so frequently adverted (*Edinburgh Review*, No. 57). This last article, published in 1817, may be supposed to contain the matured opinions of one of the most ardent, able, and we must say most candid, inquirers into the history of Hindoo mathematical science. There is here certainly an abatement of his first confidence in the opinions of Bailly on the Indian astronomy, and a corresponding caution in his own opinion as to the antiquity of the mathematical sciences. The very remote origin of the Indian astronomy had been strongly questioned by many in this country, and also on the Continent; particularly by Laplace, also by Delambre in his *Histoire de l'Astronomie Ancienne*, tome i. p. 400, &c., and again in *Histoire de l'Astronomie du Moyen Age, Discours Préliminaire*, p. 18, &c. where he speaks slightingly of their algebra; and in this country, Professor Leslie, in his very learned work on *The Philosophy of Arithmetic*, p. 225 and 226, calls the Lilavati " a very poor performance, containing merely a few scanty precepts couched in obscure memorial verses." We shall conclude this slight sketch of the history of Indian algebra with the last recorded sentiments of Professor Playfair on the mathematical science of India. " Among many subjects of wonder which the study of these ancient fragments cannot fail to suggest, it is not one of the least that algebra has existed in India, and has been cultivated for more than 1200 years, without any signal improvement, or the addition of any material discovery. The works of the ancient teachers of science have been commented on, elucidated, and explained with skill and learning; but no new methods have been invented, nor any new principle introduced. The method of resolving indeterminate problems, that constitute the highest merit of their analytical science, were known to Brahmegupta hardly less accurately than to Bhascara; and they appear to have been understood even by Arya-Bhatta, more ancient by several centuries than either. A long series of scholiasts display in their annotations great acuteness, intelligence, and judgment; but they never pass far beyond the line drawn by their predecessors, which probably seemed even to those learned and intelligent men as the barrier within which it was to be confined. In India, indeed, every thing seems equally insurmountable, and truth and error are equally assured of permanence in the stations they have once occupied. The politics, the laws, the religion, the science, and the manners, seem all nearly the same as at the remotest period to which history extends. Is it because the power which brought about a certain degree of civilisation, and advanced science to a certain height, has either ceased to act, or has met with such a resistance as it is barely able to overcome? or is it because the discoveries which the Hindoos are in possession of are an inheritance from some more inventive and more ancient people, of whom no memorial remains but some of their attainments in science?"

*Writers on Algebra, with the years in which they wrote or flourished.*

Diophantus, Arithmeticorum Libri sex, flourished, A.C. 360
——— First edition of his writings, 1575; the best, 1670.
Leonardo Bonacci (his works described in Cossali)...1202
Lucas Paciolus, or De Burgo, Summa de Arithmetica, &c....1470
Rudolph, Algebra....1522
Stifelius, Arithmetica Integra, &c....1544
Cardan, Ars Magna quam vulgo Cossam vocant....1545
Ferreus....1545
Ferrari, (first resolved biquadratic equations)....1545
Tartalea, Quesiti et Inventioni diversi....1546
Scheubelius, Algebra Compendiosa....1551
Recorde, Whetstone of Wit....1557
Peletarius, De Occulta parte Numerorum....1558
Buteo, De Logistica....1559
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*Writers on the History of Algebra.*

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NOTATION AND EXPLANATION OF THE SIGNS.

1. In arithmetic there are ten characters, which being variously combined, according to certain rules, serve to denote all magnitudes whatever. But this method of expressing quantities, although of the greatest utility in every branch of the mathematics (for we must always have recourse to it in the different applications of that science to practical purposes), is yet found to be inadequate, taken by itself, to the more difficult cases of mathematical investigation; and it is therefore necessary, in many inquiries concerning the relations of magnitude, to have recourse to that more general mode of notation, and more extensive system of operations, which constitute the science of algebra.

In algebra quantities of every kind may be denoted by any characters whatever, but those commonly used are the letters of the alphabet; and as in every mathematical problem there are certain magnitudes given, in order to determine other magnitudes which are unknown, the first letters of the alphabet $a$, $b$, $c$, &c. are used to denote known quantities, while those to be found are represented by $v$, $x$, $y$, &c. the last letters of the alphabet.

2. The sign $+$ (*plus*) denotes that the quantity before which it is placed is to be added to some other quantity. Thus, $a+b$ denotes the sum of $a$ and $b$; $3+5$ denotes the sum of 3 and 5, or 8.

The sign $-$ (*minus*) signifies that the quantity before which it is placed is to be subtracted. Thus, $a-b$ denotes the excess of $a$ above $b$; $6-2$ is the excess of 6 above 2. or 4.

3. Quantities which have the sign $+$ prefixed to them are called *positive* or *affirmative;* and such as have the sign $-$ are called *negative.*

When quantities are considered abstractedly, the terms *positive* and *negative* can only mean that such quantities are to be added or subtracted; for as it is impossible to conceive a number less than 0, it follows, that a negative quantity by itself is unintelligible. But, in considering the affections of magnitude, it appears, that in many cases a certain opposition may exist in the nature of quantities. Thus, a person's property may be considered as a positive quantity, and his debts as a negative quantity. Again, any portion of a line drawn to the right hand may be considered as positive, while a portion of the same line, continued in the opposite direction, may be taken as negative.

When no sign is prefixed to a quantity, $+$ is always understood, or the quantity is to be considered as positive.

Quantities which have the same sign, either $+$ or $-$, are said to have like signs. Thus, $+a$ and $+b$ have like signs, but $+a$ and $-c$ have unlike signs.

4. A quantity which consists of one *term*, is said to be *simple;* but if it consist of several terms, connected by the signs $+$ or $-$, it is then said to be compound. Thus, $+a$ and $-c$ are simple quantities; and $b+c$, also $a+b-d$, are compound quantities.

5. To denote the product arising from the multiplication of quantities. If they be simple, they are either joined together, as if intended to form a word, or else the quantities are connected together, with the sign $\times$ interposed between every two of them. Thus, $ab$, or $a\times b$, denotes the product of $a$ and $b$; also $abc$, or $a\times b\times c$, denotes the product of $a$, $b$, and $c$: the latter method is used when the quantities to be multiplied are numbers. If some of the quantities to be multiplied be compound, each of them has a line drawn over it called a vinculum, and the sign $\times$ is interposed, as before. Thus, $a\times\overline{c+d}\times\overline{e-f}$ denotes that $a$ is to be considered as one quantity, the sum of $c$ and $d$ as a second, and the difference between $e$ and $f$ as a third; and that these three quantities are to be multiplied into one another. Instead of placing a line over such compound quantities as enter a product, it is now common among mathematical writers to inclose each of them between two parentheses, so that the last product may be otherwise expressed thus, $a(c+d)(e-f)$; or thus, $a\times(c+d)\times(e-f)$.

6. A number prefixed to a letter is called a *numerical co-efficient*, and denotes how often that quantity is to be taken. Thus, $3a$ signifies that $a$ is to be taken three times. When no number is prefixed, the co-efficient is understood to be unity.

7. The quotient arising from the division of one quantity by another is expressed by placing the *dividend* above a line, and the *divisor* below it. Thus, $\frac{12}{3}$ denotes the quotient arising from the division of 12 by 3, or 4; $\frac{b}{a}$ denotes the quotient arising from the division of $b$ by $a$. This expression of a quotient is also called a fraction.

8. The equality of two quantities is expressed by putting the sign $=$ between them. Thus, $a+b=c-d$ denotes that the sum of $a$ and $b$ is equal to the excess of $c$ above $d$.

9. Simple quantities, or the terms of compound quantities, are said to be *like*, which consist of the same letter or letters. Thus, $+ab$ and $-5ab$ are like quantities, but $+ab$ and $+abb$ are unlike.

There are some other characters, which will be explained when we have occasion to use them; and in what follows we shall suppose that the operations of common arithmetic are sufficiently understood; for algebra, being an extension of that science, ought not to be embarrassed by the demonstration of its elementary rules.



### Sect. I.—Fundamental Operations.

The primary operations in algebra are the same as in common arithmetic; namely, addition, subtraction, multiplication, and division; and from the various combinations of these four, all the others are derived.

#### Problem I.—*To Add Quantities.*

10. In addition there may be three cases: the quantities to be added may be like, and have like signs; or they may be like, and have unlike signs; or, lastly, they may be unlike.

*Case* 1. To add quantities which are like, and have like signs.

*Rule.* Add together the co-efficients of the quantities, prefix the common sign to the sum, and annex the letter or letters common to each term.

Examples.

$$\text{Add together}\left\{\begin{array}{r}+7a\\+3a\\+a\\+2a\end{array}\right.\qquad\text{Add together}\left\{\begin{array}{r}-2ax\\-ax\\-5ax\\-12ax\end{array}\right.$$

$$\text{Sum,}\quad +13a\qquad\qquad \text{Sum,}\quad -20ax$$

*Case* 2. To add quantities which are like, but have unlike signs.

*Rule.* Add the positive co-efficients into one sum, and the negative ones into another; then subtract the least of these sums from the greatest, prefix the sign of the greatest to the remainder, and annex the common letter or letters as before.

Examples.

$$\text{Add together}\left\{\begin{array}{r}+2ax\\-ax\\-3ax\\+9ax\end{array}\right.\qquad\text{Add together}\left\{\begin{array}{r}+6ab+7\\-4ab+9\\+ab-5\\+7ab-13\end{array}\right.$$

$$\begin{array}{lr}\text{Sum of the pos.} & +11ax\\ \text{Sum of the neg.} & -4ax\\ \hline \text{Sum required,} & +7ax\end{array}\qquad\begin{array}{lr}\text{Sum of the pos.} & +14ab+16\\ \text{Sum of the neg.} & -4ab-18\\ \hline \text{Sum required,} & +10ab-2\end{array}$$

$$\begin{array}{rrr}aa+2ax-xx & \quad & -4aab\\ -2aa+3ax-4xx & & +aab\\ 6aa-5ax+11xx & & +3aab\\ \hline \text{Sum,}\quad 5aa\quad 0\quad +6xx & & \text{Sum,}\quad 0\end{array}$$

*Case* 3. To add unlike quantities.

*Rule.* Put down the quantities, one after another, in any order, with their signs and co-efficients prefixed.

Examples.

$$\begin{array}{r}2a\\3b\\-4c\\ \hline \text{Sum,}\quad 2a+3b-4c\end{array}\qquad\begin{array}{r}ax+2ay\\bb-3bz\\ \hline \text{Sum,}\quad ax+2ay+bb-3bz\end{array}$$

#### Prob. II.—*To Subtract Quantities.*

11. *General Rule.* Change the signs of the quantities to be subtracted, or suppose them changed, and then add them to the other quantities, agreeably to the rules of addition.

EXAMPLES.

$$\begin{array}{lll} \text{From} & 5a-12b & \\ \text{Subtract} & 2a-\ \ 5b & \\ \hline \text{Remainder} & 3a-\ \ 7b & \end{array} \qquad \begin{array}{ll} \text{From} & 6x-\ \ 8y+3 \\ \text{Subtract} & 2x+\ \ 9y-2 \\ \hline \text{Remainder} & 4x-17y+5 \end{array}$$

$$\begin{array}{l} 5xy-2+\ 8x-\ y \\ 3xy-8-\ 8x-3y \\ \hline 2xy+6+16x+2y \end{array} \qquad \begin{array}{l} aa-ax-yy \\ bb-by+zz \\ \hline aa-ax-yy-bb+by-zz \end{array}$$

The reason of the rule for subtraction may be explained thus. Let it be required to subtract $2p-3q$ from $m+n$. If we subtract $2p$ from $m+n$, there will remain $m+n-2p$; but if we are to subtract $2p-3q$, which is less than $2p$, it is evident that the remainder will be greater by a quantity equal to $3q$; that is, the remainder will be $m+n-2p+3q$; hence the reason of the rule is evident.

PROB. III.—*To Multiply Quantities.*

12. *General Rule for the Signs.* If the quantities to be multiplied have like signs, the sign of the product is $+$; but if they have unlike signs, the sign of the product is $-$.

The examples of multiplication may be referred to two cases; the first is when both the quantities are simple, and the second when one or both of them are compound.

*Case* 1. To multiply simple quantities.

*Rule.* Find the sign of the product by the general rule, and annex to it the product of the numeral co-efficients; then set down all the letters, one after another, as in one word.

EXAMPLES.

$$1.\left\{\begin{array}{ll} \text{Multiply} & +a \\ \text{By} & +c \\ \hline \text{Product} & +ac \end{array}\right. \qquad 2.\left\{\begin{array}{r} +\ 5b \\ -\ 4a \\ \hline -20ab \end{array}\right. \qquad 3.\left\{\begin{array}{r} -\ 3ax \\ +\ 7ab \\ \hline -21aabx \end{array}\right.$$

$$4.\left\{\begin{array}{l} -2ab \\ -3cz \\ \hline +6abcz \end{array}\right.$$

*Case* 2. To multiply compound quantities.

*Rule.* Multiply every term of the multiplicand by all the terms of the multiplier, one after another, by the preceding rule, and collect their products into one sum, which will be the product required.

EXAMPLES.

$$\begin{array}{ll} \text{Multiply} & 4a-2b+c \\ \text{By} & 3a \\ \hline \text{Product} & 12aa-6ab+3ac \end{array} \qquad \begin{array}{l} 2x+y \\ x-2y \\ \hline 2xx+xy \\ \qquad\ -4xy-2yy \\ \hline 2xx-3xy-2yy \end{array}$$

$$\begin{array}{l} aa-ab+bb \\ a+b \\ \hline aaa-aab+abb \\ \quad +aab-abb+bbb \\ \hline aaa\quad *\quad *+bbb \end{array} \qquad \begin{array}{l} a-b+c \\ a+b-c \\ \hline aa-ab+ac \\ \quad +ab\quad -bb+bc \\ \qquad -ac\quad +bc-cc \\ \hline aa\quad *\quad *-bb+2bc-cc. \end{array}$$

The reason of the rules for the multiplication of quantities may be explained in the following manner:—Let it be required to multiply $a-b$ by $c-d$; because multiplication is a repeated addition of the multiplicand as often as the multiplier contains unity; therefore, $a-b$ is to be taken as often as there are units in $c-d$, and the sum will be the product required. Now, if $a-b$ be taken as often as there are units in $c$, the result will evidently exceed the product required, and that by a quantity equal to $a-b$, taken as often as there are units in $d$. But, from the nature of addition, $a-b$ taken as often as there are units in $c$, is $ca-cb$, and for the same reason, $a-b$ taken as often as there are units in $d$, is $da-db$; therefore, to obtain the product required, we must subtract $da-db$ from $ca-cb$; but from what has been shown in subtraction, the remainder will be $ca-cb-da+db$; therefore the product arising from the multiplication of $a-b$ by $c-d$ is $ca-cb-da+db$; hence, the reason of the general rule for the signs, as well as the other rules, is manifest.

When several quantities are multiplied together so as to constitute a product, each of them is called a *factor* of that product: thus $a$, $b$, and $c$ are factors of the product $abc$; also, $a+x$ and $b-x$ are factors of the product $(a+x)(b-x)$.

The products arising from the continual multiplication of the same quantity are called *powers* of that quantity, which is called the *root*. Thus $aa$, $aaa$, $aaaa$, &c. are powers of the root $a$. These powers are commonly expressed by placing above the root, towards the right hand, a figure, denoting how often the root is repeated. This figure serves to denominate the power, and is called its *index* or *exponent*. Thus, the quantity $a$ being considered as the root, or as the first power of $a$, we have $aa$ or $a^2$ for its second power, $aaa$ or $a^3$ for its third power, $aaaa$ or $a^4$ for its fourth power, and so on.

The second and third powers of a quantity are generally called its *square* and *cube*; and the fourth, fifth, and sixth powers are sometimes respectively called its *biquadrate*, *sursolid*, and *cubocube*.

By considering the notation of powers, and the rules for multiplication, it appears that powers of the same root are multiplied by adding their exponents. Thus $a \times a^3 = a^4$, also $x^3 \times x^4 = x^7$; and in general $a^m \times a^n = a^{m+n}$.

PROB. IV.—*To Divide Quantities.*

13. *General Rule for the Signs.* If the signs of the divisor and dividend be like, the sign of the quotient is $+$; but if they be unlike, the sign of the quotient is $-$.

This rule is easily derived from the general rule for the signs in multiplication, by considering that the quotient must be such a quantity as, when multiplied by the divisor, shall produce the dividend, with its proper sign.

The quotient arising from the division of one quantity by another may be expressed by placing the dividend above a line and the divisor below it (sect. 25); but it may also be often expressed in a more simple manner by the following rules.

*Case* 1. When the divisor is simple, and a factor of every term of the dividend.

*Rule.* Divide the co-efficient of each term of the dividend by the co-efficient of the divisor, and expunge out of each term the letter or letters in the divisor: the result is the quotient.

*Ex.* 1. Divide $12abc$ by $3ac$.

From the method of notation, the quotient may be expressed thus, $\frac{12abc}{3ac}$; but the same quotient, by the rule just given, is more simply expressed thus, $4b$.

*Ex.* 2. Divide $16a^3xy-28a^2xz^2+4a^2x^3$ by $4a^2x$.

The quotient is $4ay-7z^2+x^2$.

If the divisor and dividend be powers of the same quantity, the division will evidently be performed by subtracting the exponent of the divisor from that of the dividend. Thus $a^5$, divided by $a^3$, has for a quotient $a^{5-3}=a^2$.

*Case* 2. When the divisor is simple, but not a factor of the dividend.

*Rule.* The quotient is expressed by a fraction, of which the numerator is the dividend, and the denominator the divisor.

Thus the quotient of $3ab^2$, divided by $2mbc$, is the fraction $\frac{3ab^2}{2mbc}$.

It will sometimes happen that the quotient found thus may be reduced to a more simple form, as shall be explained when we come to treat of fractions.

*Case* 3. When the divisor is compound.

*Rule* 1. The terms of this dividend are to be arranged according to the powers of some one of its letters, and those of the divisor according to the powers of the same letter.

2. The first term of the dividend is to be divided by the first term of the divisor, observing the general rule for the signs; and this quotient, being set down for a part of the quotient wanted, is to be multiplied by the whole divisor, and the product subtracted from the dividend. If nothing remain, the division is finished; but if there be a remainder, it is to be taken for a new dividend.

3. The first term of the new dividend is next to be divided by the first term of the dividend, as before, and the quotient joined to the part already found, with its proper sign. The whole divisor is also to be multiplied by this part of the quotient, and the product subtracted from the new dividend; and thus the operation is to be carried on till there be no remainder, or till it appear that there will always be a remainder.

To illustrate this rule, let it be required to divide $8a^2+2ab-15b^2$ by $2a+3b$, the operation will stand thus:

$$\begin{array}{l}
2a+3b)8a^2+2ab-15b^2(4a-5b \\
\qquad\quad 8a^2+12ab \\
\hline
\qquad\qquad -10ab-15b^2 \\
\qquad\qquad -10ab-15b^2 \\
\hline
\end{array}$$

Here the terms of the divisor and dividend are arranged according to the powers of the quantity $a$. We now divide $8a^2$, the first term of the dividend, by $2a$ the first term of the divisor; and thus get $4a$ for the first term of the quotient. We next multiply the divisor by $4a$, and subtract the product $8a^2+12ab$ from the dividend; we get $-10ab-15b^2$ for a new dividend.

By proceeding in all respects as before, we find $-5b$ for the second term of the quotient, and no remainder: the operation is therefore finished, and the whole quotient is $4a-5b$.

The following examples will also serve to illustrate the manner of applying the rule.

Ex. 1.

$$\begin{array}{l}
3a-b)3a^3-12a^2-a^2b+10ab-2b^2(a^2-4a+2b \\
\qquad\quad 3a^3 \qquad\qquad -a^2b \\
\hline
\qquad\qquad -12a^2 \quad +10ab \\
\qquad\qquad -12a^2 \quad +\ 4ab \\
\hline
\qquad\qquad\qquad\quad +6ab-2b^2 \\
\qquad\qquad\qquad\quad +6ab-2b^2 \\
\hline
\end{array}$$

Ex. 2.

$$\begin{array}{l}
a+b)a^3+b^3(a^2-ab+b^2 \\
\qquad a^3+a^2b \\
\hline
\qquad\quad -a^2b+b^3 \\
\qquad\quad -a^2b-ab^2 \\
\hline
\qquad\qquad +ab^2+b^3 \\
\qquad\qquad +ab^2+b^3 \\
\hline
\end{array}$$

Ex. 3.

$$\begin{array}{l}
a^3-b^3)a^6-b^6(a^3+b^3 \\
\qquad\quad a^6-a^3b^3 \\
\hline
\qquad\qquad +a^3b^3-b^6 \\
\qquad\qquad +a^3b^3-b^6 \\
\hline
\end{array}$$

Ex. 4.

$$\begin{array}{l}
1-x)1 \qquad (1+x+x^2+, \&c. \\
\qquad 1-x \\
\hline
\qquad\quad +x \\
\qquad\quad +x-x^2 \\
\hline
\qquad\qquad +x^2 \\
\qquad\qquad +x^2-x^3 \\
\hline
\qquad\qquad\quad +x^3.
\end{array}$$

14. Sometimes, as in this last example, the quotient will never terminate: in such a case it may either be considered as an infinite series, the law according to which the terms are formed being in general sufficiently obvious; or the quotient may be completed as in arithmetical division, by annexing to it a fraction, the numerator of which is the remainder, and denominator the divisor. Thus the quotient in last example may stand thus:

$$1+x+x^2+\frac{x^3}{1-x}.$$

The reason of the rule for division is sufficiently manifest. For, in the course of the operation, all the terms of the quotient obtained by it are multiplied by all the terms of the divisor, and the products successively subtracted from the dividend, till nothing remain; that therefore must evidently be the true quotient.

## Sect. II.—Of Fractions.

15. In the operation of division, the divisor may be sometimes less than the dividend, or may not be contained in it an exact number of times: in either case the quotient is expressed by means of a fraction. There can be no difficulty, however, in estimating the magnitude of such a quotient; if, for example, it were the fraction $\frac{5}{7}$, we may consider it as denoting either that some unit is divided into 7 equal parts, and that 5 of these are taken, or that 5 times the same unit is divided into 7 equal parts, and one of them taken.

16. In any fraction the upper number, or the dividend, is called the *numerator*, and the lower number or divisor is called the *denominator*. Thus, in the fraction $\frac{a}{b}$, $a$ is the numerator, and $b$ the denominator.

17. If the numerator be less than the denominator, such a fraction is called a *proper* fraction; but if the numerator be either equal to, or greater than the denominator, it is called an *improper* fraction; and if a quantity be

made up of an integer and a fraction, it is called a *mixed* quantity. Thus, $\frac{a}{a+x}$ is a proper fraction; $\frac{a}{a}$, also $\frac{a+x}{a}$, are both improper fractions; and $b+\frac{x}{a}$ is a mixed quantity.

18. The *reciprocal* of a fraction is another fraction, having its numerator and denominator respectively equal to the denominator and numerator of the former.

Thus, $\frac{b}{a}$ is the reciprocal of the fraction $\frac{a}{b}$.

19. The following proposition is the foundation of the operations relating to fractions.

If the numerator and denominator of a fraction be either both multiplied or both divided by the same quantity, the value of that fraction is the same as before. For, let any fraction $\frac{b}{a}=c$; then, because $c$ is the quotient arising from the division of $b$ by $a$, it follows that $b=ac$; and multiplying both by any quantity $n$, we have $nb=nac$: let these equals be both divided by the same quantity $na$, and the quotients will be equal, that is, $\frac{nb}{na}=c=\frac{b}{a}$; hence the truth of the proposition is manifest.

From this proposition, it is obvious that a fraction may be very differently expressed, without changing its value, and that any integer may be reduced to the form of a fraction, by placing the product arising from its multiplication by any assumed quantity as the numerator, and the assumed quantity as the denominator of the fraction. It also appears that a fraction very complex in its form may often be reduced to another of the same value, but more simple, by finding a quantity which will divide both the numerator and denominator, without leaving a remainder. Such a common measure, or common divisor, may be either simple or compound; if it be simple, it is readily found by inspection, but if it be compound, it may be found as in the following problem.

20. Prob. I.—*To find the greatest common Measure of two Quantities.*

*Rule* 1. Range the quantities according to the power of some one of the letters, as taught in division, leaving out the simple divisors of each quantity.

2. Divide that quantity which is of most dimensions by the other one, and if there be a remainder, divide it by its greatest simple divisor; and then divide the last compound divisor by the resulting quantity, and if any thing yet remain, divide it also by its greatest simple divisor, and the last compound divisor by the resulting quantity. Proceed in this way till nothing remain, and the last divisor shall be the common measure required.

*Note.* It will sometimes be necessary to multiply the dividends by simple quantities in order to make the divisions succeed.

*Ex.* 1. Required the greatest common measure of the quantities $a^2x—x^3$ and $a^3—2a^2x+ax^2$. The simple divisor $x$ being taken out of the former of these quantities, and $a$ out of the latter, they are reduced to $a^2—x^2$, and $a^2—2ax+x^2$; and as the quantity $a$ rises to the same dimensions in both, we may take either of them as the first divisor: let us take that which consists of several terms, and the operation will stand thus:

$$
\begin{array}{l}
a^2—x^2)a^2—2ax+x^2(1 \\
\qquad\quad a^2—x^2 \\
\hline
\qquad\quad —2ax+2x^2 \text{ remainder,}
\end{array}
$$

which divided by $—2x$ is $a—x)a^2—x^2(a+x$



$$
\begin{array}{l}
a^2—ax \\
\hline
+ax—x^2 \\
+ax—x^2 \\
\hline
\quad * \quad *
\end{array}
$$

Hence it appears that $a—x$ is the greatest common measure required.

*Ex.* 2. Required the greatest common measure of $8a^2b^2—10ab^3+2b^4$, and $9a^4b—9a^3b^2+3a^2b^3—3ab^4$.

It is evident, from inspection, that $b$ is a simple divisor of both quantities; it will therefore be a factor of the common measure required. Let the simple divisors be now left out of each quantity, and they are reduced to $4a^2—5ab+b^2$ and $3a^3—3a^2b+ab^2—b^3$; but as the second of these is to be divided by the first, it must be multiplied by 4 to make the division succeed, and the operation will stand thus:

$$
\begin{array}{l}
4a^2—5ab+b^2)12a^3—12a^2b+4ab^2—4b^3(3a \\
\qquad\qquad\qquad 12a^3—15a^2b+3ab^2 \\
\hline
\qquad\qquad\qquad\qquad +3a^2b+ab^2—4b^3.
\end{array}
$$

This remainder is to be divided by $b$, and the new dividend multiplied by 3, to make the division again succeed, and the work will stand thus:

$$
\begin{array}{l}
3a^2+ab—4b^2)12a^2—15ab+3b^2(4 \\
\qquad\qquad\qquad 12a^2+4ab—16b^2 \\
\hline
\qquad\qquad\qquad —19ab+19b^2.
\end{array}
$$

This remainder is to be divided by $—19b$, which being done, and the last divisor taken as a dividend as before, the rest of the operation will be as follows:

$$
\begin{array}{l}
a—b)3a^2+ab—4b^2(3a+4b \\
\qquad 3a^2—3ab \\
\hline
\qquad +4ab—4b^2 \\
\qquad +4ab—4b^2 \\
\hline
\qquad\quad * \quad *
\end{array}
$$

from which it appears that the compound divisor sought is $a—b$, and remarking that the quantities proposed have also a simple divisor $b$, the greatest common measure which is required will be $b(a—b)$.

21. The reason of the rule given in this problem may be deduced from the following considerations.

1. If two quantities have a compound divisor common to both, and they be either multiplied or divided by any simple quantities, the results will each have the same compound divisor. Thus the quantities $p(a—x)$ and $q(a—x)$ have the common divisor $a—x$, and the quantities $n\,p(a—x)$, $r\,q(a—x)$ have each the very same divisor.

2. In the operation of division, whatever quantity measures both the divisor and dividend, the same will also measure the remainder. For let $x$ be such a quantity, then the divisor and dividend may be represented by $ax$ and $bx$; let $q$ be the quotient, and the remainder will evidently be $bx—qax$, which is evidently divisible by $x$.

3. Whatever quantity measures both the divisor and remainder, the same will also measure the dividend; for, let the divisor be $ax$, and the remainder $rx$, then $q$, denoting the quotient, the dividend will be $aqx+rx$, which, as well as the divisor and dividend, is divisible by $x$.

Let us apply these observations to the last example. From the first observation, the reason for leaving out the simple quantities in the course of the operation, as well as for multiplying by certain other quantities, to make the divisions succeed, is obvious; and from the second observation it appears, that whatever quantity measures $4a^2-5ab+b^2$, and $12a^3-12a^2b+4ab^2-4b^3$, the same must measure $3a^2b+ab^2-4b^3$, the first remainder, as also $-19ab+19ab^2$, the second remainder; but the only compound divisor which this last quantity can have is $a-b$, which is also found to be a divisor of $3a^2+ab-4b^2$, or of $3a^2b+ab^2-4b^3$. The first remainder, therefore, by the third observation, $a-b$, must also be a divisor of $12a^2-15ab+3b^2$, or of $4a^2-5ab+b^2$, the first divisor, and therefore also it must be a divisor of $12a^3-12a^2b+4ab^2-4b^3$, the first dividend; so that $a-b$ is the greatest common measure, as was required.

22. Prob. II.—*To Reduce a Fraction to its lowest Terms.*

*Rule.* Divide both numerator and denominator by their greatest common measure, which may be found by Prob. I.

*Ex.* 1. Reduce $\frac{56a^2bc}{24adc^2}$ to its lowest terms.

It appears from inspection, that the greatest common measure is $8ac$; and dividing both numerator and denominator by this quantity, we have $\frac{56a^2bc}{24adc^2}=\frac{7ab}{3dc}$.

*Ex.* 2. Reduce $\frac{a^2x-x^3}{a^3-2a^2x+ax^2}$ to its lowest terms.

We have already found in the first example of Prob. I. that the greatest common measure of the numerator and denominator is $a-x$; and dividing both by this quantity, we have $\frac{a^2x-x^3}{a^3-2a^2x+ax^2}=\frac{ax+x^2}{a^2-ax}$.

In like manner we find

$$\frac{9a^4b-9a^3b^2+3a^2b^3-3ab^4}{8a^2b^2-10ab^3+2b^4}=\frac{9a^3+3ab^2}{8ab-2b^2};$$

the common measure being $b(a-b)$, as was shown in Example 2. Problem I.

23. Prob. III.—*To Reduce a mixed Quantity to an improper Fraction.*

*Rule.* Multiply the integer by the denominator of the fraction, and to the product add the numerator; and the denominator being placed under this sum, the result will be the improper fraction required.

*Ex.* 1. Let $x+\frac{x^2}{a}$, and $x-\frac{a^2-x^2}{x}$ be reduced to improper fractions.

First, $x+\frac{x^2}{a}=\frac{ax+x^2}{a}$, the answer.

And $x-\frac{a^2-x^2}{x}=\frac{x^2-a^2+x^2}{x}=\frac{2x^2-a^2}{x}$, Ans.

*Ex.* 2. Reduce $a-x+\frac{x^2}{a+x}$ to an improper fraction.

$$a-x+\frac{x^2}{a+x}=\frac{(a+x)(a-x)+x^2}{a+x}=\frac{a^2}{a+x}, \text{ Ans.}$$

24. Prob. IV.—*To Reduce an improper Fraction to a whole or mixed Number.*

*Rule.* Divide the numerator by the denominator for the integral part, and place the remainder, if any, over the denominator, and it will be the mixed quantity required.

*Ex.* 1. Reduce $\frac{ax+a^2}{x}$ to a whole or mixed quantity.

$\frac{ax+a^2}{x}=a+\frac{a^2}{x}$, the answer required.

*Ex.* 2. Reduce $\frac{ax+2x^2}{a+x}$, also $\frac{x^2-y^2}{x-y}$, to whole or mixed quantities.

First $\frac{ax+2x^2}{a+x}=x+\frac{x^2}{a+x}$, the answer.

And $\frac{x^2-y^2}{x-y}=x+y$ a whole quantity, which is the answer.

25. Prob. V.—*To Reduce Fractions of different Denominators to others of the same value which shall have a common Denominator.*

*Rule.* Multiply each numerator separately into all the denominators except its own for the new numerators, and all the denominators together for the common denominator.

*Ex.* 1. Reduce $\frac{a}{b}, \frac{c}{d}$, and $\frac{e}{f}$, to fractions of equal value which have a common denominator.

$$\left.\begin{array}{l} a\times d\times f=adf \\ c\times b\times f=cbf \\ e\times b\times d=ebd \end{array}\right\} \text{New numerators.}$$

$b\times d\times f=bdf$ Common denominator.

Hence we find $\frac{a}{b}=\frac{adf}{bdf}, \frac{c}{d}=\frac{cbf}{bdf}$, and $\frac{e}{f}=\frac{ebd}{bdf}$, where the new fractions have a common denominator, as was required.

*Ex.* 2. Reduce $\frac{ax}{a-x}$ and $\frac{a^2-x^2}{a+x}$ to fractions of equal value, and having a common denominator.

$$\left.\begin{array}{l} ax(a+x)=a^2x+ax^2 \\ (a^2-x^2)(a-x)=a^3-a^2x-ax^2+x^3 \end{array}\right\} \text{New numerators.}$$

$a-x)(a+x)=a^2-x^2$, the common denominator.

Hence $\frac{ax}{a-x}=\frac{a^2x+ax^2}{a^2-x^2}$ and $\frac{a^2-x^2}{a+x}=\frac{a^3-a^2x-a^2x+x^3}{a^2-x^2}$.

26. Prob. VI.—*To Add or Subtract Fractions.*

*Rule.* Reduce the fractions to a common denominator, and add or subtract their numerators, and the sum or difference placed over the common denominator, is the sum or remainder required.

*Ex.* 1. Add together $\frac{a}{b}, \frac{c}{d}$, and $\frac{e}{f}$.

$$\frac{a}{b}=\frac{adf}{bdf}$$
$$\frac{c}{d}=\frac{bcf}{bdf}$$
$$\frac{e}{f}=\frac{bde}{bdf}$$

Hence $\frac{a}{b}+\frac{c}{d}+\frac{e}{f}=\frac{adf+bcf+bde}{bdf}$, the sum required.

*Ex.* 2. From $\frac{a+x}{a}$ subtract $\frac{a}{a+x}$.

$$\frac{a+x}{a}=\frac{a^2+2ax+x^2}{a^2+ax}$$
$$\frac{a}{a+x}=\frac{a^2}{a^2+ax}$$

Hence $\frac{a+x}{a}-\frac{a}{a+x}=\frac{2ax+x^2}{a^2+ax}$.

*Ex.* 3. Add together $\frac{x+2}{3}, \frac{x}{4}$, and $\frac{x-5}{2}$.

$$\frac{x+2}{3}+\frac{x}{4}+\frac{x-5}{2}=\frac{8x+16+6x+12x-60}{24}=$$

$\frac{13x-22}{12}$. If it be required to add or subtract mixed quantities, they may either be reduced to the form of fractions by prob. 3, and then added or subtracted, or else these operations may be performed first on the integer quantities, and afterwards on the fractions.

27. Prob. VII.—*To Multiply Fractions.*

*Rule.* Multiply the numerators of the fractions for the numerator of the product, and the denominators for the denominator of the product.

*Ex.* 1. Multiply $\frac{b}{a}$ by $\frac{d}{c}$.

$\frac{b}{a} \times \frac{d}{c} = \frac{bd}{ac}$, the product required.

*Ex.* 2. Multiply $\frac{a+b}{c}$ by $\frac{a-b}{d}$.

$\frac{a+b}{c} \times \frac{a-b}{d} = \frac{a^2-b^2}{cd}$, the product.

If it be required to multiply an integer by a fraction, the integer may be considered as having unity for a denominator. Thus, $(a+x) \times \frac{3d}{c} = \frac{a+x}{1} \times \frac{3d}{c} = \frac{3ad+3dx}{c}$.

Mixed quantities may be multiplied after being reduced to the form of fractions by prob. 3. Thus, $\left(b+\frac{bx}{a}\right) \times \frac{a}{x} = \frac{ab+bx}{a} \times \frac{a}{x} = \frac{a^2b+abx}{ax} = \frac{ab+bx}{x}$.

The reason of the rule for multiplication may be explained thus. If $\frac{a}{b}$ is to be multiplied by $c$, the product will evidently be $\frac{ac}{b}$; but if it is only to be multiplied by $\frac{c}{d}$, the former product must be divided by $d$, and it becomes $\frac{ac}{bd}$, which is the product required. Or let $\frac{a}{b} = m$, and $\frac{c}{d} = n$, then $a = bm$ and $c = dn$ and $ac = bdmn$; hence, $mn$ or $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$.

28. Prob. VIII.—*To Divide Fractions.*

*Rule.* Multiply the denominator of the divisor by the numerator of the dividend for the numerator of the quotient. Then multiply the numerator of the divisor by the denominator of the dividend for the denominator of the quotient.

Or, multiply the dividend by the reciprocal of the divisor, the product will be the quotient required.

*Ex.* 1. Divide $\frac{a}{b}$ by $\frac{c}{d}$.

$\frac{c}{d}\Big)\frac{a}{b}\Big(\frac{ad}{bc}$ the quotient required, or $\frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$ as before.

*Ex.* 2. Divide $\frac{a^2+ab}{2x}$ by $\frac{3a^2}{a-b}$.

$\frac{3a^2}{a-b}\Big)\frac{a^2+ab}{2x}\Big(\frac{a^3-ab^2}{6a^2x} = \frac{a^2-b^2}{6ax}$, the quotient.

If either the divisor or dividend be an integer quantity, it may be represented as a fraction, by placing unity for a denominator; or if it be a mixed quantity, it may be reduced to a fraction by prob. 3, and the operation of division performed agreeably to the rule.

The reason of the rule for division may be explained thus: Let it be required to divide $\frac{c}{d}$ by $\frac{a}{b}$. If $\frac{c}{d}$ is to be divided by $a$, the quotient is $\frac{c}{ad}$; but if it is to be divided by $\frac{a}{b}$, then the last quotient must be multiplied by $b$; thus we have $\frac{cb}{ad}$ for the quotient required. Or let $\frac{a}{b} = m$, and $\frac{c}{d} = n$, then $a = bm$ and $c = dn$; also $ad = bdm$ and $bc = bdn$; therefore $\frac{bdn}{bdm} = \frac{n}{m} = \frac{bc}{ad}$.

Sect. III.—Involution and Evolution.

29. In treating of multiplication, we have observed, that when a quantity is multiplied by itself any number of times, the product is called a *power* of that quantity, while the quantity itself, from which the powers are formed, is called the *root* (sect. 12). Thus, $a$, $a^2$, and $a^3$, are the first, second, and third powers of the root $a$; and in like manner $\frac{1}{a}$, $\frac{1}{a^2}$, and $\frac{1}{a^3}$, denote the same powers of the root $\frac{1}{a}$.

But before considering more particularly what relates to powers and roots, it will be proper to observe, that the quantities $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, &c. admit of being expressed under a different form; for, like as the quantities $a$, $a^2$, $a^3$, &c. are expressed as *positive* powers of the root $a$, so the quantities $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, &c. may be respectively expressed thus, $a^{-1}$, $a^{-2}$, $a^{-3}$, &c. and considered as *negative* powers of the root $a$.

30. This method of expressing the fractions $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, as powers of the root $a$, but with negative indices, is a consequence of the rule which has been given for the division of powers; for we may consider $\frac{1}{a}$ as the quotient arising from the division of any power of $a$ by the next higher power; for example, from the division of the 2d by the 3d, and so we have $\frac{1}{a} = \frac{a^2}{a^3}$; but since powers of the same quantity are divided by subtracting the exponent of the divisor from that of the dividend (sect. 30), it follows, that $\frac{a^2}{a^3} = a^{2-3} = a^{-1}$; therefore the fraction $\frac{1}{a}$ may also be expressed thus, $a^{-1}$. By considering $\frac{1}{a}$ as equal to $\frac{a^2}{a^4}$, it will appear in the same manner that $\frac{1}{a^2} = \frac{a^2}{a^4} = a^{-2}$; and proceeding in this way, we get $\frac{1}{a^3} = \frac{a^2}{a^5} = a^{-3}$, $\frac{1}{a^4} = \frac{a^3}{a^6} = a^{-4}$, &c. and so on, as far as we please. It also appears that unity or 1 may be represented by $a^0$, where the exponent is a cypher, for $1 = \frac{a^2}{a^2} = a^{2-2} = a^0$.

31. The rules which have been given for the multiplication and division of powers with positive exponents will apply in every case, whether the exponents be positive or negative; and this must evidently take place; for the mode of notation, by which we represent fractional quantities as the powers of integers, but with negative exponents, has been derived from those rules. Thus, $\frac{1}{a^2} \times a^3$ or $a^{-2} \times a^3$

$= a^{-2+3} = a$, also $\frac{1}{x^2} \times \frac{1}{x^3}$ or $x^{-2} \times x^{-3} = x^{-2-3} = x^{-5}$ $= \frac{1}{x^5}$, and $\frac{1}{x^3} \times x^3$ or $x^{-3} \times x^{+3} = x^{-3+3} = x^0 = 1$.

From this method of notation it appears, that any quantity may be taken from the denominator of a fraction, and placed in the numerator, by changing the sign of its exponent; and hence it follows, that every fraction may also be represented as an integer quantity. Thus, $\frac{a^2}{bc^3}$ denotes the same thing as $\frac{a^2b^{-1}}{c^3}$ or as $a^2b^{-1}c^{-3}$; also $\frac{a^2}{(x-1)^3}$ may be otherwise expressed thus, $a^2(x-1)^{-3}$.

*Of Involution.*

32. Involution is the method of finding any power of any assigned quantity, whether it be simple or compound: hence its rules are easily derived from the operation of multiplication.

*Case* 1. When the quantity is simple.

*Rule.* Multiply the exponents of the letters by the index of the power required, and raise the co-efficient to the same power.

*Note.* If the sign of the quantity be $+$, all its powers will be positive; but if it be $-$, then all its powers whose exponents are even numbers are positive, and all its powers whose exponents are odd numbers are negative.

*Ex.* 1. Required the cube, or third power, of $2a^2x$. $(2a^2x)^3 = 2 \times 2 \times 2a^{2\times3}x^{1\times3} = 8a^6x^3$, the answer.

*Ex.* 2. Required the fifth power of $-3a^2x^3$. $(-3a^2x^3)^5 = -243a^{10}x^{15}$, the answer.

*Ex.* 3. Required the fourth power of $-\frac{2ax^2}{3b^2y}$.

$$\left(\frac{-2ax^2}{3b^2y}\right)^4 = \frac{16a^4x^8}{81b^8y^4}, \text{ the answer.}$$

*Case* 2. When the quantity is compound.

*Rule.* The powers must be found by a continual multiplication of the quantity by itself.

*Ex.* Required the first four powers of the binomial quantity $a+x$.

$a+x$ the root, or first power.
$a+x$

$a^2+ax$
$\quad +ax+x^2$

$a^2+2ax+x^2$ the square, or second power.
$a+x$

$a^3+2a^2x+ax^2$
$\quad + a^2x+2ax^2+x^3$

$a^3+3a^2x+3ax^2+x^3$ the cube, or third power.
$a+x$

$a^4+3a^3x+3a^2x^2+ax^3$
$\quad + a^3x+3a^2x^2+3ax^3+x^4$

$a^4+4a^3x+6a^2x^2+4ax^3+x^4$ the fourth power.

If it be required to find the same powers of $a-x$, it will be found that
$a-x$ being the root, or first power; then
$a^2-2ax+x^2$ is the square, or second power;
$a^3-3a^2x+3ax^2-x^3$, the cube, or third power;
$a^4-4a^3x+6a^2x^2-4ax^3+x^4$, the fourth power.

Hence it appears that the powers of $a+x$ differ from the powers of $a-x$ only in this respect, that in the former the signs of the terms are all positive, but in the latter they are positive and negative alternately.



33. Besides the method of finding the powers of a compound quantity by multiplication, which we have just now explained, there is another more general, as well as more expeditious, by which a quantity may be raised to any power whatever without the trouble of finding any of the inferior powers, namely, by means of what is commonly called the *binomial theorem.* This theorem may be expressed as follows: Let $a-x$ be a binomial quantity, which is to be raised to any power denoted by the number $n$, then $(a+x)^n=$

$$a^n + \frac{n}{1}a^{n-1}x + \frac{n(n-1)}{1 \cdot 2}a^{n-2}x^2 + \frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3}a^{n-3}x^3$$
$$+ \frac{n(n-1)(n-2)(n-3)}{1 \cdot 2 \cdot 3 \cdot 4}a^{n-4}x^4$$
$$+ \frac{n(n-1)(n-2)(n-3)(n-4)}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5}a^{n-5}x^5 +, \text{ \&c.}$$

This series will always terminate when $n$ is any whole positive number, by reason of some one of the factors $n-1$, $n-2$, &c. becoming $=0$; but if $n$ be either a negative or fractional number, the series will consist of an infinite number of terms. As, however, we mean to treat in this section only of the powers of quantities when their exponents are whole positive numbers, we shall make no further remarks upon any other: we shall afterwards give a demonstration of the theorem, and show its application to fractional and negative powers, in treating of infinite series. The $n$th power of $a-x$ will not differ from the same power of $a+x$, but in the signs of the terms which compose it, for it will stand thus: $(a-x)^n = a^n - \frac{n}{1}a^{n-1}x$

$$+ \frac{n(n-1)}{1 \cdot 2}a^{n-2}x^2 - \frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3}a^{n-3}x^3$$
$$+ \frac{n(n-1)(n-2)(n-3)}{1 \cdot 2 \cdot 3 \cdot 4}a^{n-4}x^4 -, \text{ \&c.}$$

where the signs are $+$ and $-$ alternately.

*Ex.* 1. Let it be required to raise $a + x$ to the fifth power.

Here $n$, the exponent of the power, being 5, the first term $a^n$ of the general theorem will be equal to $a^5$, the second $na^{n-1}x = 5a^4x$, the third $\frac{n(n-1)}{1 \cdot 2}a^{n-2}x^2 = \frac{5\times4}{1\times2}a^3x^2 = 10a^3x^2$, the fourth $\frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3}a^{n-3}x^3 = \frac{5\times4\times3}{1\times2\times3}a^2x^3, = 10a^2x^3$, the fifth $\frac{n(n-1)(n-2)(n-3)}{1 \cdot 2 \cdot 3 \cdot 4}a^{n-4}x^4 = \frac{5\times4\times3\times2}{1\times2\times3\times4}ax^4 = 5ax^4$, and the sixth and last $\frac{n(n-1)(n-2)(n-3)(n-4)}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5}a^{n-5}x^5 = \frac{5\times4\times3\times2\times1}{1\times2\times3\times4\times5}a^0x^5 = x^5$; the remaining terms of the general theorem all vanish, by reason of the factor $n - 5 = 0$ by which each of them is multiplied, so that we get $(a+x)^5 = a^5 + 5a^4x + 10a^3x^2 + 10a^2x^3 + 5ax^4 + x^5$.

*Ex.* 2. It is required to raise $2d - \frac{z}{3}$ to the third power.

In this case $n = 3$, so that if we put $a = 2d$ and $x = \frac{z}{3}$, we have the first term of the general theorem, or $a^n = 8d^3$, the second $\frac{n}{1}a^{n-1}x = 3 \times 4d^2 \times \frac{z}{3} = 4d^2z$, the third

$\frac{n(n-1)}{1\cdot 2}\,a^{n-2}\,x^2 = 3\times 2d\times\frac{z^2}{9}=\frac{2dz^2}{3}$, and the fourth and last term $\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\,a^{n-3}x^3=\frac{z^3}{27}$; and since the signs of the terms of any power of $a-x$ are $+$ and $-$ alternately, we have $\left(2d-\frac{z}{3}\right)^3=8d^3-4d^2z+\frac{2dz^2}{3}-\frac{z^3}{27}$.

34. If the quantity to be involved consists of more than two terms, as if $p+q-r$ were to be raised to the second power, put $p=a$ and $q-r=b$, then $(p+q-r)^2=(a+b)^2=a^2+2ab+b^2=p^2+2p\,(q-r)+(q-r)^2$, but $2p\,(q-r)=2pq-2pr$, and by the general theorem $(q-r)^2=q^2-2qr+r^2$, therefore we get $(p+q-r)^2=p^2+2pq-2pr+q^2-2qr+r^2$; and by a similar method of proceeding a quantity consisting of four or more terms may be raised to any power.

### *Of Evolution.*

35. Evolution is the reverse of involution, or it is the method of finding the root of any quantity, whether simple or compound, which is considered as a power of that root: hence it follows that its operations, generally speaking, must be the reverse of those of involution.

To denote that the root of any quantity is to be taken, the sign $\surd$ (called the *radical sign*) is placed before it, and a small number placed over the sign to express the denomination of the root. Thus $\sqrt[2]{a}$ denotes the square root of $a$, $\sqrt[3]{a}$ its cube root, $\sqrt[4]{a}$ its fourth root, and in general, $\sqrt[n]{a}$ its $n$th root. The number placed over the radical sign is called the *index* or *exponent* of the root, and is usually omitted in expressing the square root: thus, either $\sqrt[2]{a}$ or $\sqrt{a}$ denotes the square root of $a$.

*Case* 1. When roots of simple quantities are to be found.

*Rule.* Divide the exponents of the letters by the index of the root required, and prefix the root of the numeral co-efficient; the result will be the root required.

*Note* 1. The root of any positive quantity may be either positive or negative, if the index of the root be an even number; but if it be an odd number, the root can be positive only.

2. The root of a negative quantity is also negative when the index of the root is an odd number.

3. But if the quantity be negative, and the index of the root even, then no root can be assigned.

*Ex.* 1. Required the square root of $36a^2x^4$.

Here the index of the root is 2, and the root of the co-efficient 6, therefore $\sqrt{36a^2x^4}=+6ax^2$ or $\sqrt{36a^2x^4}=-6ax^2$; for either of these quantities, when multiplied by itself, produces $36a^2x^4$; so that the root required is $\pm 6ax^2$, where the sign $\pm$ denotes that the quantity to which it is prefixed may be considered either as positive or negative.

*Ex.* 2. Required the cube root of $125a^6x^9$.

Here the index of the root is 3, and the root of the co-efficient 5, therefore $\sqrt[3]{125a^6x^9}=5a^2x^3$, the root required; and in like manner the cube root of $-125a^6x^9$ is found to be $-5a^2x^3$.

If it be required to extract the square root of $-a^2$, it will immediately appear that no such root can be assigned; for it can neither be $+a$ nor $-a$, seeing that each of these quantities, when squared, produces $+a^2$: the root required is therefore said to be *impossible*, and may be expressed thus: $\sqrt{-a^2}$.

The root of a fraction is found by extracting that root out of both numerator and denominator. Thus the square root of $\frac{4a^2x^4}{9b^2y^6}$ is $\frac{2ax^2}{3by^3}$.

*Case* 2. When the quantity of which the root is to be extracted is compound.

36. I. To extract the square root.

Range the terms of the quantity according to the powers of the letters, as in division.

Find the square root of the first term for the first part of the root sought, subtract its square from the given quantity, and divide the remainder by double the part already found, and the quotient is the second term of the root.

Add the second part to double the first, and multiply their sum by the second part; subtract the product from the remainder, and if nothing remain, the square root is obtained. But if there is a remainder, it must be divided by the double of the parts already found, and the quotient will give the third term of the root, and so on.

*Ex.* 1. Required the square root of $a^2+2ax+x^2$.

$$\begin{array}{rl}
 & a^2+2ax+x^2\,(a+x, \text{ the root required.} \\
 & a^2 \\
\hline
2a+x\,) & +2ax+x^2 \\
\times x\,) & +2ax+x^2 \\
\hline
 & * \quad * 
\end{array}$$

*Ex.* 2. Required the square root of $x^4-2x^3+\frac{3}{2}x^2-\frac{x}{2}+\frac{1}{16}$.

$$\begin{array}{rl}
 & x^4-2x^3+\frac{3}{2}x^2-\frac{x}{2}+\frac{1}{16}\left(x^2-x+\frac{1}{4}\right. \\
 & x^4 \\
\hline
2x^2-x\,) & -2x^3+\frac{3}{2}x^2 \\
\times -x\,) & -2x^3+\ x^2 \\
\hline
2x^2-2x+\frac{1}{4}\,) & \frac{x^2}{2}-\frac{x}{2}+\frac{1}{16} \\
\times\frac{1}{4} & \frac{x^2}{2}-\frac{x}{2}+\frac{1}{16} \\
\hline
 & * \quad * \quad *
\end{array}$$

To understand the reason of the rule for finding the square root of a compound quantity, it is only necessary to involve any quantity, as $a+b+c$, to the second power, and observe the composition of its square; for we have $(a+b+c)^2=a^2+2ab+b^2+2ac+2bc+c^2$; but $2ab+b^2=(2a+b)b$ and $2ac+2bc+c^2=(2a+2b+c)c$, therefore,

$$(a+b+c)^2=a^2+(2a+b)b+(2a+2b+c)c;$$

and from this expression the manner of deriving the rule is obvious.

As an illustration of the common rule for extracting the square root of any proposed number, we shall suppose that the root of 59049 is required.

Accordingly we have $(a+b+c)^2=59049$, and from hence we are to find the values of $a$, $b$, and $c$.

$$\begin{array}{r|l}
 & 59049(200=a \\
a^2=200\times 200= & 40000 \quad 40=b \\
 & \qquad\ \ 3=c \\
2a=400 & 19049 \\
b=\ \ 40 & \\
2a+b=440 & 17600=(2a+b)b \\
2a+2b=480 & 1449 \\
c=\ \ \ 3 & \\
2a+2b+c=483 & 1449=(2a+2b+c)c
\end{array}$$

Hence 243 is the root required.

The same example when wrought by the common rule (see ARITHMETIC) will stand thus:

$$\begin{array}{l}
\quad 59049(243 \text{ the root required.} \\
\quad 4 \\
\hline
44)190 \\
\quad 176 \\
\hline
483)1449 \\
\quad\ \ 1449 \\
\hline
\end{array}$$

and by a comparison of the two operations, the reason of the common rule is obvious.

37. II. To extract the cube root.

Range the terms of the quantity according to the powers of some one of the letters.

Find the root of the first term, for the first part of the root sought; subtract its cube from the whole quantity, and divide the remainder by three times the square of the part already found, and the quotient is the second part of the root.

Add together three times the square of the part of the root already found, three times the product of that part and the second part of the root, and the square of the second part; multiply the sum by the second part, and subtract the product from the first remainder, and if nothing remain, the root is obtained; but if there is a remainder, it must be divided by three times the square of the sum of the parts already found, and the quotient is a third term of the root, and so on, till the whole root is obtained.

*Ex.* Required the cube root of $a^3+3a^2x+3ax^2+x^3$.

$$\begin{array}{l}
\qquad\qquad\qquad a^3+3a^2x+3ax^2+x^3(a+x \text{ the root required.} \\
\qquad\qquad\qquad a^3 \\
\hline
3a^2+3ax+x^2)3a^2x+3ax^2+x^3 \\
\qquad\qquad\qquad 3a^2x+3ax^2+x^3 \\
\hline
\qquad\qquad\qquad * \quad * \quad *
\end{array}$$

The reason of the preceding rule is evident from the composition of a cube; for if any quantity, as $a+b+c$ be raised to the third power, we have $(a+b+c)^3=a^3+(3a^2+3ab+b^2)b+3(a+b)^2+3(a+b)c+c^2)c$, and by considering in what manner the terms $a$, $b$, and $c$ are deduced from this expression for the cube of their sum, we also see the reason for the common rule for extracting the cube root in numbers. Let it be required to find the cube root of 13312053, where the root will evidently consist of three figures; let us suppose it to be represented by $a+b+c$, and the operation for finding the numerical values of these quantities may stand as follows.

$$\begin{array}{r|l}
 & 13312053(200=a \\
a^3= & 8000000 \quad 30=b \\
 & \qquad\qquad\ \ 7=c \\
3a^2=120000 & 5312053 \quad \overline{\ \ \ } \\
3ab=\ \ 18000 & \qquad\quad 237 \text{ the root required.} \\
b^2=\qquad 900 & \\
3a^2+3ab+b^2=138900 & 4167000=(3a^2+3ab+b^2)b \\
3(a+b)^2=158700 & 1145053 \\
3(a+b)c=\ \ \ 4830 & \\
c^2=\qquad\ 49 & \\
3(a+b)^2+3(a+b)c+c^2=163579 & 1145053=[3(a+b)^2+3(a+b)c+c^2]c
\end{array}$$

The operation as performed by the common rule (see ARITHMETIC) will stand thus:

$$\begin{array}{r|l}
 & 13312053(237 \text{ the root required.} \\
 & 8 \\
12.. & 5312 \\
18\ . & \\
9 & \\
\hline
1389 & 4167 \\
1587.. & 1145053 \\
483\ . & \\
49 & \\
\hline
163579 & 1145053
\end{array}$$

38. III. To extract any other root.

*Rule.* Range the quantity of which the root is to be found, according to the powers of its letters, and extract the root of the first term, and that shall be the first member of the root required.

Involve the first member of the root to a power less by unity than the number that denominates the root required, and multiply the power that arises by the number itself; divide the second term of the given quantity by the product, and the quotient shall give the second member of the root required.

Find the remaining members of the root in the same manner by considering those already found as making one term.

*Ex.* Required the cube root of $x^6+6x^5-40x^3+96x-64$.

$$\begin{array}{l}
\qquad\qquad\quad x^6+6x^5-40x^3+96x-64(x^2+2x-4 \\
(x^2)^3=x^6 \\
\hline
\quad 3x^4)6x^5 \\
\hline
(x^2+2x)^3=x^6+6x^5+12x^4+8x^3 \\
\hline
\quad 3x^4+,\ \&c.)-12x^4 \\
\hline
(x^2+2x-4)^3=x^6+6x^5-40x^3+96x-64 \\
\hline
\qquad\qquad\qquad *
\end{array}$$

In this example, the cube root of $x^6$, or $x^2$, is the first member of the root; and to find a second member, the first is raised to the power next lower, or to the second power, and also multiplied by 3, the index of the root required. Thus we get $3x^4$ for a divisor, by which the second term $6x^5$ being divided, we find $2x$ for the second member of the root. We must now consider $x^2+2x$ as forming one term: accordingly, having subtracted its cube from the quantity of which the root is sought, we have $-12x^4-$, &c. for a new dividend; and having also raised $x^2+2x$ to the second power, and multiplied the result by 3, we find $3x^4+$, &c. for a divisor. (As it is only the terms which contain the highest powers of the dividend and divisor that we have occasion for, the remaining terms are expressed by &c.) Having divided $-12x^4$ by $3x^4$, we find $-4$ for the third term of the root; and because it appears that $x^2+2x-4$, when raised to the third power, gives a result the very same with the proposed power, we conclude $x^2+2x-4$ to be the root sought.

39. In the preceding examples, the quantities whose roots were to be found have been all such as could have their roots expressed by a finite number of terms; but it will frequently happen that the root cannot be otherwise assigned than by a series consisting of an infinite number of terms. The preceding rules, however, will serve to determine any number of terms of the series. Thus, the square root of $a^2+x^2$ will be found to be $a+\frac{x^2}{2a}-\frac{x^4}{8a^3}+\frac{x^6}{16a^5}-\frac{5x^8}{128a^7}+$, &c., and the cube root of $a^3+x^3$ will stand thus, $a+\frac{x^3}{3a^2}-\frac{x^6}{9a^5}+\frac{5x^9}{81a^8}-\frac{10x^{12}}{243a^{11}}+$, &c. But as the extraction of roots in the form of series can be more easily performed by other methods, we shall refer the reader to sect. 19, which treats of series, where this subject is resumed.

## Sect. IV.—Of Surds.

40. It has been already observed (35), that the root of any proposed quantity is found by dividing the exponent of the quantity by the index of the root; and the rule has been illustrated by suitable examples, in all which, however, the quotient expressing the exponent of the result is a whole number; but there may be cases in which the quotient is a fraction. Thus, if the cube root of $a^2$ were required, it might be expressed, agreeably to the method of notation already explained, either thus, $\sqrt[3]{a^2}$, or thus, $a^{\frac{2}{3}}$.

Quantities which have fractional exponents are called *surds*, or imperfect powers, and are said to be *irrational*, in opposition to others with integral exponents, which are called *rational.*

Surds may be denoted by means of the radical sign, but it will be often more convenient to use the notation of fractional exponents. The following examples will show how they may be expressed either way.

$$\sqrt[3]{a} = a^{\frac{1}{3}}, \quad \sqrt{4ab^2} = 2ba^{\frac{1}{2}}, \quad \sqrt[4]{a^3b^2} = a^{\frac{3}{4}}b^{\frac{2}{4}},$$
$$\sqrt{a^2+b^2} = (a^2+b^2)^{\frac{1}{2}}, \quad \sqrt[5]{(a-b)^2} = (a-b)^{\frac{2}{5}},$$
$$\frac{\sqrt{a+b}}{\sqrt{ab}} = (a+b)^{\frac{1}{2}}\, a^{-\frac{1}{2}}b^{-\frac{1}{2}}.$$

The operations concerning surds depend on the following principle: If the numerator and denominator of a fractional exponent be either both multiplied or both divided by the same quantity, the value of the power is the same. Thus, $a^{\frac{m}{n}} = a^{\frac{cm}{cn}}$. For let $a^{\frac{m}{n}} = b$, then raising both to the power $n$, $a^m = b^n$, and further, raising both to the power $c$, we get $a^{cm} = b^{cn}$: let the root $cn$ be now taken, and we find $a^{\frac{cm}{cn}} = b = {}^{\frac{n}{n}}$.

41. Prob. I.—*To Reduce a Rational Quantity to the form of a Surd of any given denomination.*

*Rule.* Reduce the exponent of the quantity to the form of a fraction of the same denomination as the given surd.

*Ex.* I. Reduce $a^2$ to the form of the cube root.

Here the exponent 2 must be reduced to the form of a fraction having 3 for a denominator, which will be the fraction $\frac{6}{3}$; therefore $a^2 = a^{\frac{6}{3}} = \sqrt[3]{a^6}$.

*Ex.* 2. Reduce 5 to the form of the cube root, and $3ab^2$ to the form of the square root.

First, $5 = 5^{\frac{3}{3}} = \sqrt[3]{5\times5\times5} = \sqrt[3]{125}$,

And $3\,a\,b^2 = 3^{\frac{2}{2}}a^{\frac{2}{2}}b^{\frac{4}{2}} = (3^2a^2b^4)^{\frac{1}{2}} = \sqrt{9a^2b^4}$.

42. Prob. II.—*To Reduce Surds of different denominations to others of the same value, and of the same denomination.*

*Rule.* Reduce the fractional exponents to others of the same value, and having the same common denominator.

*Ex.* 1. Reduce $\sqrt{a}$ and $\sqrt[3]{b^2}$, or $a^{\frac{1}{2}}$ and $b^{\frac{2}{3}}$ to other equivalent surds of the same denomination.

The exponents $\frac{1}{2}$, $\frac{2}{3}$, when reduced to a common denominator, are $\frac{3}{6}$ and $\frac{4}{6}$; therefore the surds required are $a^{\frac{3}{6}}$ and $b^{\frac{4}{6}}$, or $\sqrt[6]{a^3}$ and $\sqrt[6]{b^4}$.

*Ex.* 2. Reduce $3^{\frac{1}{2}}$ and $2^{\frac{1}{3}}$ to surds of the same denomination.

The new exponents are $\frac{3}{6}$ and $\frac{2}{6}$, therefore we have $3^{\frac{1}{2}} = 3^{\frac{3}{6}} = \sqrt[6]{3^3} = \sqrt[6]{27}$, and $2^{\frac{1}{3}} = 2^{\frac{2}{6}} = \sqrt[6]{2^2} = \sqrt[6]{4}$.

And in the same way the surds $A^{\frac{1}{m}}$, $B^{\frac{1}{n}}$, are reduced to these two, $\sqrt[mn]{A^n}$ and $\sqrt[mn]{B^m}$.

43. Prob. III.—*To Reduce Surds to their most simple terms.*

*Rule.* Reduce the surd into two factors, so that one of them may be a complete power, having its exponent divisible by the index of the surd. Extract the root of that power, and place it before the remaining quantities, with the proper radical sign between them.

*Ex.* 1. Reduce $\sqrt{48}$ to its most simple terms.

The number 48 may be resolved into the two factors 16 and 3, of which the first is a complete square; therefore $\sqrt{48} = (4^2\times3)^{\frac{1}{2}} = 4\times3^{\frac{1}{2}} = 4\sqrt{3}$.

*Ex.* 2. Reduce $\sqrt{98a^4x}$, and $\sqrt[3]{24a^3x+40a^3x^2}$, each to its most simple terms.

First, $\sqrt{98a^4x} = (7^2a^4\times2x)^{\frac{1}{2}} = 7a^2\times(2x)^{\frac{1}{2}} = 7a^2\sqrt{2x}$.

Also $\sqrt[3]{24a^3x+40a^3x^2} = (2^3a^3(3x+5x^2))^{\frac{1}{3}} = 2a\sqrt[3]{3x+5x^2}$.

44. Prob. IV.—*To Add and Subtract Surds.*

*Rule.* If the surds are of different denominations, reduce them to others of the same denomination, by prob. 2, and then reduce them to their simplest terms by last problem. Then, if the surd part be the same in them all, annex it to the sum or difference of the rational parts, with the sign of multiplication, and it will give the sum or difference required. But if the surd part be not the same in all the quantities, they can only be added or subtracted by placing the signs $+$ or $-$ between them.

*Ex.* 1. Required the sum of $\sqrt{27}$ and $\sqrt{48}$.

By prob. 3 we find $\sqrt{27}=3\sqrt{3}$ and $\sqrt{48}=4\sqrt{3}$, therefore $\sqrt{27}+\sqrt{48}=3\sqrt{3}+4\sqrt{3}=7\sqrt{3}$.

*Ex.* 2. Required the sum of $3\sqrt[3]{\tfrac{1}{4}}$ and $5\sqrt[3]{\tfrac{1}{32}}$.

$3\sqrt[3]{\tfrac{1}{4}}=3\sqrt[3]{\tfrac{2}{8}}=\tfrac{3}{2}\sqrt[3]{2}$ and $5\sqrt[3]{\tfrac{1}{32}}=5\sqrt[3]{\tfrac{2}{64}}=\tfrac{5}{4}\sqrt[3]{2}$, therefore $3\sqrt[3]{\tfrac{1}{4}}+5\sqrt[3]{\tfrac{1}{32}}=\tfrac{3}{2}\sqrt[3]{2}+\tfrac{5}{4}\sqrt[3]{2}=\tfrac{11}{4}\sqrt[3]{2}$.

*Ex.* 3. Required the difference between $\sqrt{80a^4x}$ and $\sqrt{20a^2x^3}$.

$\sqrt{80a^4x}=(4^2a^4\times 5x)^{\frac{1}{2}}=4a^2\sqrt{5x}$, and $\sqrt{20a^2x^3}=(2^2a^2x^2\times 5x)^{\frac{1}{2}}=2ax\sqrt{5x}$; therefore $\sqrt{80a^4x}-\sqrt{20a^2x^3}=(4a^2-2ax)\sqrt{5x}$.

45. Prob. V.—*To Multiply and Divide Surds.*

*Rule.* If they are surds of the same rational quantity, add or subtract their exponents.

But if they are surds of different rational quantities, let them be brought to others of the same denomination, by prob. 2. Then, by multiplying or dividing these rational quantities, their product or quotient may be set under the common radical sign.

*Note.* If the surds have any rational co-efficients, their product or quotient must be prefixed.

*Ex.* 1. Required the product of $\sqrt[3]{a^2}$ and $\sqrt[5]{a^3}$.

$$\sqrt[3]{a^2}\times\sqrt[5]{a^3}=a^{\frac{2}{3}}\times a^{\frac{3}{5}}=a^{\frac{2}{3}+\frac{3}{5}}=a^{\frac{19}{15}}=\sqrt[15]{a^{19}},\ \text{Ans.}$$

*Ex.* 2. Divide $\sqrt{a^2-b^2}$ by $\sqrt[3]{a+b}$.

These surds, when reduced to the same denomination, are $(a^2-b^2)^{\frac{3}{6}}$ and $(a+b)^{\frac{2}{6}}$. Hence $\frac{\sqrt{a^2-b^2}}{\sqrt[3]{a+b}}$

$$=\left(\frac{(a^2-b^2)^3}{(a+b)^2}\right)^{\frac{1}{6}}=\left(\frac{(a+b)^3(a-b)^3}{(a+b)^2}\right)^{\frac{1}{6}}$$

$$=\left((a+b)(a-b)^3\right)^{\frac{1}{6}}=\sqrt[6]{(a+b)(a-b)^3}.$$

*Ex.* 3. Required the product of $5\sqrt{8}$ and $3\sqrt{5}$.

$5\sqrt{8}\times 3\sqrt{5}=5\times 3\times\sqrt{8}\times\sqrt{5}=15\times\sqrt{40}=15\times\sqrt{4\times 10}=30\sqrt{10}$.

*Ex.* 4. Divide $8\sqrt[3]{56}$ by $4\sqrt[3]{2}$.

$$\frac{8\sqrt[3]{56}}{4\sqrt[3]{2}}=2\sqrt[3]{\frac{56}{2}}=2\sqrt[3]{28}.$$

*Ex.* 5. Required the product of $x^{\frac{1}{m}}$ and $x^{\frac{1}{n}}$; also the quotient arising from the division of $a^{\frac{1}{m}}$ by $b^{\frac{1}{n}}$.

First, $x^{\frac{1}{m}}\times x^{\frac{1}{n}}=x^{\frac{1}{m}+\frac{1}{n}}=x^{\frac{m+n}{mn}}=\sqrt[mn]{x^{m+n}}$,

And $\frac{a^{\frac{1}{m}}}{b^{\frac{1}{n}}}=\left(\frac{a^n}{b^m}\right)^{\frac{1}{mn}}=\sqrt[mn]{\frac{a^n}{b^m}}$.

46. Prob. VI.—*To Involve and Evolve Surds.*

Surds are involved or evolved in the same manner as any other quantities, namely, by multiplying or dividing their exponents by the index of the power or root required. Thus, the square of $3\sqrt[3]{3}$ is $3\times 3\times(3)^{\frac{2}{3}}=9\sqrt[3]{9}$. The $n$th power of $x^{\frac{1}{m}}$ is $x^{\frac{n}{m}}$. The cube root of $\frac{1}{8}\sqrt{2}$ is $\frac{1}{2}(2)^{\frac{1}{6}}=\frac{\sqrt[6]{2}}{2}$, and the $n$th root of $x^{\frac{1}{m}}$ is $x^{\frac{1}{mn}}$.

47. If a compound quantity involve one or more surds, its powers may be found by multiplication. Thus, the square of $3+\sqrt{5}$ is found as follows:

$$\begin{array}{l} 3+\sqrt{5} \\ 3+\sqrt{5} \\ \hline 9+3\sqrt{5} \\ \quad +3\sqrt{5}+5 \\ \hline 9+6\sqrt{5}+5=14+6\sqrt{5},\ \text{the square required.} \end{array}$$

48. The square root of a binomial or residual surd, $A+B$, or $A-B$, may be found thus. Find $D=\sqrt{A^2-B^2}$,

then $\sqrt{A+B}=\sqrt{\frac{A+D}{2}}+\sqrt{\frac{A-D}{2}}$,

and $\sqrt{A-B}=\sqrt{\frac{A+D}{2}}-\sqrt{\frac{A-D}{2}}$.

Thus the square root of $8+2\sqrt{7}$ is $1+\sqrt{7}$; and the square root of $3-\sqrt{8}$ is $\sqrt{2}-1$. With respect to the extraction of the cube or any higher root, no general rule can be given.

Sect. V.—Of Proportion.

49. In comparing together any two quantities of the same kind in respect of magnitude, we may consider how much the one is greater than the other, or else how many times the one contains either the whole or some part of the other; or, which is the same thing, we may consider either what is the difference between the quantities, or what is the quotient arising from the division of the one quantity by the other: the former of these is called their *arithmetical ratio*, and the latter their *geometrical ratio*. These denominations, however, have been assumed arbitrarily, and have little or no connection with the relations they are intended to express.

I. *Of Arithmetical Proportion.*

50. When of four quantities the difference between the first and second is equal to the difference between the third and fourth, the quantities are called *arithmetical proportionals*. Such, for example, are the numbers 2, 5, 9, 12; and, in general, the quantities $a$, $a+d$, $b$, $b+d$. If the two middle terms are equal, the quantities constitute an *arithmetical progression*.

51. The principal property of four arithmetical proportionals is this:—If four quantities be arithmetically proportional, the sum of the extreme terms is equal to the sum of the means. Let the quantities be $a$, $a+d$, $b$, $b+d$; where $d$ is the difference between the first and second, and also between the third and fourth, the sum of the extremes is $a+b+d$, and that of the means $a+d+b$; so that the truth of the proposition is evident. Hence it follows, that if any three quantities be arithmetically proportional, the sum of the two extremes is double the mean.

52. If any three terms of four arithmetical proportionals be given, the fourth may be found from the preceding

proposition. Let $a$, $b$, $c$, be the first, second, and fourth terms, and let $x$, the third term, be required; because $a+c=b+x$, therefore $x=a+c-b$. In like manner any two of three arithmetical proportionals being supposed given, the remaining term may be readily found.

53. If a series of quantities be such, that the difference between any two adjacent terms is always the same, these terms form a *continued arithmetical progression.* Thus, the numbers 2, 4, 6, 8, 10, &c. form a series in continued arithmetical proportion, and, in general, such a series may be represented thus:

$a, a+d, a+2d, a+3d, a+4d, a+5d, a+6d$, &c. where $a$ denotes the first term, and $d$ the common difference.

By a little attention to this series, we readily discover that it has the following properties:

1. The last term of the series is equal to the first term, together with the common difference taken as often as there are terms after the first. Thus, when the number of terms is 7, the last term is $a+6d$; and so on. Hence if $z$ denote the last term, $n$ the number of terms, and $a$ and $d$ express the first term and common difference, we have $z=a+(n-1)\,d$.

2. The sum of the first and last term is equal to the sum of any two terms at the same distance from them. Thus, suppose the number of terms to be 7, then the last term is $a+6d$, and the sum of the first and last $2a+6d$; but the same is also the sum of the second and last but one, of the third and last but two, and so on till we come to the middle term, which, because it is equally distant from the extremes, must be added to itself.

From the last-mentioned property we derive a rule for finding the sum of all the terms of the series. For if the sum of the first and last be taken, as also the sum of the second and last but one, of the third and last but two, and so on along the series till we come to the sum of the last and first terms, it is evident that we shall have as many sums as there are terms, and each equal to the sum of the first and last terms; but the aggregate of those sums is equal to all the terms of the series taken twice, therefore the sum of the first and last term, taken as often as there are terms, is equal to twice the sum of all the terms; so that if $s$ denote that sum, we have $2s=n(a+z)$, and $s=\frac{n}{2}(a+z)$.

Hence the sum of the odd numbers 1, 3, 5, 7, 9, &c. continued to $n$ terms, is equal to the square of the number of terms. For in this case $a=1$, $d=2$, $z=1+(n-1)\,d$ $=2n-1$, therefore $s=\frac{n}{2}\times 2n=n^2$.

## II. *Of Geometrical Proportion.*

54. When, of four quantities, the quotient arising from the division of the first by the second is equal to that arising from the division of the third by the fourth, these quantities are said to be in *geometrical proportion,* or are called simply *proportionals.* Thus, 12, 4, 15, 5, are four numbers in geometrical proportion; and, in general, $na$, $a$, $nb$, $b$, may express any four proportionals, for $\frac{na}{a}=n$, and also $\frac{nb}{b}=n$.

To denote that any four quantities $a$, $b$, $c$, $d$, are proportionals, it is common to place them thus, $a:b::c:d$; or thus, $a:b=c:d$; which notation, when expressed in words, is read thus, $a$ is to $b$ as $c$ to $d$, or the ratio of $a$ to $b$ is equal to the ratio of $c$ to $d$.

The first and third terms of a proportion are called the *antecedents,* and the second and fourth the *consequents.*

When the two middle terms of a proportion are the same, the remaining terms, and that quantity, constitute three geometrical proportionals; such as 4, 6, 9, and in general $n\,a, a, \frac{a}{n}$. In this case the middle quantity is called a mean proportional between the other two.

55. The principal properties of four proportionals are the following:

1. If four quantities be proportionals, the product of the extremes is equal to the product of the means. Let $a$, $b$, $c$, $d$, be four quantities, such that $a:b::c:d$; then, from the nature of proportionals, $\frac{a}{b}=\frac{c}{d}$: let these equal quotients be multiplied by $b\,d$, and we have $\frac{abd}{b}=\frac{cbd}{d}$, or $ad=bc$. Hence it follows, that when three quantities are proportional, the product of the extremes is equal to the square of the middle term. It also appears, that if any three of four proportionals be given, the remaining one may be found. Thus, let $a$, $b$, $c$, the first three, be given, and let it be required to find $x$, the fourth term; because $a:b::c:x$, $ax=bc$, and dividing by $a$, $x=\frac{bc}{a}$. This conclusion may be considered as a demonstration of what is called the rule of three in arithmetic.

2. If four quantities be such, that the product of two of them is equal to the product of the other two, these quantities are proportionals.

Let $a$, $b$, $c$, $d$, be the quantities, which are such that $ad=bc$; if these equals be divided by $bd$, then $\frac{ad}{bd}=\frac{bc}{bd}$, or $\frac{a}{b}=\frac{c}{d}$; hence, from the definition given of proportionals (sect. 54), $a:b::c:d$. From this property of proportionals it appears, that if three quantities be such that the square of one of them is equal to the product of the other two, these quantities are three proportionals.

If four quantities are proportional, that is, if $a:b::c:d$, then will each of the following combinations or arrangements of the quantities be also four proportionals.

1*st*, By inversion, $b:a::d:c$.

2*d*, By alternation, $a:c::b:d$.

*Note.*—The quantities in the second case must be all of the same kind.

3*d*, By composition, $a+b:a::c+d:c$,
or, $a+b:b::c+d:d$.

4*th*, By division, $a-b:a::c-d:c$,
or, $a-b:b::c-d:d$.

5*th*, By mixing, $a+b:a-b::c+d:c-d$.

6*th*, By taking any equimultiples of the antecedents, and also any equimultiples of the consequents,

$$na:pb::nc:pd.$$

7*th*, Or, by taking any parts of the antecedents and consequents, $\frac{a}{n}:\frac{b}{p}::\frac{c}{n}:\frac{d}{p}$.

That the preceding combinations of the quantities $a$, $b$, $c$, $d$, are proportionals, may be readily proved, by taking the products of the extremes and means; for from each of them we derive this conclusion, that $ad=bc$, which is known to be true, from the original assumption of the quantities.

If four quantities be proportional, and also other four, the product of the corresponding terms will be proportional.

Let $a:b::c:d$,
And $e:f::g:h$;
Then $ae:bf::cg:dh$.

*Adv. Bib.*

Algebra. For $ad = bc$, and $eh = fg$ (sect. 55), therefore, multiplying together these equal quantities, $adeh = bcfg$, or $ae \times dh = bf \times cg$; therefore, by the second property (sect. 55), $ae : bf :: cg : dh$.

Hence it follows, that if there be any number of proportions whatever, the products of the corresponding terms will still be proportional.

56. If a series of quantities be so related to each other, that the quotient arising from the division of any term by that which follows it is always the same quantity, these are said to be in *continued geometrical proportion*; such are the numbers 2, 4, 8, 16, 32, &c. also $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$, &c. and in general, a series of such quantities may be represented thus, $a, ar, ar^2, ar^3, ar^4, ar^5$, &c. Here $a$ is the first term, and $r$ the quotient of any two adjoining terms, which is also called the *common ratio.*

By inspecting this series, we find that it has the following properties:

1. The last term is equal to the first, multiplied by the common ratio raised to a power, the index of which is one less than the number of terms. Therefore, if $z$ denote the last term, and $n$ the number of terms, $z = ar^{n-1}$.

2. The product of the first and last term is equal to the product of any two terms equally distant from them: thus, supposing $ar^5$ the last term, it is evident that $a \times ar^5 = ar \times ar^4 = ar^2 \times ar^3$, &c.

The sum of $n$ terms of a geometrical series may be found thus:

Let $s = a + ar + ar^2 + ar^3 \ldots + ar^{n-1}$,

Then $rs = ar + ar^2 + ar^3 \ldots + ar^{n-1} + ar^n$.

Subtract, $rs - s = ar^n - a$;

That is, $(r - 1)\, s = a(r^n - 1)$.

Hence $s = \dfrac{r^n - 1}{r - 1}\, a$.

## Sect. VI.—Of the Resolution of Equations involving one Unknown Quantity.

57. The general object of algebraic investigation is to discover certain unknown quantities, by comparing them with other quantities which are given, or supposed to be known. The relation between the known and unknown quantities is either that of equality, or else such as may be reduced to equality; and a proposition which affirms that certain combinations of quantities are equal to one another is called an *equation.* Such are the following:—

$$\frac{x}{2} + \frac{x}{3} = \frac{24}{x},$$

$$2x + 3y = xy.$$

The first of these equations expresses the relation between an unknown quantity $x$ and certain known numbers; and the second expresses the relation which the two indefinite quantities $x$ and $y$ have to each other.

58. When a quantity stands alone on one side of an equation, the terms on the other side are said to be a *value* of that quantity. Thus, in the equation $x = ay + b - c$, the quantity $x$ stands alone on one side, and $ay + b - c$ is its value.

The conditions of a problem may be such as to require several equations and symbols of unknown quantities for their complete expression. These, however, by rules hereafter to be explained, may be reduced to one equation, involving only one unknown quantity and its powers, besides the known quantities; and the method of expressing that quantity by means of the known quantities constitutes the theory of equations, one of the most important as well as most intricate branches of algebraic analysis.

59. An equation is said to be *resolved* when the unknown quantity is made to stand alone on one side, and only known quantities on the other side; and the value of the unknown quantity is called a *root* of the equation. Algebra.

60. Equations containing only one unknown quantity and its powers, are divided into different *orders*, according to the highest power of that quantity contained in any one of its terms. The equation, however, is supposed to be reduced to such a form that the unknown quantity is found only in the numerators of the terms, and that the exponents of its powers are expressed by positive integers.

61. If an equation contains only the first power of the unknown quantity, it is called a *simple* equation, or an equation of the first order. Such is $ax + b = c$, where $x$ denotes an unknown, and $a, b, c$, known quantities.

If the equation contains the second power of the unknown quantity, it is said to be of the second degree, or is called a *quadratic* equation; such is $4x^2 + 3x = 12$, and in general $ax^2 + bx = c$. If it contains the third power of the unknown quantity, it is of the third degree, or is a *cubic* equation; such are $x^3 - 2x^2 + 4x = 10$, and $ax^3 + bx^2 + ca = d$; and so on with respect to equations of the higher orders. A simple equation is sometimes said to be *linear*, or of one *dimension*. In like manner, quadratic equations are said to be of two dimensions, and cubic equations of three dimensions.

62. When in the course of an algebraic investigation we arrive at an equation involving only one unknown quantity, that quantity will often be so entangled in the different terms as to render several previous reductions necessary before the equation can be expressed under its characteristic form, so as to be resolved by the rules which belong to that form.

These reductions depend upon the operations which have been explained in the former part of this treatise, and the application of a few self-evident principles, namely, that if equal quantities be added to or subtracted from equal quantities, the sums or remainders will be equal; if equal quantities be multiplied or divided by the same quantity, the products or quotients will be equal; and, lastly, if equal quantities be raised to the same power, or have the same root extracted out of each, the results will still be equal.

From these considerations are derived the following rules, which apply alike to equations of all orders, and are alone sufficient for the resolution of simple equations.

63. *Rule* 1. Any quantity may be transposed from one side of an equation to the other, by changing its signs.

Thus, if $x - 3 = 5$,

Then $x = 5 + 3$,

Or $x = 8$.

And if $3x - 10 = 2x + 5$,

Then $3x - 2x = 5 + 10$,

Or $x = 15$.

Again, if $ax + b = cx - dx + e$,

Then $ax - cx + dx = e - b$,

Or $(a - c + d)x = e - b$.

The reason of this rule is evident, for the transposing of a quantity from one side of an equation to the other is nothing more than adding the same quantity to each side of the equation, if the sign of the quantity transposed was $-$; or subtracting it, if the sign was $+$.

From this rule we may infer, that if any quantity be found on each side of the equation with the same sign, it may be left out of both. Also, that the signs of all the terms of an equation may be changed into the contrary, without affecting the truth of the equation.

Thus, if $a+x=b+a-c$,
Then $x=b+c$;
And if $a-x=b-d$,
Then $x-a=d-b$.

64. *Rule* 2. If the unknown quantity in an equation be multiplied by any quantity, that quantity may be taken away, by dividing all the other terms of the equation by it.

If $3x=24$,
Then $x=\frac{24}{3}=8$.
If $ax=b-c$,
Then $x=\frac{b-c}{a}=\frac{b}{a}-\frac{c}{a}$.

Here equal quantities are divided by the same quantity, and therefore the quotients are equal.

65. *Rule* 3. If any term of an equation be a fraction, its denominator may be taken away, by multiplying all the other terms of the equation by that denominator.

If $\frac{x}{5}=7$,
Then $x=35$.
If $\frac{x}{a}=b-c+d$,
Then $x=ab-ac+ad$.
If $a-\frac{b}{x}=c$,
We have $ax-b=cx$.

In these examples, equal quantities are multiplied by the same quantity, and therefore the products are equal.

66. The denominators may be taken away from several terms of an equation by one operation, if we multiply all the terms by any number which is a multiple of each of these denominators.

Thus, if $\frac{x}{2}+\frac{x}{3}+\frac{x}{4}=26$;

let all the terms be multiplied by 12, which is a multiple of 2, 3, and 4, and we have

$$\frac{12x}{2}+\frac{12x}{3}+\frac{12x}{4}=312;$$
Or $6x+4x+3x=312$;
Hence $13x=312$.

Universally, if $\frac{x}{a}-\frac{x}{b}+\frac{x}{c}=d-e$;

to take away the denominators $a$, $b$, $c$, let the whole equation be multiplied by $a\,b\,c$, their product, and we have

$$bcx-acx+abx=abc\,(d-e),$$
Or $(bc-ac+ab)\,x=abc\,(d-e)$.

From the last two rules it appears, that if all the terms of an equation be either multiplied or divided by the same quantity, that quantity may be left out of all the terms.

If $ax=ab-ac$,
Then $x=b-c$;
And if $\frac{x}{a}=\frac{b}{a}+\frac{c}{a}$,
Then $x=b+c$.

67. *Rule* 4. If the unknown quantity is found in any term which is a surd, let that surd be made to stand alone on one side of the equation, and the remaining terms on the opposite side; then involve each side to a power denoted by the index of the surd, and thus the unknown quantity shall be freed from the surd expression.

If $\sqrt{x}+6=10$,
Then, by transposition, $\sqrt{x}=10-6=4$;
And, squaring both sides, $\sqrt{x}\times\sqrt{x}=4\times 4$,
Or $x=16$.
Also, if $\sqrt{a^2+x^2}-b=x$,
By trans. $\sqrt{a^2+x^2}=b+x$,
And, squaring, $a^2+x^2=(b+x)^2=b^2+2bx+x^2$,
Hence $a^2=b^2+2bx$.
And if $\sqrt[3]{a^2x-b^2x}=x$,
Then $a^2x-b^2x=x^3$.

68. *Rule* 5. If the side of the equation which contains the unknown quantity be a perfect power, the equation may be reduced to another of a lower order, by extracting the root of that power out of each side of the equation.

Thus, if $x^3=64a^3$,
Then, by extracting the cube root, $x=8a$;
And if $(a+x)^2=b^2-a^2$,
Then $a+x=\sqrt{b^2-a^2}$.

69. The use of the preceding rules will be further illustrated by the following examples:

*Ex.* 1. Let $20-3x-8=60-7x$,
By rule 1, $7x-3x=60+8-20$,
Or $4x=48$,
Therefore, by rule 2, $x=12$.

*Ex.* 2. Let $ax-b=cx+d$,
By rule 1, $ax-cx=b+d$,
Or $(a-c)x=b+d$,
And by rule 2, $x=\frac{b+d}{a-c}$.

*Ex.* 3. Let $\frac{x+1}{2}+\frac{x+2}{3}=16-\frac{x+3}{4}$,

By rule 3, $\begin{cases} x+1+\frac{2x+4}{3}=32-\frac{2x+6}{4}, \\ 3x+3+2x+4=96-\frac{6x+18}{4}, \\ 12x+12+8x+16=384-6x-18, \end{cases}$
Or $20x+28=366-6x$,
Hence, by rule 1, $26x=338$,
And by rule 2, $x=13$.

In this example, instead of taking away the denominators one after another, they might have been all taken away at once, by multiplying the given equation by 12, which is divisible by the numbers 2, 3, and 4; thus we should have got $6x+6+4x+8=192-3x-9$, and hence, as before, $x=13$.

*Ex.* 4. Let $6x^3-20x^2=16x^2+2x^3$;
Then, dividing by $2x^2$, $3x-10=8+x$,
And transposing, $3x-x=8+10$,
Or $2x=18$,
And therefore $2x=9$.

*Ex.* 5. Let $a-\frac{b^2}{x}=c$,
Then $ax-b^2=cx$,
And $ax-cx=b^2$,
Whence $x=\frac{b^2}{a-c}$.

*Ex.* 6. Let $x-6=\frac{x^2}{x+24}$,
Then $(x-6)(x+24)=x^2$;

That is, $x^2+18x-144=x^2$,
Therefore $18x=144$,
And $x=8$.

*Ex.* 7. Let $ax+b^2=\frac{ax^2+ac^2}{a+x}$;
Then $(a+x)(ax+b^2)=ax^2+ac^2$,
Or $a^2x+ab^2+ax^2+b^2x=ax^2+ac^2$,
Hence $a^2x+b^2x=ac^2-ab^2$,
And $x=\frac{ac^2-ab^2}{a^2+b^2}$.

*Ex.* 8. Let $\frac{1-x}{1+a}=a$;
Then $1-x=a+ax$,
And $-x-ax=a-1$,
Or, changing the signs, $x+ax=1-a$;
Hence $x=\frac{1-a}{1+a}$.

*Ex.* 9. Let $\sqrt{12+x}=2+\sqrt{x}$;
Then, by rule 4, $12+x=4+4\sqrt{x}+x$,
And by transposition, $8=4\sqrt{x}$,
And by division, $2=\sqrt{x}$,
And again, by rule 4, $4=x$.

*Ex.* 10. Let $x+\sqrt{a^2+x^2}=\frac{2a^2}{\sqrt{a^2+x^2}}$;
Then, by rule 3, $x\sqrt{a^2+x^2}+a^2+x^2=2a^2$,
And by transposition, &c. $x\sqrt{a^2+x^2}=a^2-x^2$,
Therefore, by rule 4, $a^2x^2+x^4=a^4-2a^2x^2+x^4$,
Whence $3a^2x^2=a^4$,
And $x^2=\frac{a^2}{3}$, therefore, by rule 5, $x=\frac{a}{\sqrt{3}}$.

*Ex.* 11. Let $\frac{1-\sqrt{1-x^2}}{1+\sqrt{1-x^2}}=a$;
Then $1-\sqrt{1-x^2}=a+a\sqrt{1-x^2}$
And $1-a=a\sqrt{1-x^2}+\sqrt{1-x^2}=(1+a)\sqrt{1-x^2}$,
Whence $\frac{1-a}{1+a}=\sqrt{1-x^2}$;
And, taking the square of both sides, $\frac{(1-a)^2}{(1+a)^2}=1-x^2$,
Therefore, by transposition, $x^2=1-\frac{(1-a)^2}{(1+a)^2}$,
That is, $x^2=\frac{(1+a)^2-(1-a)^2}{(1+a)^2}=\frac{4a}{(1+a)^2}$,
Therefore $x=\frac{\sqrt{a}}{1+a}$.

*Ex.* 12. Let $a+x=\sqrt{a^2+x\sqrt{b^2+x^2}}$,
Then $(a+x)^2=a^2+x\sqrt{b^2+x^2}$,
That is, $a^2+2ax+x^2=a^2+x\sqrt{b^2+x^2}$,
Therefore $2ax+x^2=x\sqrt{b^2+x^2}$,
And dividing by $x$, $2a+x=\sqrt{b^2+x^2}$.
Again, taking the squares of both sides, $4a^2+4ax+x^2=b^2+x^2$,
Whence $4a^2+4ax=b^2$,
And $4ax=b^2-4a^2$; so that $x=\frac{b^2-4a^2}{4a}$.

In all these examples we have been able to determine the value of the unknown quantity by the rules already delivered, because in every case the first, or at most the second power of that quantity, has been made to stand alone on one side of the equation, while the other consisted only of known quantities; but the same methods of reduction serve to bring equations of all degrees to a proper form for solution. Thus, if $\frac{1-p+q+r}{x+1}=1-p-x+\frac{r}{x}$; by proper reduction, we have $x^3+px^2+qx=r$, a cubic equation, which may be resolved by rules to be afterwards explained.

## Sect. VII.—Of the Reduction of Equations involving more than one Unknown Quantity.

70. Having shown in the last section in what manner an equation involving one unknown quantity may be resolved, or at least fitted for a final solution, we are next to explain the methods by which two or more equations, involving as many unknown quantities, may at last be reduced to one equation and one unknown quantity.

As the unknown quantities may be combined together in very different ways, so as to constitute an equation, the methods most proper for their elimination must therefore be various. The three following, however, are of general application, and the last of them may be used with advantage, not only when the unknown quantity to be eliminated rises to the same power in all the equations, but also when the equations contain different powers of that quantity.

71. *Method* 1. Observe which of the unknown quantities is the least involved, and let its value be found from each equation, by the rules of last section.

Let the values thus found be put equal to each other, and hence new equations will arise, from which that quantity is wholly excluded. Let this operation be now repeated with these equations, thus eliminating the unknown quantities one by one, till at last an equation be found which contains only one unknown quantity.

*Ex.* Let it be required to determine $x$ and $y$ from these two equations.

$$2x+3y=23,$$
$$5x-2y=10.$$

From the first equation, $2x=23-3y$,
And $x=\frac{23-3y}{2}$.
From the second equation, $5x=10+2y$,
And $x=\frac{10+2y}{5}$.
Let these values of $x$ be now put equal to each other,
And we have $\frac{10+2y}{5}=\frac{23-2y}{2}$,
Or $20+4y=125-15y$;
Therefore $19y=95$,
And $y=5$:
And since $x=\frac{23-3y}{2}$, or $x=\frac{10+2y}{5}$, from either of these values we find $x=4$.

72. *Method* 2. Let the value of the unknown quantity which is to be eliminated be found from that equation wherein it is least involved. Let this value and its powers be substituted for that quantity, and its respective powers in the other equations; and with the new equations thus arising, let the operation be repeated till there remain only one equation and one unknown quantity.

*Ex.* Let the given equations, as in last method, be

$$2x+3y=23,$$
$$5x-2y=10.$$

From the first equation, $x=\frac{23-3y}{2}$;

And this value of $x$ being substituted in the second equation, we have $5\times\frac{23-3y}{2}-2y=10$,

Or $115-15y-4y=20$;
Therefore $95=19y$,
And $5=y$,
And hence $x=\frac{23-3y}{2}=4$, as before.

73. *Method* 3. Let the given equations be multiplied or divided by such numbers or quantities, whether known or unknown, that the term which involved the highest power of the unknown quantity may be the same in each equation.

Then, by adding or subtracting the equations, as occasion may require, that term will vanish, and a new equation emerge, wherein the number of dimensions of the unknown quantity in some cases, and in others the number of unknown quantities, will be diminished; and by a repetition of the same or similar operations, a final equation may be at last obtained, involving only one unknown quantity.

*Ex.* Let the same example be taken, as in the illustration of the former methods, namely,

$$2x+3y=23,$$
$$5x-2y=10;$$

and from these equations we are to determine $x$ and $y$. To eliminate $x$, let the first equation be multiplied by 5, and the second by 2; thus we have

$$10x+15y=115,$$
$$10x-\ 4y=\ 20.$$

Here the term involving $x$ is the same in both equations; and it is obvious, that by subtracting the one from the other, the resulting equation will contain only $y$, and known numbers; for by such subtraction we find $19y=95$, and therefore $y=5$.

Having got the value of $y$, it is easy to see how $x$ may be found, from either of the given equations; but it may also be found in the same manner as we found $y$. For let the first of the given equations be multiplied by 2, and the second by 3, and we have

$$4x+6y=46,$$
$$15x-6y=30.$$

By adding these equations, we find

$$19x=76, \text{ and } y=4.$$

74. The following examples will serve further to illustrate these different methods of eliminating the unknown quantities from equations.

*Ex.* 1. Given $\left\{\begin{array}{l}\frac{x}{2}+\frac{y}{3}=16,\\ \frac{x}{5}-\frac{y}{9}=\ 2;\end{array}\right\}$ required $x$ and $y$.

*By Method* 1.

From the first equation, $x=32-\frac{2y}{3}$,

And from the second, $x=10+\frac{5y}{9}$;

Therefore $10+\frac{5y}{9}=32-\frac{2y}{3}$,
Or $90+5y=288-6y$;
Hence $11y=198$ and $y=18$.



The value of $y$ being substituted in either of the values of $x$, namely, $32-\frac{2y}{3}$, or $10+\frac{5y}{9}$, we find $x=20$.

*By Method* 2.

Having found from the first equation

$$x=32-\frac{2y}{3},$$

let this value of $x$ be substituted in the second, and

$$\frac{1}{5}\left(32-\frac{2y}{3}\right)-\frac{y}{9}=2,$$

Or $\frac{32}{5}-\frac{2y}{15}-\frac{y}{9}=2$;

Hence $198=11y$ and $y=18$.

The value of $y$ being now substituted in either of the given equations, we thence find $x=20$, as before.

*By Method* 3.

The denominators of the two given equations being taken away by rule 3 of last section, we have

$$3x+2y=96,$$
$$9x-5y=90.$$

From three times the first of these, or $9x+6y=288$, let the second be subtracted, there remains

$$11y=198 \text{ and } y=18.$$

The value of $y$ being now substituted in either of the equations $3x+2y=96$, $9x-5y=90$, we readily find $x=20$.

75. Having shown in what way the different methods of eliminating the unknown quantities may be applied, we shall, in the remaining examples of this section, chiefly make use of the last method, because it is the most easy and expeditious in practice.

*Ex.* 2. Given $\left\{\begin{array}{l}\frac{x}{2}-12=\frac{y}{4}+8,\\ \frac{x+y}{5}+\frac{x}{3}-8=\frac{2y-x}{4}+27.\end{array}\right.$

It is required to determine $x$ and $y$.

From the 1st equation, $4x-96=2y+64$;
From the 2d, $12x+12y+20x-480=30y-15x+1620$.
These equations, when abridged, become

$$4x-2y=160,$$
$$47x-18y=2100.$$

To eliminate $y$; from this last equation let 9 times the one preceding it be subtracted.

Thus we find $11x=660$, and $x=60$;
And because $2y=4x-160=80$,
Therefore $y=40$.

*Ex.* 3. Given $\left\{\begin{array}{l}ax+by=c\\ dx+fy=g\end{array}\right\}$ to determine $x$ and $y$.

To eliminate $y$, let the first equation be multiplied by $f$, and the second by $b$, and we have

$$afx+bfy=cf,$$
$$bdx+bfy=bg.$$

Taking now the difference between these equations,

$$afx-bdx=cf-bg,$$
Or $(af-bd)x=cf-bg$,
And therefore $x=\frac{cf-bg}{af-bd}$.

In the same manner may $y$ be determined, by multiplying the first of the given equations by $d$, and the second by $a$; for we find

$$adx+bdy=cd,$$
$$adx+afy=ag.$$

And taking the difference as before, we get

$$bdy-afy=cd-ag,$$

And therefore $$y=\frac{cd-ag}{bd-af}.$$

This last example may be considered as a general solution of the following problem. Two equations expressing the relation between the first powers of two unknown quantities being given, to determine those quantities; for whatever be the number of terms in each equation, it will readily appear, as in example 2, that by proper reduction they may be brought to the same form as those given in the third example.

76. Let us next consider such equations as involve three unknown quantities.

*Ex.* 4. Given $\left.\begin{cases} x+y+z\quad=29 \\ x+2y+3z=62 \\ \frac{x}{2}+\frac{y}{3}+\frac{z}{4}\quad=10 \end{cases}\right\}$ to find $x$, $y$, and $z$.

We shall in this example proceed by the first method for eliminating the unknown quantities.

From the first equation, $x=29-y-z$,
From the second, $x=62-2y-3z$,
From the third, $x=20-\frac{2y}{3}-\frac{z}{2}$.

Let these values of $x$ be put equal to each other; thus we get the two following equations:

$$29-y-z=62-2y-3z,$$
$$29-y-z=20-\frac{2y}{3}-\frac{z}{2}.$$

Again, from these equations, by transposition, &c.

$$y=33-2z,$$
$$y=27-\frac{3z}{2}.$$

Therefore $$33-2z=27-\frac{3z}{2}.$$

And hence, by reduction, $z=12$;
Whence also, $y=33-2z=9$,
And $x=29-y-z=8$.

*Ex.* 5. Given $\left.\begin{cases} \frac{x}{2}+\frac{y}{3}+\frac{z}{4}=62 \\ \frac{x}{3}+\frac{y}{4}+\frac{z}{5}=47 \\ \frac{x}{4}+\frac{y}{5}+\frac{z}{6}=38 \end{cases}\right\}$ to find $x$, $y$, and $z$.

Here the given equations, when cleared from fractions, become

$$12x+8y+6z=1488,$$
$$20x+15y+12z=2820,$$
$$30x+24y+20z=4560.$$

To eliminate $z$ by the third method, let the first equation be multiplied by 10, the second by 5, and the third by 3, the results will be these:

$$120x+80y+60z=14880,$$
$$100x+75y+60z=14100,$$
$$90x+72y+60z=13680.$$

Let the second equation be now subtracted from the first, and the third from the second, and we have

$$20x+5y=780,$$
$$10x+3y=420.$$

Next, to eliminate $y$, let the first of these equations be multiplied by 3, and the second by 5; hence,

$$60x+15y=2340,$$
$$50x+15y=2100.$$

Subtracting now the latter equation from the former,

$$10x=240 \text{ and } x=24,$$

Therefore $$y=\frac{420-10x}{3}=60,$$

And $$z=\frac{1448-12x-8y}{6}=120.$$

77. From the preceding examples, it is manifest in what manner any number of unknown quantities may be determined by an equal number of equations, which contain only the first power of those quantities, in the numerators of the terms. Such are the following:

$$ax+by+cz=n,$$
$$dx+cy+fz=p,$$
$$gx+hy+kz=q;$$

where $a$, $b$, $c$, &c. represent known, and $x$, $y$, $z$, unknown quantities; and in every case the unknown quantities may be directly found, for they will be always expressed by whole numbers or rational fractions, provided that the known quantities, $a$, $b$, $c$, &c. are also rational.

78. We shall now add a few examples, in which the equations that result from the elimination of an unknown quantity rise to some of the higher degrees; and therefore their final solution must be referred to the sections which treat of those degrees.

*Ex.* 6. Let $x-y=2$, and $xy+5x-6y=120$; it is required to eliminate $x$.

From the first equation $x=y+2$; which value being substituted in the other equation according to the second general method (sect. 72) it becomes

$$(y+2)y+5(y+2)-6y=120,$$
that is, $y^2+2y+5y+10-6y=120$;
therefore the equation required is $y^2+y=110$.

*Ex.* 7. There is given $x+y=a$, and $x^2y^2=b$, to eliminate $x$.

From the first equation $x=a-y$, and $x^2=(a-y)^2$,
And from the second $x^2=b-y^2$;
Therefore $(a-y)^2=b-y^2$;
That is, $a^2-2ay+y^2=b-y^2$.

Hence $2y^2-2ay=b-a^2$; an equation involving only $y$.

*Ex.* 8. Given $\left.\begin{cases} axy+bx+cy=d \\ fxy+gx+hy=k \end{cases}\right\}$ to eliminate $y$.

From the first equation $y=\frac{d-bx}{ax+c}$,

And from the second $y=\frac{k-gx}{fx+h}$;

Therefore $$\frac{d-bx}{ax+c}=\frac{k-gx}{fx+h},$$

an equation in which the unknown quantity $y$ is not found.

*Ex.* 9. Given $\left.\begin{cases} y^2-3xy+ay=x^2 \\ y^2+2ax-by=4x^2-b^2 \end{cases}\right\}$ to eliminate $y$.

As the co-efficient of $y^2$ is unity in both equations, if their difference be taken, the highest power of $y$ will vanish; but to give a general solution, let the terms of the equations be all brought to one side and made equal to 0, thus,

$$y^2-(3x-a)\,y-x^2=0,$$
$$y^2-by+2ax-4x^2+b^2=0.$$

In the first equation put $1 = A$, $-(3x - a) = B$, $-x^2 = C$; and in the second, $1 = D$, $-b = E$, $2ax - 4x^2 + b^2 = F$; and the two become

$$Ay^2 + By + C = 0,$$
$$Dy^2 + Ey + F = 0.$$

To eliminate $y^2$, let the first equation be multiplied by D, and the second by A; then

$$ADy^2 + BDy + CD = 0,$$
$$ADy^2 + AEy + AF = 0.$$

Therefore, taking the difference of these equations,

$$(BD - AE)y + CD - AF = 0,$$

And $$y = \frac{AF - CD}{BD - AE}.$$

Again, to find another value of $y$, multiply the first equation by F, and the second by C; then

$$AFy^2 + BFy + CF = 0,$$
$$CDy^2 + CEy + CF = 0.$$

Therefore, subtracting as before,

$$(AF - CD)y^2 + (BF - CE)y = 0,$$

And dividing by $y$, $(AF - CD)y + BF - CE = 0.$

Therefore $y = \dfrac{CE - BF}{AF - CD}.$

Let this value of $y$ be put equal to the former, then

$$\frac{AF - CD}{BD - AE} = \frac{CE - BF}{AF - CD};$$

And therefore $(AF - CD)^2 = (BD - AE)(CE - BF)$.

Now, as $y$ does not enter this equation, if we restore the values of A, B, C, &c. we have the following equation, which involves only $x$ and known quantities. $(b^2 + 2ax - 3x^2)^2 = [a + b - 3x]\,[bx^2 - (a - 3x)(2ax - 4x^2 + b^2)]$. This equation, when properly reduced, will be of the fourth order, and therefore its final resolution belongs not to this place.

## Sect. VIII.—Questions producing Simple Equations.

79. When a problem is proposed to be resolved by the algebraic method of analysis, its true meaning ought in the first place to be perfectly understood, so that, if necessary, it may be freed from all superfluous and ambiguous expressions, and its conditions exhibited in the clearest point of view possible. The several quantities concerned in the problem are next to be denoted by proper symbols, and their relation to one another expressed agreeably to the algebraic notation. Thus we shall obtain a series of equations, which, if the question be properly limited, will enable us to determine all the unknown quantities required by the rules already delivered in the two preceding sections.

80. In reducing the conditions of a problem to equations, the following rule will be of service. Suppose that the quantities to be determined are actually found, and then consider by what operations the truth of the solution may be verified; then let the same operations be performed upon the quantities, whether known or unknown, and thus all the conditions of the problem will be reduced to a series of equations, such as is required. For example, suppose that it is required to find two numbers, such, that their sum is 20, and the quotient arising from the division of their difference by the lesser 3; then if we denote the greater of the two numbers by $x$, and the lesser by $y$, and proceed as if to prove the truth of the solution, we shall have $x + y$ for the sum of the numbers, and $x - y$ for their difference. Now, as the former must be equal to 20, and the latter divided by $y$ equal to 3, the first condition of the problem will be expressed by this equation, $x + y = 20$, and the second by $\dfrac{x - y}{y} = 3$; and from these the values of $x$ and $y$ may easily be found.

81. When the conditions of a problem have been expressed by equations, or translated from the common language into that of algebra, we must consider whether the problem be properly limited; for in some cases the conditions may be such as to admit of innumerable solutions, and in others they may involve an absurdity, and thus render the problem altogether impossible.

Now, by considering the examples of last section, it will appear, that to determine any number of unknown quantities, there must be given as many equations as there are unknown quantities. These, however, must be such as cannot be derived from each other, and they must not involve any contradiction; for in the one case the problem would admit of an unlimited number of answers, and in the other case it would be impossible. For example, if it were required to determine $x$ and $y$ from these two equations, $2x - 3y = 13$, $4x - 6y = 26$; as the latter equation is a consequence of the former (for each term of the one is the half of the corresponding term of the other), it is evident, that innumerable values of $x$ and $y$ might be found to satisfy both equations. Again, if $x$ and $y$ were to be determined from these equations, $x + 2y = 8$, $3x + 6y = 26$, it is easy to see that it is impossible to find such values of $x$ and $y$ as will satisfy both; for, from the first, we find $3x = 24 - 6y$; and from the second, $3x = 26 - 6y$; and therefore $24 - 6y = 26 - 6y$, or $24 = 26$, which is absurd; and so also must have been the conditions from which this conclusion is drawn.

82. But there is yet another case in which a problem may be impossible; and that is, when there are more equations than unknown quantities; for it appears, that in this case, by the rules of last section, we would at last find two equations, each involving the same unknown quantity. Now, unless these happened to agree, the problem would admit of no solution. On the whole therefore it appears, that a problem is limited when the conditions furnish just as many independent equations as there are known quantities to be determined: if there be fewer, the problem is indeterminate; but if there be more, the problem in general admits of no solution whatever.

83. In expressing the conditions of a problem by equations, it will sometimes be convenient to introduce as few symbols of unknown quantities as possible. Therefore, if two quantities be sought and their sum be given, suppose it $= s$; then if the one quantity be represented by $x$, the other may be denoted by $s - x$. If, again, their difference be given $= d$, the quantities may be denoted by $x$, and $d + x$, or by $x$, and $x - d$. If their product be given $= p$, the quantities are $x$, and $\dfrac{p}{x}$; and so on.

84. We shall now apply the preceding observations to some examples, which are so chosen as to admit of being resolved by simple equations.

*Ex.* 1. What is that number, to which if there be added its half, its third, and its fourth parts, the sum will be 50?

Let $x$ denote the number sought; then its half will be $\dfrac{x}{2}$, its third $\dfrac{x}{3}$, and its fourth $\dfrac{x}{4}$;

Therefore $$x + \frac{x}{2} + \frac{x}{3} + \frac{x}{4} = 50.$$

Hence $$24x + 12x + 8x + 6x = 1200,$$

Or $$50x = 1200;$$

Therefore $$x = 24.$$

Thus it appears, that the number sought is 24, which upon trial will be found to answer the conditions of the question.

*Ex.* 2. A post is $\frac{1}{4}$ of its length in the mud, $\frac{1}{3}$ in the water, and 10 feet above the water; what is its whole length?

Let its length be $x$ feet, then the part in the mud is $\frac{x}{4}$, and that in the water $\frac{x}{3}$; therefore, from the nature of the question,

$$\frac{x}{4}+\frac{x}{3}+10=x.$$

From this equation we find $7x+120=12x$, and $x=24$.

*Ex.* 3. Two travellers set out at the same time from London and York, the distance between which places is 150 miles; the one goes 8 miles a day, and the other 7: in what time will they meet?

Suppose that they meet after $x$ days.

Then the one traveller has gone $8x$ miles, and the other $7x$ miles; now the sum of the distances they travel is, by the question, equal to the distance from London to York.

Therefore $8x+7x=150$,

That is, $15x=150$, and $x=10$ days.

*Ex.* 4. A labourer engaged to serve for 40 days, upon these conditions; that for every day he worked he was to receive 20d., but for every day he played or was absent, he was to forfeit 8d.: now at the end of the time he had to receive L.1. 11s. 8d. It is required to find how many days he worked, and how many days he was idle.

Let $x$ be the number of days he worked;

Then will $40-x$ be the number of days he was idle,

Also $20\times x=20x=$ the sum he earned in pence,

And $8\times(40-x)=320-8x=$ the sum he forfeited.

Now the difference of these two was L.1. 11s. 8d. or 380d.;

Therefore $20x-(320-8x)=380$;

That is, $28x=700$.

Hence $x=25=$ the number of days he worked,

And $40-x=15=$ the number of days he was idle.

*Ex.* 5. A market-woman bought a certain number of eggs at 2 a penny, and as many at 3 a penny, and sold them all out again at 5 for 2d.; but, instead of getting her own money for them, as she expected, she lost 4d.: what number of eggs did she buy?

Let $x$ be the number of eggs of each sort;

Then will $\frac{x}{2}$ be the price of the first sort,

And $\frac{x}{3}=$ the price of the second sort.

Now, the whole number being $2x$, we have

$5:2x::2:\frac{4x}{5}=$ price of both sorts at 5 for 2d.;

Therefore $\frac{x}{2}+\frac{x}{3}-\frac{4x}{5}=4$, by the question.

Hence $15x+10x-24x=120$,

And $x=120$, the number of each sort.

*Ex.* 6. A bill of L.120 was paid in guineas and moidores: the number of pieces of both sorts used was 100; how many were there of each?

Let the number of guineas be $x$;

Then the number of moidores will be $100-x$;

Also the value of the guineas, reckoned in shillings, will be $21x$, and that of the moidores $27(100-x)=2700-27x$;

Therefore, by the question, $21x+2700-27x=2400$.

Hence $6x=300$, and $x=50$;

So that the number of pieces of each sort was 50.

*Ex.* 7. A footman agreed to serve his master for L.8 a year and livery, but was turned away at the end of 7 months, and received only L.2. 13s. 4d. and his livery; what was its value?



Suppose $x$ the value of the livery, in pence.

Then his wages for a year were to be $x+1920$ pence.

But for 7 months he received $x+640$ pence.

Now he was paid in proportion to the time he served;

Therefore $12:7::x+1920:x+640$.

And, taking the product of the extremes and means,

$$12x+7680=7x+13440.$$

Hence $5x=5760$d. and $x=1152$d.$=$L.4. 16s.

*Ex.* 8. A person at play lost $\frac{1}{4}$ of his money, and then won 3s.; after which he lost $\frac{1}{3}$ of what he then had, and then won 2s.; lastly, he lost $\frac{1}{7}$ of what he then had; and, this done, found he had only 12s. left: what had he at first?

Suppose he began to play with $x$ shillings.

He lost $\frac{1}{4}$ of his money, or $\frac{x}{4}$, and had left $x-\frac{x}{4}=\frac{3x}{4}$.

He won 3s. and had then $\frac{3x}{4}+3=\frac{3x+12}{4}$.

He lost $\frac{1}{3}$ of $\frac{3x+12}{4}$, or $\frac{x+4}{4}$, and had left

$\frac{3x+12}{4}-\frac{x+4}{4}=\frac{2x+8}{4}$.

He won 2s. and had then $\frac{2x+8}{4}+2=\frac{2x+16}{4}$.

He lost $\frac{1}{7}$ of $\frac{2x+16}{4}$ or $\frac{2x+16}{28}$, and had left

$\frac{2x+16}{4}-\frac{2x+16}{28}=\frac{12x+96}{28}$.

And because he had now 12s. left, we have this equation,

$$\frac{12x+96}{28}=12.$$

Hence $12x=240$, and $x=20$.

*Ex.* 9. Two tradesmen, A and B, are employed upon a piece of work; A can perform it alone in 15 hours, and B in 10 hours: in what time will they do it when working together?

Suppose that they can do it in $x$ hours, and let the whole work be denoted by 1.

Then $15:x::1:\frac{x}{15}=$ the part of the work done by A.

And $10:x::1:\frac{x}{10}$, the part done by B.

Now, by the question, they are to perform the whole work between them;

Therefore $\frac{x}{15}+\frac{x}{10}=1$.

Hence $25x=150$, and $x=6$ hours.

*Ex.* 10. The sum of any two quantities being given $=s$, and their difference$=d$, it is required to find each of the quantities.

Let $x$ denote the greater of the two quantities, and $y$ the lesser.

Then $x+y=s$, and $x-y=d$.

Taking the sum of the equations, we get $2x=s+d$,

And, subtracting the second from the first, $2y=s-d$;

Therefore $x=\frac{s+d}{2}$, and $y=\frac{s-d}{2}$.

*Ex.* 11. A gentleman distributing money among some poor people, found he wanted 10s. to be able to give each 5s.; therefore he gave only 4s. to each, and had 5s. left. Required the number of shillings and poor people.

Let the number of shillings be $x$, and that of the poor people $y$; then, from the nature of the question, we have these two equations,

$$5y=x+10 \qquad 4y=x-5.$$

From the first equation, $x=5y-10$,
And from the second, $x=4y+5$;
Therefore $5y-10=4y+5$;
Hence $y=15$, and $x=4y+5=65$.

*Ex.* 12. A farmer kept a servant for every 40 acres of ground he rented, and on taking a lease of 104 more acres, he engaged 5 additional servants, after which he had a servant for every 36 acres. Required the number of servants and acres.

Suppose that he had at first $x$ servants, and $y$ acres.

From the first condition of the question, $x=\frac{y}{40}$;

And from the second, $x+5=\frac{y+104}{36}$.

By comparing the values of $x$, as found from these equations, we have

$$\frac{y+104}{36}-5=\frac{y}{40}.$$

Hence $40y+4160-7200=36y$, so that $4y=3040$;

Therefore $y=760$, and $x=\frac{y}{40}=19$.

*Ex.* 13. Two persons, A and B, were talking of their ages; says A to B, seven years ago I was just three times as old as you were then, and seven years hence I shall be just twice as old as you will be. What is their present ages?

Let the ages of A and B be $x$ and $y$ respectively. Their ages seven years ago were $x-7$ and $y-7$, and seven years hence they will be $x+7$ and $y+7$.

Therefore by the question

$$x-7=3(y-7) \text{ and } x+7=2(y+7).$$

From the first equation, $x=3y-14$,
And from the second, $x=2y+7$;
Therefore $3y-14=2y+7$; hence $y=21$.
And because $x=2y+7$, therefore $x=49$.

*Ex.* 14. A hare is 50 leaps before a greyhound, and takes 4 leaps to the greyhound's 3, but 2 of the greyhound's leaps are as much as 3 of the hare's. How many leaps must the greyhound take to catch the hare?

In this example there is only one quantity required, it will, however, be convenient to make use of two letters; therefore let $x$ denote the number of leaps of the greyhound, and $y$ those of the hare; then, by considering the proportion between the number of leaps each takes in the same time, we have

$$3:4::x:y, \text{ hence } 3y=4x.$$

Again, by considering the proportion between the number of leaps each must take to run the same distance, we find $x:50+y::2:3$, hence $100+2y=3x$.

From the first equation we find $6y=8x$,
And from the second $6y=9x-300$.
Hence $9x-300=8x$, and $x=300$.

*Ex.* 15. To divide the number 90 into 4 such parts, that if the first be increased by 2, the second diminished by 2, the third multiplied by 2, and the fourth divided by 2, the sum, difference, product, and quotient, shall be all equal to each other.



In this question there are four quantities to be determined; but instead of introducing several letters, having put $x$ to denote the first of them, we may find an expression for each of the remaining ones, as follows:

Because $x+2=$second quantity $-2$,
Therefore $x+4=$the second quantity;
And because $x+2=$third $\times 2$,
Therefore $\frac{x+2}{2}=$the third quantity.

And in like manner $2(x+2)=$ the fourth quantity.
Now, by the question, the sum of all the four $=90$;

Therefore $x+x+4+\frac{x+2}{2}+2(x+2)=90$.

Hence $9x=162$, and $x=18$;
Therefore the numbers required are 18, 22, 10, and 40.

*Ex.* 16. A and B together can perform a piece of work in 12 hours, A and C in 20, and B and C in 15 hours; in what time will each be able to perform it when working separately?

That we may have a general solution, let us suppose A and B can perform the work in $a$ hours, A and C in $b$ hours, and B and C in $c$ hours. Let $x$, $y$, and $z$, denote the times in which A, B, and C, could perform it respectively, if each wrought alone; and let the whole work be represented by 1.

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$$\left.\begin{aligned} \text{Then } x:a::1:\frac{a}{x}&=\text{ the part done by A} \\ y:a::1:\frac{a}{y}&=\text{ the part done by B} \end{aligned}\right\} \text{in } a \text{ hours.}$$

$$\left.\begin{aligned} \text{Also } x:b::1:\frac{b}{x}&=\text{ the part done by A} \\ z:b::1:\frac{b}{z}&=\text{ the part done by C} \end{aligned}\right\} \text{in } b \text{ hours.}$$

$$\left.\begin{aligned} \text{And } y:c::1:\frac{c}{y}&=\text{ the part done by B} \\ z:c::1:\frac{c}{z}&=\text{ the part done by C} \end{aligned}\right\} \text{in } c \text{ hours.}$$

The question gives the three following equations;

$$\frac{a}{x}+\frac{a}{y}=1, \qquad \frac{b}{x}+\frac{b}{z}=1, \qquad \frac{c}{y}+\frac{c}{z}=1.$$

Let the first equation be divided by $a$, the second by $b$, and the third by $c$: thus we have

$$\frac{1}{x}+\frac{1}{y}=\frac{1}{a}, \quad \frac{1}{x}+\frac{1}{z}=\frac{1}{b}, \quad \frac{1}{y}+\frac{1}{z}=\frac{1}{c}.$$

If these be added, and their sum divided by 2, we find

$$\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=\frac{1}{2a}+\frac{1}{2b}+\frac{1}{2c}.$$

From this equation let each of the three preceding be subtracted in its turn: thus we get

$$\frac{1}{z}=-\frac{1}{2a}+\frac{1}{2b}+\frac{1}{2c}=\frac{+ab+ac-bc}{2abc},$$

$$\frac{1}{y}=\frac{1}{2a}-\frac{1}{2b}+\frac{1}{2c}=\frac{ab-ac+bc}{2abc},$$

$$\frac{1}{x}=\frac{1}{2a}+\frac{1}{2b}-\frac{1}{2c}=\frac{-ab+ac+bc}{2abc}.$$

Algebra.

$$\text{Hence } z=\frac{2abc}{+ab+ac-bc}=\frac{7200}{120}=60,$$

$$y=\frac{2abc}{+ab-ac+bc}=\frac{7200}{360}=20,$$

$$x=\frac{2abc}{-ab+ac+bc}=\frac{7200}{240}=30.$$

### Sect. IX.—Of Quadratic Equations.

85. We are next to explain the resolution of equations of the second degree, or quadratic equations. These involve the second power of the unknown quantity, and may be divided into two kinds, *pure* and *adfected.*

I. *Pure* quadratic equations are such as after proper reduction have the square of the unknown quantity in one term, while the remaining terms contain only known quantities. Thus, $x^2=64$, and $ax^2+b=c$, are examples of pure quadratics.

II. *Adfected* quadratic equations contain the square of the unknown quantity in one term, and its first or simple power in another; the remaining terms consisting entirely of known quantities. Such are the following, $x^2+3x=28$, $2x^2=33-5x$, $ax^2+bx-c=d$.

The manner of resolving a pure quadratic equation is sufficiently evident. If the unknown quantity be made to stand alone on one side, with unity as a co-efficient, while the other side consists entirely of known quantities, and the square root of each side be taken, we immediately obtain the value of the simple power of the unknown quantity as directed by rule 5th of sect. VI.

86. In extracting the square root of any quantity, it is necessary to observe, that the sign of the root may be either $+$ or $-$. This is an evident consequence of the rule for the signs in multiplication; for since by that rule any quantity, whether positive or negative, if multiplied by itself, will produce a positive quantity, and therefore the square of $+a$, as well as that of $-a$, is $+a^2$; so, on the contrary, the square root of $+a^2$ is to be considered either as $+a$ or as $-a$, and may accordingly be expressed thus, $\pm a$.

87. Having remarked that the square of any quantity, whatever be its sign, is always positive, it evidently follows that no real quantity whatever, when multiplied by itself, can produce a negative quantity; therefore, if the square root of a negative quantity be required, no such root can be assigned. Hence it also follows, that if a problem requires for its solution the extraction of the square root of a negative quantity, some contradiction must necessarily be involved, either in the condition of the problem, or in the process of reasoning by which that solution has been obtained.

88. When an adfected quadratic equation is to be resolved, it may always, by proper reduction, be brought to one or other of the three following forms:

1. $x^2+px=q$.
2. $x^2-px=q$.
3. $x^2-px=-q$.

But as the manner of resolving each of the three forms is the very same, it will be sufficient if we consider any one of them.

Resuming therefore the first equation, or $x^2+px=q$, let us compare the side of it which involves the unknown quantity $x$ with the square of a binomial $x+a$; that is, let us compare $x^2+px$ with $x^2+2ax+a^2=(x+a)^2$, and it will presently appear, that if we suppose $p=2a$, or $\frac{p}{2}=a$, the quantities $x^2+px$ and $x^2+2ax$ will be equal; and as $x^2+2ax$ is rendered a complete square, by adding to it $a^2$, so also may $x^2+px$ be completed into a square by adding to it $\frac{p^2}{4}$, which is equal to $a^2$; therefore, let $\frac{p^2}{4}$ be added to both sides of the equation $x^2+px=q$, and we have

Algebra.

$$x^2+px+\frac{p^2}{4}=\frac{p^2}{4}+q, \text{ or } \left(x+\frac{p}{2}\right)^2=\frac{p^2}{4}+q;$$

and, extracting the square root of each side, $x+\frac{p}{2}=\pm\sqrt{\frac{p^2}{4}+q}$; hence $x=-\frac{p}{2}\pm\sqrt{\frac{p^2}{4}+q}$.

89. From these observations we derive the following general rules for resolving adfective quadratic equations.

1. Bring all the terms involving the unknown quantity to one side, and the known quantities to the other side, and so that the term involving the square of the unknown quantity may be positive.

2. If the square of the unknown quantity be multiplied by a co-efficient, let the other terms be divided by it, so that the co-efficient of the square of the unknown quantity may be 1.

3. Add to both sides the square of half the co-efficient of the unknown quantity itself, and the side of the equation involving the unknown quantity will now be a complete square.

4. Extract the square root of both sides of the equation, by which it becomes simple with respect to the unknown quantity; and by transposition, that quantity may be made to stand alone on one side of the equation, while the other side consists of known quantities; and therefore the equation is resolved.

*Note.* The square root of the first side of the equation is always equal to the sum or difference of the unknown quantity, and half the co-efficient of the second term. If the sign of that term be $+$, it is equal to the sum, but if it be $-$, then it is equal to the difference.

*Ex.* 1. Given $x^2+2x=35$, to determine $x$.

Here the co-efficient of the second term is 2; therefore, adding the square of its half to each side, we have

$$x^2+2x+1=35+1=36,$$

And, extracting the square root, $x+1=\sqrt{36}=\pm 6$.

Hence $x=\pm 6-1$, that is $x=+5$, or $x-7$, and either of these numbers will be found to satisfy the equation, for $5\times 5+2\times 5=35$, also $-7\times-7+2\times-7=35$.

*Ex.* 2. Given $\frac{x^2}{6}-12=x$, to find $x$.

This equation, when reduced, becomes $x^2-6x=72$,
And, by completing the square, $x^2-6x+9=72+9=81$.
Hence, by extracting the square root, $x-3=\pm 9$, and $x=\pm 9+3$;
Therefore $x=+12$, or $x=-6$; and upon trial we find that each of these values satisfies the original equation, for $\frac{12\times 12}{6}-12=12$, also $\frac{-6\times-6}{6}-12=-6$.

*Ex.* 3. Given $x^2+28=11x$, to find $x$,
Then $x^2-11x=-28$.

And, by completing the square, $x^2-11x+\frac{121}{4}=\frac{121}{4}-28=\frac{9}{4}$.

Therefore, by extracting the root, $x-\frac{11}{2}=\pm\frac{3}{2}$.

Hence $x=\frac{11}{2}\pm\frac{3}{2}$; that is, $x=+7$, or $x=+4$.

In the first two examples, we found one positive value for $x$ in each, and also one negative value; but in this example both the values of $x$ are positive, and, upon trial, each of them is found to satisfy the equation; for $7\times7+28=11\times7$, also $4\times4+28=11\times4$.

90. As at first sight it appears remarkable, that in every quadratic equation the unknown quantity admits always of two distinct values or roots, it will be proper to consider a little further the circumstances upon which this peculiarity depends. This is the more necessary, as the property of the unknown quantity admitting of several values is not peculiar to quadratics, but takes place also in equations of the higher degrees, where the cause of the ambiguity requires an explanation somewhat different from that which we have already given in the present case.

91. Let us again consider the equation $x^2+2x=35$, which forms the first of the three preceding examples. By bringing all the terms to one side, the same equation may be also expressed thus, $x^2+2x-35=0$; so that we shall have determined $x$, when we have found such a number as, when substituted for it in the quantity $x^2+2x-35$, will render the result equal to 0. But $x^2+2x-35$ is the product of these two factors $x-5$ and $x+7$, as may be proved by actual multiplication; therefore, to find $x$, we have $(x-5)(x+7)=0$; and as a product can only become $=0$ when one of its factors is reduced to 0, it follows that either of the two factors $x-5$ and $x+7$ may be assumed $=0$. If $x-5=0$, then $x=5$; but if $x+7=0$, then $x=-7$; so that the two values of $x$, or two roots of the equation $x^2+2x=35$, are $+5$ and $-7$, as we have already found in a different manner.

92. What has been shown in a particular case is true of any quadratic equation whatever; that is, if $x^2+px=q$, or, by bringing all the terms to one side, $x^2+px-q=0$, it is always possible to find two factors $x-a$, and $x+b$, such, that

$$x^2+px+q=(x-a)(x+b),$$

where $a$ and $b$ are known quantities, which depend only upon $p$ and $q$, the given numbers in the equation; and since that to have $(x-a)(x+b)=0$, we may either assume $x-a=0$ or $x+b=0$, it evidently follows that the conditions of the equation $x^2+px-q=0$, or $x^2+px=q$, are alike satisfied by taking $x=+a$ or $x=-b$.

From these considerations it follows, that $x$ can have only two values in a quadratic equation; for if it could be supposed to have three or more values, then it would be possible to resolve $x^2+px-q$ into as many factors, $x-c$, $x-d$, &c.; but the product of more than two factors must necessarily contain the third or higher powers of $x$, and as $x^2+px-q$ contains no higher power than the second, therefore no such resolution can take place.

93. Since it appears that $x^2+px-q$ may be considered as the product of the two factors $x-a$ and $x+b$, let us examine the nature of these factors. Accordingly, taking their product, we find it $x^2+(b-a)x-ab$; and since this quantity must be equal to $x^2+px-q$, it follows that $b-a=p$ and $ab=q$, or, changing the signs of the terms of both equations, $a-b=-p$, $-ab=-q$. Now, if we consider that $+a$ and $-b$ are the roots of the equation $x^2+px=q$, it is evident that $a-b$ is the sum of the roots, and $-ab$ their product. So that from the equations $a-b=-p$, and $-ab=q$, we derive the following proposition relating to the roots of any quadratic equation. The sum of the roots of any quadratic equation $x^2+px=q$ is equal to $-p$, that is, to the co-efficient of the second term, having its sign changed; and their product is equal to $-q$, or to the latter side of the equation, having its sign also changed.



This proposition enables us to resolve several important questions concerning the roots of a quadratic equation, without actually resolving that equation. Thus we learn from it, that if $q$, the term which does not involve the unknown quantity (called sometimes the absolute number), be positive, the equation has one of its roots positive and the other negative; but if that term be negative, the roots are either both positive or both negative. It also follows, that in the former case the root which is denoted by the least number will have the same sign with the second term; and in the latter case, the common sign of the roots will be the contrary to that of the second term.

94. From this property of the roots we may also derive a general solution to any quadratic equation $x^2+px=q$; for we have only to determine two quantities whose sum is $-p$ and product $-q$, and these shall be the two values of $x$, or the two roots of the equation.

Without considering the signs of the roots, let us call them $v$ and $z$; then

$$v+z=-p, \text{ and } vz=-q.$$

From the square of each side of the first equation let four times the second be subtracted, and we have

$$v^2-2vz+z^2=p^2+4q, \text{ or } (v-z)^2=p^2+4q;$$

therefore, $v-z=\pm\sqrt{p^2+4q}$.

From this equation, and from the equation

$v+z=-p$, we readily obtain $v=\frac{-p\pm\sqrt{p^2+4q}}{2}$

$z=\frac{-p\mp\sqrt{p^2+4q}}{2}$; that is, if $v=\frac{-p+\sqrt{p^2+4q}}{2}$,

then $z=\frac{-p-\sqrt{p^2+4q}}{2}$; and if $v=\frac{-p-\sqrt{p^2+4q}}{2}$,

then $z=\frac{-p+\sqrt{p^2+4q}}{2}$.

But the value of $v$ upon the one supposition is the same as the value of $z$ upon the other supposition, and *vice versa;* therefore, in reality, the only two distinct values of the roots $v$ and $z$ are $\frac{-p+\sqrt{p^2+4q}}{2}$ and $\frac{-p-\sqrt{p^2+4q}}{2}$, which agrees with the conclusion we have already found (sect. 89).

95. It appears, from what has been already shown, that the roots of a quadratic equation $x^2+px=q$ always involve the quantity $\sqrt{p^2+4q}$; hence it follows, that $p^2+4q$ must be a positive quantity; for if it were negative, as the square root of such a quantity could not be found, the value of $x$ could not possibly be obtained. If, for example, the value of $x$ were required from this equation, $x^2+13=4x$, or $x^2-4x=-13$, we should find $x=2\pm\sqrt{-9}$; and as this expression for the roots requires us to extract the square root of $-9$, the equation from which it is derived must necessarily have involved some contradiction. It is not difficult to see wherein the absurdity consists; for since in this case $p=-4$, and $q=-13$, the roots of the equation ought to be both positive (sect. 93), and such that

their sum $= 4$, while their product $= 13$ (sect. 93), which is impossible.

96. Although imaginary quantities serve no other purpose in the resolution of quadratic equations than to show that a particular problem cannot be resolved, by reason of some want of consistency in its data, yet they are not upon that account to be rejected. By introducing them into mathematical investigations, many curious theories may be explained, and problems resolved, in a more concise way than can be done without the use of such quantities. This is particularly the case in the higher parts of the mathematics.

The method which has been applied to the resolution of quadratic equations properly so called, namely, such as are of this form, $x^2+px = q$, will also apply to all equations of this form,

$$x^{2n}+px^n = q,$$

where the unknown quantity $x$ is found only in two terms, and such that its exponent in the one term is double that in the other; for let us assume $x^n = y$, then $x^{2n} = y^2$, and therefore the equation

$$x^{2n}+px^n = q \text{ becomes}$$
$$y^2+py = q,$$

a quadratic equation, from which $x$ may be found, and thence $x$, by considering that $x = \sqrt[n]{y}$.

97. Although every quadratic equation admits of two roots, yet it will frequently happen that only one of them can be of use, the other being excluded by the conditions of the question. This will often be the case with respect to the negative root; as, for example, when the unknown quantity denotes a number of men, a number of days, &c. And hence, in reckoning the cases of quadratic equations, it is common to neglect this one, $x^2+px=-q$, where the roots are both negative; for an equation of this form can only be derived from a question which has some fault in its enunciation, and which, by a proper change in its form, will produce another equation having both its roots positive.

98. The remainder of this section shall be employed in solving some questions which produce quadratic equations.

*Ex.* 1. It is required to divide the number 10 into two such parts that the sum of their squares may be 58.

Let $x$ be the one number;

Then, since their sum is 10, we have $10-x$ for the other;

And by the question $x^2+(10-x)^2=58$;

That is, $x^2+100-20x+x^2=58$,

Or $2x^2-20x = 58-100= -42$;

Hence $x^2-10x = -21$.

And completing the square, $x^2-10x+25=25-21=4$;

Hence, by extracting the root, $x-5=\pm\sqrt{4}=\pm 2$

And $x=5\pm 2$,

That is, $x=7$, or $x=3$.

If we take the greatest value of $x$, viz. 7, the other number $10-x$ will be 3; and if we take the least value of $x$, viz. 3, then the other number is 7. Thus it appears, that the greatest value of the one number corresponds to the least of the other; and indeed this must necessarily be the case, seeing that both are alike concerned in the question. Hence, upon the whole, the only numbers that will answer the conditions of the question are 7 and 3.

*Ex.* 2. What two numbers are those whose product is 28; and such, that twice the greater, together with thrice the lesser, is equal to 26?

Let $x$ be the greatest and $y$ the least number; then, from the nature of the question, we have these two equations,

$$xy=28,\ 2x+3y=26.$$

From the first equation we have $y=\dfrac{28}{x}$,

And from the second $y=\dfrac{26-2x}{3}$.

Hence $\dfrac{26-2x}{3}=\dfrac{28}{x}$;

And, reducing, $26x-2x^2=84$,

Or $2x^2-26x=-84$,

Hence $x^2-13x=-42$.

And comp. the sq. $x^2-13x+\frac{169}{4}=\frac{169}{4}-42=\frac{1}{4}$.

Hence, by extracting the root, $x-\frac{13}{2}=\pm\sqrt{\frac{1}{4}}=\pm\frac{1}{2}$,

Therefore $x=\frac{13}{2}\pm\frac{1}{2}$;

That is, $x=7$, or $x=6$.

And since $y=\dfrac{28}{x}$, we have $y=4$, or $y=\frac{14}{3}$.

Thus we have obtained two sets of numbers, which fulfil the conditions required, viz.

$$x=7,\ y=4: \text{ Or } x=6,\ y=\tfrac{14}{3}.$$

And besides these, there can be no other numbers.

*Ex.* 3. A company dining together at an inn, find their bill amount to 175 shillings; two of them were not allowed to pay, and the rest found that their shares amounted to 10 shillings a man more than if they had all paid. How many were in company?

Suppose their number to be $x$.

Then, if all had paid, the share of each would have been $\dfrac{175}{x}$.

But because only $x-2$ paid, the share of each was $\dfrac{175}{x-2}$.

Therefore, by the question, $\dfrac{175}{x-2}-\dfrac{175}{x}=10$.

And, by reduction, $175x-175x+350=10x^2-20x$;

That is, $10x^2-20x=350$,

Or $x^2-2x=35$.

And comp. the sq. $x^2-2x+1=35+1=36$;

Hence, by extracting the root, $x^2+1=\pm 6$.

Therefore $x=+5$, or $x=-7$. But from the nature of the question, the negative root can be of no use; therefore $x=6$.

*Ex.* 4. A mercer sold a piece of cloth for L.24, and gained as much per cent. as the cloth cost him. What was the price of the cloth?

Suppose that it cost $x$ pounds;

Then the gain was $24-x$,

And, by the question, $100 : x :: x : 24-x$.

Therefore, taking the product of the extremes and means,

$$2400-100x=x^2,$$

Or $x^2+100x=2400$;

And comp. the sq. $x^2+100x+2500=4900$;

Hence, taking the root, $x+50=\pm 70$,

And $x=+20$ or $-120$.

Here, as in the last question, the negative root cannot apply; therefore $x=20$ pounds, the price required.

*Ex.* 5. A grazier bought as many sheep as cost him L.60, out of which he reserved 15, and sold the remainder for L.54, and gained 2s. each upon them. How many sheep did he buy, and what did each cost him?

Suppose that he bought $x$ sheep;

Then each would cost him $\frac{1200}{x}$ shillings.

Therefore, after reserving 15, he sold each of the remaining $x-15$ for $\frac{1200}{x}+2$ shillings.

Hence, he would receive for them $(x-15)(\frac{1200}{x}+2)$ shillings. And, because L.54=1080 shillings, we have by the question

$$(x-15)(\frac{1200}{x}+2)=1080;$$

Which, by proper reduction, becomes $x^2+45x=9000$;

And, completing the square, $x^2+45x+\frac{2025}{4}=\frac{38025}{4}$.

Therefore, extracting the root, &c. $x=\pm\frac{195}{2}-\frac{45}{2}$.

And, taking the positive root, $x=75$, the number of sheep; and consequently $\frac{1200}{75}=16$ shillings, the price of each.

*Ex.* 6. What number is that which, when divided by the product of its two digits, the quotient is 3; and if 18 be added to it, the digits are inverted?

Let $x$ and $y$ denote the digits; then the number itself will be expressed by $10x+y$, and that number in which the digits are inverted, by $10y+x$. Thus the conditions of the problem will be expressed by these two equations,

$$\frac{10x+y}{xy}=3,\ 10x+y+18=10y+x.$$

From the first equation we have $y=\frac{10x}{3x-1}$,

And from the second, $y=x+2$;

Therefore $x+2=\frac{10x}{3x-1}$,

And $3x^2+5x-2=10x$.

Hence, $x^2-\frac{5}{3}x=\frac{2}{3}$,

And comp. sq. $x^2-\frac{5}{3}x+\frac{25}{36}=\frac{25}{36}+\frac{2}{3}=\frac{49}{36}$;

Therefore, taking the root, $x-\frac{5}{6}=\pm\frac{7}{6}$,

So that $x=2$, or $x=-\frac{1}{3}$.

Here it is evident that the negative root is useless; hence, $y=x+2=4$, and 24 is the number required.

*Ex.* 7. Find two numbers whose product is 100, and the difference of their square roots 3.

Let $x$ be the one number; then $\frac{100}{x}$ is the other.

Now by the question, $\frac{10}{\sqrt{x}}-\sqrt{x}=3$;

Hence we have $10-x=3\sqrt{x}=3x^{\frac{1}{2}}$,

Or $x+3x^{\frac{1}{2}}=10$;

And comp. the sq. $x+3x^{\frac{1}{2}}+\frac{9}{4}=10+\frac{9}{4}=\frac{49}{4}$,

and taking the root, $x^{\frac{1}{2}}+\frac{3}{2}=\pm\frac{7}{2}$;

So that $x^{\frac{1}{2}}=+5$, or $x^{\frac{1}{2}}=-2$,

and therefore $x=25$, or $x=4$.

If $x=4$, the other number is $\frac{100}{4}=25$, and if $x=25$, then the other number is 4; so that, in either case, the two numbers which answer the conditions of the question are 4 and 25.

*Ex.* 8. It is required to find two numbers, of which the product shall be 6, and the sum of their cubes 35.

Let $x$ be the one number; then $\frac{6}{x}$ will be the other.

Therefore, by the question, $x^3+\frac{216}{x^3}=35$;

Hence $x^6+216=35x^3$,

Or $x^6-35x^3=-216$.

This equation, by putting $x^3=y$, becomes

$$y^2-35y=-216;$$

Hence we find $y=27$, or $y=8$.

And since $x^3=y$, therefore $x=3$, or $x=2$

If $x=3$, then the other number is 2, and if $x=2$, the other number is 3; so that 2 and 3 are the numbers required.

In general, if it be required to find two numbers which are exactly alike concerned in a question that produces a quadratic equation, they will be the roots of that equation. A similar observation applies to any number of quantities which require for their determination the resolution of an equation of any degree whatever.

### Sect. X.—Of Equations in general

99. Before we proceed to the resolution of cubic and the higher orders of equations, it will be proper to explain some general properties which belong to equations of every degree, and also certain operations which must frequently be performed upon equations before they be fitted for a final solution.

In treating of equations in general, we shall suppose all the terms brought to one side, and put equal to 0; so that an equation of the fourth degree will stand thus:

$$x^4+px^3+qx^2+rx+s=0,$$

where $x$ denotes an unknown quantity, and $p$, $q$, $r$, $s$, known quantities, either positive or negative. Here the co-efficient of the highest power of $x$ is unity, but had it been any other quantity, that quantity might have been taken away, and the equation reduced to the above form, by rules already explained (Sect. VI).

The terms being thus arranged, if such a quantity be found as, when substituted for $x$, will render both sides $=0$, and therefore satisfy the equation, that quantity, whether it be positive or negative, or even imaginary, is to be considered as a root of the equation. But we have seen that every quadratic equation has always two roots, real or imaginary; we may therefore suppose that a similar diversity will take place in all equations of a higher degree; and this supposition appears to be well founded, by the following proposition, which is of great importance in the theory of equations.

If a root of any equation, as $x^4+px^3+qx+r=0$, be represented by $a$, the first side of that equation is divisible by $x-a$;

For since $x^4+px^3+qx^2+rx+s=0$,

And also $a^4+pa^3+qa^2+ra+s=0$;

Therefore, by subtraction,

$$x^4-a^4+p(x^3-a^3)+q(x^2-a^2)+r(x-a)=0.$$

But any quantity of this form $x^n-a^n$, where $n$ denotes a whole positive number, is equal to

$$(x-a)(x^{n-1}+ax^{n-2}+a^2x^{n-3}+\ldots+a^{n-2}x+a^{n-1}),$$

as may be proved by multiplication; therefore, putting $x=4$, 3, and 2 successively, we have

$$x^4-a^4=(x-a)(x^3+ax^2+a^2x+a^3),$$
$$x^3-a^3=(x-a)(x^2+ax+a^2),$$
$$x^2-a^2=(x-a)(x+a),$$
$$x-a=(x-a);$$

and by substitution, and collecting into one term the co-efficients of the like powers of $x$, the equation becomes

$(x-a)[x^3+(a+p)x^2+(a^2+pa+q)x+a^3+pa^2+qa+r]=0$; so that, putting $p'=a+p$, $q'=a^2+pa+q$, $r'=a^3+pa^2+qa+r$, we have

$$x^4+px^3+qx^2+rx+s=(x-a)(x^3+p'x^2+q'x+r').$$

Hence, if the proposed equation $x^4+px^3+qx^2+rx+s$ be divided by $x-a$, the quotient will be $x^3+p'x^2+q'x+r'$, an integer quantity; and since the same mode of reasoning will apply to any equation whatever, the truth of the proposition is evident.

We have found that $(x-a)(x^3+p'x^2+q'x+r')=0$; and as a product becomes $=0$, when any one of its factors $=0$, therefore the equation will have its conditions fulfilled, not only when $x-a=0$, but also when $x^3+p'x^2+q'x+r'=0$.

Let us now suppose that $b$ is a root of this equation; then, by reasoning exactly as in last article, and putting $p''=b+p'$, $q''=b^2+p'b+q'$, we shall have

$$x^3+p'x^2+q'x+r'=(x-b)(x^2+p''x+q'')=0.$$

By proceeding in the same manner with the quadratic equation $x^2+p''x+q''=0$, we shall find that if $c$ denote one of its roots, then

$$x^2+p''x+q''=(x-c)(x+c+p'').$$

So that if we put $d=-(c+p'')$, we at last find $x^4+px^3+qx^2+rx+s=(x-a)(x-b)(x-c)(x-d)$; and since each of the factors $x-a$, $x-b$, $x-c$, $x-d$ may be assumed $=0$, it follows that there are four different values of $x$, which will render the equation $x^4+px^3+qx^2+rx+s=0$, namely, $x=a$, $x=b$, $x=c$, $x=d$.

The mode of reasoning which has been just now employed in a particular case, may be applied to an equation of any order whatever; we may therefore conclude, that every equation may be considered as the product of as many simple factors as the number denoting its order contains unity, and therefore, that the number of roots in any equation is precisely equal to the exponent of the highest power of the unknown quantity contained in that equation.

100. By considering equations of all degrees as formed from the products of factors $x-a$, $x-b$, $x-c$, &c. we discover curious relations, which subsist between the roots of any equation and its co-efficients. Thus, if we limit the number of factors to four, and suppose that $a, b, c, d$, are the roots of this equation of the fourth degree,

$$x^4+px^3+qx^2+rx+s=0,$$

we shall also have $(x-a)(x-b)(x-c)(x-d)=0$; and therefore, by actual multiplication,

$$x^4 \left.\begin{array}{r} -a \\ -b \\ -c \\ -d \end{array}\right\} x^3 \left.\begin{array}{r} +ab \\ +ac \\ +ad \\ +bc \\ +bd \\ +cd \end{array}\right] x^2 \left.\begin{array}{r} -abc \\ -abd \\ -acd \\ -bcd \end{array}\right\} x+abcd=0.$$

If we compare together the co-efficients of the same powers of $x$, we find the following series of equations:

$$\begin{aligned} a+b+c+d &= -p, \\ ab+ac+ad+bc+bd+cd &= +q, \\ abc+abd+acd+bcd &= -r, \\ abcd &= +s; \end{aligned}$$

and as similar results will be obtained for equations of all degrees, we hence derive the following propositions, which are of great importance in the theory of equations.

1. The co-efficient of the second term of any equation, taken with a contrary sign, is equal to the sum of all the roots.

2. The co-efficient of the third term is equal to the sum of the products of the roots multiplied together two and two.

3. The co-efficient of the fourth term, taken with a contrary sign, is equal to the sum of the roots multiplied together three and three; and so on in the remaining co-efficients, till we come to the last term of the equation, which is equal to the product of all the roots having their signs changed.

Instead of supposing an equation to be produced by multiplying together simple equations, we may consider it as formed by the product of equations of any degree, provided that the sum of their dimensions be equal to that of the proposed equation. Thus, an equation of the fourth degree may be formed either from a simple and cubic equation, or from two quadratic equations.

101. If $n$ denote the degree of an equation, we have shown, that by considering it as the product of simple factors, that equation will have $n$ divisors of the first degree; but if we suppose the simple factors to be combined two and two, they will form quantities of the second degree, which are also factors of the equation; and since there may be formed $\frac{n(n-1)}{1\cdot 2}$ such combinations, any equation will admit of $\frac{n(n-1)}{1\cdot 2}$ divisors of the second degree.

For example, the equation $x^4+px^3+qx^2+rx+s=0$, which we have considered as equal to

$$(x-a)(x-b)(x-c)(x-d)=0,$$

may be formed of the product of two factors of the second degree, in these six different ways.

By the product of $(x-a)(x-b)$ and $(x-c)(x-d)$,
$(x-a)(x-c)$ $(x-b)(x-d)$,
$(x-a)(x-d)$ $(x-b)(x-c)$,
$(x-b)(x-c)$ $(x-a)(x-d)$,
$(x-b)(x-d)$ $(x-a)(x-c)$,
$(x-c)(x-d)$ $(x-a)(x-b)$.

Thus an equation of the fourth degree may have $\frac{4\times 3}{1\times 2}=6$ quadratic divisors.

By combining the simple factors three and three, we shall have divisors of the third degree, of which the number for an equation of the $n$th order will be

$$\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}; \text{ and so on.}$$

102. When the roots of an equation are all positive, its simple factors will have this form, $x-a$, $x-b$, $x-c$, &c.; and if, for the sake of brevity, we take only these three, the cubic equation which results from their product will have this form,

$$x^3-px^2+qx-r=0,$$

where $p=a+b+c$, $q=ab+ac+bc$, $r=abc$; and here it appears that the signs of the terms are $+$ and $-$ alternately.

Hence we infer, that when the roots of an equation are all positive, the signs of its terms are positive and negative alternately.

If again the roots of the equation be all negative, and therefore its factors $x+a$, $x+b$, $x+c$, then $p$, $q$, and $r$ being as before, the resulting equation will stand thus:

$$x^3+px^2+qx+r=0.$$

And hence we conclude, that when the roots are all negative, there is no change whatever in the signs.

103. In general, if the roots of an equation be all real, that equation will have as many positive roots as there are changes of the signs from $+$ to $-$, or from $-$ to $+$; and the remaining roots are negative. This rule, however, does not apply when the equation has imaginary

roots, unless such roots be considered as either positive or negative.

That the rule is true when applied to quadratic equations will be evident from Sect. IX. With respect to cubic equations, the rule also applies when the roots are either all positive, or all negative, as we have just now shown.

When a cubic equation has one positive root, and the other two negative, its factors will be $x-a$, $x+b$, $x+c$, and the equation itself

$$x^3\left.\begin{matrix}-a\\+b\\+c\end{matrix}\right\} x^2 \left.\begin{matrix}-ab\\-ac\\+bc\end{matrix}\right\} x - abc = 0.$$

Here there must always be one change of the signs, since the first term is positive and the last negative; and there can be no more than one; for if the second term is negative, or $b+c$ less than $a$, then $(b+c)^2$ will be less than $(b+c)\,a$; but $(b+c)^2$ is always greater than $b\,c$, therefore $b\,c$ will be much less than $(b+c)\,a$, or $ab+ac$, so that the third term must also be negative, and therefore, in this case there can be only one change of the signs. If, again, the second term be positive, then, because the sign of the last term is negative, whatever be the sign of the third term, there can still be no more than one change of the signs.

When the equation has two positive roots, and one negative, its factors are $x-a$, $x-b$, $x+c$, and the equation

$$x^3\left.\begin{matrix}-a\\-b\\+c\end{matrix}\right\} x^2 \left.\begin{matrix}+ab\\-ac\\-bc\end{matrix}\right\} x + abc = 0.$$

Here there must always be two changes of the signs; for if $a+b$ be greater than $c$, the second term is negative, and the last term being always positive, there must be two changes, whether the sign of the third term be positive or negative. If, again, $a+b$ be less than $c$, and therefore the second term positive, it may be shown as before, that $ab$ is much less than $ac+bc$; and hence the third term will be negative; so that in either case there must be two changes of the signs. We may conclude, therefore, upon the whole, that in cubic equations there are always as many positive roots as changes of the signs from + to —, or from — to +; and, by the same method of reasoning, the rule will be found to extend to all equations whatever.

104. It appears, from the manner in which the co-efficients of an equation are formed from its roots, that when the roots are all real, the co-efficients must consist entirely of real quantities. But it does not follow, on the contrary, that when the co-efficients are real, the roots are also real; for we have already found, that in a quadratic equation, $x^2+px+q=0$, where $p$ and $q$ denote real quantities, the roots are sometimes both imaginary.

When the roots of a quadratic equation are imaginary, they have always this form, $a+\sqrt{-b^2}$, $a-\sqrt{-b^2}$, which quantities may also be expressed thus, $a+b\sqrt{-1}$, $a-b\sqrt{-1}$; so that we have these two factors $x-a-b\sqrt{-1}$, $x-a+b\sqrt{-1}$, and taking their product,

$$x^2-2ax+a+b^2=0.$$

Thus we see that two imaginary factors may be of such a form as to admit of their product being expressed by a real quantity; and hence the origin of imaginary roots in quadratic equations.

105. It appears by induction, that no real equation can be formed from imaginary factors, unless those factors be taken in pairs, and each pair have the form $x\pm a-b\sqrt{-1}$, $x\pm a+b\sqrt{-1}$; for the product of three, or any odd number of imaginary factors, whatever be their form, is still an imaginary quantity. Thus, if we take the product of any three of these four imaginary expressions, $x+a+b\sqrt{-1}$, $x+a-b\sqrt{-1}$, $x+c+d\sqrt{-1}$, $x+c-d\sqrt{-1}$, we may form four different equations, each of which will involve imaginary quantities. If, however, each equation be multiplied by the remaining factor, which had not previously entered into its composition, the product will be found to be rational, and the same for all the four.

Hence we may deduce the three following inferences respecting the roots of equations:

1. If an equation have imaginary roots, it must have two, or four, or some even number of such roots.

2. If the degree of an equation be denoted by an odd number, that equation must have at least one real root.

3. If the degree of an equation be denoted by an even number, and that equation have one real root, it will also have another real root.

106. We shall now explain some transformations which are frequently necessary to prepare the higher orders of equations for a solution.

Any equation may have its positive roots changed into negative roots of the same value, and its negative roots into such as are positive, by changing the signs of the terms alternately, beginning with the second. The truth of this remark will be evident, if we take two equations,

$$(x-a)(x-b)(x+c)=0,$$
$$(x+a)(x+b)(x-c)=0,$$

(which are such, that the positive roots of the one have the same values as the negative roots of the other), and multiply together their respective factors; for these equations will stand thus:

$$x^3\left.\begin{matrix}-a\\-b\\+c\end{matrix}\right\} x^2 \left.\begin{matrix}+ab\\-ac\\-bc\end{matrix}\right\} x + abc = 0,$$

$$x^3\left.\begin{matrix}+a\\+b\\-c\end{matrix}\right\} x^2 \left.\begin{matrix}+ab\\-ac\\-bc\end{matrix}\right\} x - abc = 0;$$

where it appears that the signs of the first and third terms are the same in each, but the signs of the second and fourth are just the opposite of each other. And this will be found to hold true, not only of cubic equations, but of all equations, to whatever order they belong.

107. It will sometimes be useful to transform an equation into another that shall have each of its roots greater or less than the corresponding roots of the other equation, by some given quantity.

Let $(x-a)(x-b)(x+c)=0$ be any proposed equation which is to be transformed into another, having its roots greater or less than those of the proposed equation by the given quantity $n$; then, because the roots of the transformed equation are to be $+a\pm n$, $+b\pm n$, and $-c\pm n$, the equation itself will be

$$(y\mp n-a)(y\mp n-b)(y\mp n+c)=0.$$

Hence the reason of the following rule is evident.

If the new equation is to have its roots greater than those of the proposed equation; instead of $x$ and its powers, substitute $y-n$ and its powers: but if the roots are to be less; then, instead of $x$ substitute $y+n$; and in either case, a new equation will be produced, the roots of which shall have the property required.

108. By the preceding rule, an equation may be changed into another, which has its roots either all positive, or all negative; but it is chiefly used in preparing cubic and biquadratic equations for a solution, by transforming them

into others of the same degrees, but which want their second term.

Let $x^3+px^2+qx+r=0$ be any cubic equation; if we substitute $y+n$ for $x$, the equation is changed into the following:

$$\left.\begin{matrix} y^3+3n \\ +\ p \end{matrix}\right\} y^2 \quad \left.\begin{matrix} +3n^2 \\ +2pn \\ +\ q \end{matrix}\right\} y \quad \left.\begin{matrix} +n^3 \\ +pn^2 \\ +qn \\ +\ r \end{matrix}\right\} = 0.$$

Now, that this equation may want its second term, it is evident that we have only to suppose $3n+p=0$, or $n=-\frac{p}{3}$; for this assumption being made, and the value of $n$ substituted in the remaining terms, the equation becomes

$$y^3 * +(q-\frac{p^2}{3})y+\frac{2p^3}{27}-\frac{pq}{3}+r=0;$$

or, putting $-\frac{p^2}{3}+q=q'$, and $+\frac{2p^3}{27}-\frac{pq}{3}+r=r'$, the same equation may also stand thus,

$$y^3+q'y+r'=0.$$

109. In general, any equation whatever may be transformed into another, which shall want its second term, by the following rule.

Divide the co-efficient of the second term of the proposed equation by the exponent of the first term, and add the quotient, with its sign changed, to a new unknown quantity; the sum being substituted for the unknown quantity in the proposed equation, a new equation will be produced, which will want the second term, as required.

By this rule any adfected quadratic equation may be readily resolved; for by transforming it into another equation which wants the second term, we thus reduce its solution to that of a pure quadratic. Thus, if the quadratic equation $x^2-5x+6=0$ be proposed; by substituting $y+\frac{5}{2}$ for $x$, we find

$$\left.\begin{matrix} y^2+5y+\frac{25}{4} \\ -5y-\frac{25}{2} \\ +6 \end{matrix}\right\} = 0, \text{ or } y^2-\tfrac{1}{4}=0.$$

Hence $y=\pm\frac{1}{2}$, and since $x=y+\frac{5}{2}$, therefore $x=\pm\frac{1}{2}+\frac{5}{2}=+3$, or $+2$.

110. It has been shown (sect. 100) that in any equation, the co-efficient of the second term, having its sign changed, is equal to the sum of all the roots; or, abstracting from their signs, it is equal to the difference between the sum of the positive and the sum of the negative roots: Therefore, if the second term be wanting, the sum of the positive roots in the equation must necessarily be equal to that of the negative roots.

111. Instead of taking away the second term from an equation, any other term may be made to vanish, by an assumption similar to that which has been employed to take away the second term. Thus, if in sect. 108 we assume $3n^2+2pn+q=0$, by resolving this quadratic equation, a value of $n$ will be found which, when substituted in the equation, will cause the third term to vanish; and, by the resolution of a cubic equation, the third term may be taken away; and so on.

112. Another species of transformation, of use in the resolution of equations, is that by which an equation, having the co-efficients of some of its terms expressed by fractional quantities, is changed into another, the co-efficients of which are all integers.

Let $x^3+\frac{p}{a}x^2+\frac{q}{b}x+\frac{r}{c}=0$ denote an equation to be so transformed, and let us assume $y=abcx$, and therefore $x=\frac{y}{abc}$; then, by substitution, our equation becomes



$$\frac{y^3}{a^3b^3c^3}+\frac{p}{a^3b^2c^2}y^2+\frac{q}{ab^2c}y+\frac{r}{c}=0;$$

and multiplying the whole equation by $a^3b^3c^3$, we have

$$y^3+bcpy^2+a^2bc^2qy+a^3b^3c^2r=0.$$

Thus we have an equation free from fractions, while at the same time the co-efficient of the highest power of the unknown quantity is unity, as before.

This transformation may always be performed by the following rule: Instead of the unknown quantity, substitute a new unknown quantity divided by the product of all the denominators; then, by proper reduction, the equation will be found to have the form required.

If, however, the equation have this form,

$$x^3+\frac{p}{a}x^2+\frac{q}{a}x+\frac{r}{a}=0,$$

it will be sufficient to assume $y=ax$, and therefore $x=\frac{y}{a}$; for then we have

$$\frac{y^3}{a^3}+\frac{p}{a^3}y^2+\frac{q}{a^2}y+\frac{r}{a}=0,$$

$$\text{and } y^3+py^2+aqy+a^2r=0;$$

which last equation has the form required.

### Sect. XI.—Of Cubic Equations.

113. Cubic equations, as well as equations of every higher degree, are, like quadratics, divided into two classes: they are said to be *pure* when they contain only one power of the unknown quantity; and *adfected* when they contain two or more powers of that quantity.

Pure cubic equations are therefore of this form, $x^3=125$, or $x^3=-27$, or, in general, $x^3=r$; and hence it appears, that the value of the simple power of the unknown quantity may always be found without difficulty, by extracting the cube root of each side of the equation; thus, from the first of the three preceding examples we find $x=+5$, from the second, $x=-3$, and from the third, $x=\sqrt[3]{r}$.

It would seem at first sight that the only value which $x$ can have in the cubic equation $x^3=r$, or putting $r=c^3$, $x^3-c^3=0$, is this one, $x=c$; but since $x^3-c^3$ may be resolved into these two factors, $x-c$ and $x^2+cx+c^2$, it follows, that besides the value of $x$ already found, which results from making the factor $x-c=0$, it has yet other two values, which may be found by making the other factor $x^2+cx+c^2=0$; and accordingly, by resolving the quadratic equation $x^2+cx=-c^2$, we find these values to be $\frac{-c+\sqrt{-3c^2}}{2}$ and $\frac{-c-\sqrt{-3c^2}}{2}$, or $\frac{-1+\sqrt{-3}}{2}c$ and $\frac{-1-\sqrt{-3}}{3}c$. Thus it appears, that any cubic equation of this form, $x^3=c^3$, or $x^3-c^3=0$, has these three roots,

$$x=c,\ x=\frac{-1+\sqrt{-3}}{2}c,\ x=\frac{-1-\sqrt{-3}}{2}c;$$

the first of which is real, but the two last are imaginary. If, however, each of the imaginary values of $x$ be raised to the third power, the same results will be obtained as from the real value of $x$: the original equation $x^3-c^3=0$ may also be reproduced, by multiplying together the three factors $x-c$, $x-\frac{-1+\sqrt{-3}}{2}c$, and $x-\frac{-1-\sqrt{-3}}{2}c$.

114. Let us now consider such cubic equations as have all their terms, and which are therefore of this form,

$$x^3 + Ax^2 + Bx + C = 0,$$

where A, B, and C, denote known quantities, either positive or negative.

It has been shown (sect. 108) how an equation having all its terms may be transformed into another which wants the second term; therefore, assume $x = y - \frac{A}{3}$, as directed in that article; then, by proper substitution, the above equation will be changed into another of this form,

$$y^3 + qy + r = 0,$$

where $q$ and $r$ denote known quantities, whether positive or negative; now the roots of this equation being found, it is evident that those of the former may be readily obtained by means of the assumed equation $x = y - \frac{A}{3}$.

Resuming, therefore, the equation $y^3 + qy + r = 0$, let us suppose $y = v + z$, and it becomes

$$\left.\begin{array}{r} v^3 + 3v^2z + 3vz^2 + z^3 \\ +qv + qz \\ +r \end{array}\right\} = 0.$$

Thus we have a new equation, which, as it involves two unknown quantities, $v$ and $z$, may be resolved into any two others, which will simplify the determination of those quantities.

Now it appears, that the only way in which we can divide that equation into two others, so as to simplify the question, is the following:

$$3v^2z + 3vz^2 + qv + qz = 0,$$
$$v^3 + z^3 + r = 0.$$

The first of these may also be expressed thus,

$$(3vz + q)(v + z) = 0.$$

Hence, we must either suppose that $v + z = 0$, or that $3vz + q = 0$; but the former supposition cannot be admitted without supposing also that $y = 0$, which does not agree with the hypothesis of the equation $y^3 + qy + r = 0$; therefore we must adopt the latter. So that to determine $v$ and $z$ we have these two equations,

$$3vz + q = 0, \qquad v^3 + z^3 + r = 0.$$

From the first, we find $vz = -\frac{q}{3}$, and $v^3z^3 = -\frac{q^3}{27}$; and from the second $v^3 + z^3 = -r$; so that to determine the quantities $v^3$ and $z^3$, we have given their sum and product: now this is a problem which we have already resolved when treating of quadratic equations; and by proceeding in the same manner in the present case, we shall find

$$v^3 = -\tfrac{1}{2}r + \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}; \quad z^3 = -\tfrac{1}{2}r - \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2};$$

$$v = \sqrt[3]{-\tfrac{1}{2}r + \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}}; \quad z = \sqrt[3]{-\tfrac{1}{2}r - \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}};$$

and $y = v + z$

$$= \sqrt[3]{-\tfrac{1}{2}r + \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}} + \sqrt[3]{-\tfrac{1}{2}r - \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{2}r^2}}.$$

Thus we have at last obtained a value of the unknown quantity $y$, in terms of the known quantities $q$ and $r$; therefore the equation is resolved.

115. But this is only one of three values which $y$ may have. Let us, for the sake of brevity, put

$$A = -\tfrac{1}{2}r + \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}, \quad B = -\tfrac{1}{2}r - \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2},$$

$$\text{and put} \left\{ \begin{array}{l} \alpha = \dfrac{-1 + \sqrt{-3}}{2}, \\[2ex] \beta = \dfrac{-1 - \sqrt{-3}}{2}. \end{array} \right.$$

Then, from what has been shown (sect. 113), it is evident that $v$ and $z$ have each these three values,

$$v = \sqrt[3]{A}, \quad v = \alpha\sqrt[3]{A}, \quad v = \beta\sqrt[3]{A};$$
$$z = \sqrt[3]{B}, \quad z = \alpha\sqrt[3]{B}, \quad z = \beta\sqrt[3]{B}.$$

To determine the corresponding values of $v$ and $z$, we must consider that $vz = -\frac{q}{3} = \sqrt[3]{AB}$: Now if we observe that $\alpha\beta = 1$, it will immediately appear that $v + z$ has these three values,

$$v + z = \sqrt[3]{A} + \sqrt[3]{B},$$
$$v + z = \alpha\sqrt[3]{A} + \beta\sqrt[3]{B},$$
$$v + z = \beta\sqrt[3]{A} + \alpha\sqrt[3]{B}.$$

Hence the three values of $y$ are also these,

$$y = \sqrt[3]{A} + \sqrt[3]{B},$$
$$y = \alpha\sqrt[3]{A} + \beta\sqrt[3]{B},$$
$$y = \beta\sqrt[3]{A} + \alpha\sqrt[3]{B}.$$

The first of these formulæ is commonly known by the name of Cardan's rule; but it is well known that Cardan was not the inventor, and that it ought to be attributed to Nicholas Tartalea and Scipio Ferreus, who discovered it much about the same time, and independently of each other. (See the *Introduction.*)

The formulæ given above for the roots of a cubic equation may be put under a different form, and better adapted to the purposes of arithmetical calculation as follows. Because $vz = -\frac{q}{3}$, therefore $z = -\frac{q}{3} \times \frac{1}{v} = -\frac{\frac{1}{3}q}{\sqrt[3]{A}}$; hence $v + z = \sqrt[3]{A} - \frac{\frac{1}{3}q}{\sqrt[3]{A}}$: thus it appears that the three values of $y$ may also be expressed thus:

$$y = \sqrt[3]{A} - \frac{\frac{1}{3}q}{\sqrt[3]{A}}$$
$$y = \alpha\sqrt[3]{A} - \frac{\frac{1}{3}q\beta}{\sqrt[3]{A}},$$
$$y = \beta\sqrt[3]{A} - \frac{\frac{1}{3}q\alpha}{\sqrt[3]{A}}.$$

116. To show the manner of applying these formulæ, let it be required to determine $x$ from the cubic equation

$$x^3 + 3x^2 + 9x - 13 = 0:$$

And as this equation has all its terms, the first step towards its resolution is to transform it into another which shall want the second term, by substituting $y - 1$ for $x$ as directed (sect. 109). The operation will stand thus:

$$\begin{array}{rrrrr} x^3 = & y^3 & -3y^2 & +3y & -1 \\ +3x^2 = & & +3y^2 & -6y & +3 \\ +9x = & & & +9y & -9 \\ -13 = & & & & -13 \end{array}$$

The transformed equation is $y^3 \quad + 6y - 20 = 0$, which being compared with the general equation,

$$y^3 + qy + r = 0,$$

gives $q = 6$, $r = -20$; hence

$$A = \sqrt[3]{-\tfrac{1}{2}r + \sqrt{\tfrac{1}{27}q^3 + \tfrac{1}{4}r^2}} = \sqrt[3]{10 + \sqrt{108}},$$

therefore the second formula of last article gives $y = \sqrt[3]{10 + \sqrt{108}} - \frac{2}{\sqrt[3]{10 + \sqrt{108}}}$; but as this expression involves a radical quantity, let the square root of 108 be taken and added to 10, and the cube root of the sum found; thus we have $\sqrt[3]{10+\sqrt{108}} = 2{\cdot}732$ nearly, and therefore $\dfrac{2}{\sqrt[3]{10+\sqrt{108}}} = \dfrac{2}{2{\cdot}732} = {\cdot}732$; hence we at last find one of the values of $y$ to be $2.732 - {\cdot}732 = 2$.

In finding the cube root of the radical quantity $\sqrt[3]{10+\sqrt{108}}$, we have taken only its approximate value, so as to have the expression for the root under a rational form, and in this way we can always find, as near as we please, the cube root of any surd of the form $a+\sqrt{b}$, where $b$ is a positive number. But it will sometimes happen that the cube root of such a surd can be expressed exactly by another surd of the same form; and accordingly, in the present case, it appears that the cube root of $10+\sqrt{108}$ is $1+\sqrt{3}$, as may be proved by actually raising $1+\sqrt{3}$ to the third power. Hence we find

$$\frac{2}{\sqrt[3]{10+\sqrt{108}}} = \frac{2}{1+\sqrt{3}} = \frac{2(1-\sqrt{3})}{(1-\sqrt{3})(1+\sqrt{3})} =$$

$-(1-\sqrt{3})$; so that $y = 1+\sqrt{3}+1-\sqrt{3} = 2$, as before.

The other two values of $y$ will be had by substituting $1+\sqrt{3}$ and $1-\sqrt{3}$ for $\sqrt[3]{A}$ and $\dfrac{\frac{1}{3}q}{\sqrt[3]{A}}$ in the second and third formulæ of last article, and restoring the values of $\alpha$ and $\beta$. We thus have

$$y = \frac{-1+\sqrt{-3}}{2} \times (1+\sqrt{3}) + \frac{-1-\sqrt{-3}}{2} \times (1-\sqrt{3})$$
$$= -1+\sqrt{-9}$$
$$y = \frac{-1-\sqrt{-3}}{2} \times (1+\sqrt{3}) + \frac{-1+\sqrt{-3}}{2} \times (1-\sqrt{3})$$
$$= -1-\sqrt{-9}.$$

So that the three values of $y$ are

$$+2, \quad -1+\sqrt{-9}, \quad -1-\sqrt{-9};$$

and since $x = y - 1$, the corresponding values of $x$ are

$$+1, \quad -2+\sqrt{-9}, \quad -2-\sqrt{-9}.$$

Thus it appears that one of the roots of the proposed equation is real, and the other two imaginary.

The two imaginary roots might have been found otherwise, by considering that since one root of the equation is 1, the equation must be divisible by $x-1$ (sect. 99). Accordingly, the division being actually performed, and the quotient put $= 0$, we have this quadratic equation,

$$x^2+4x+13 = 0;$$

which, when resolved by the rule for quadratics, gives $x = -2 \pm \sqrt{-9}$, the same imaginary value as before.

117. In the application of the preceding formulæ (sect. 114 and 115) to the resolution of the equation $y^3+qy+r=0$, it is necessary to find the square root of $\frac{1}{27}q^3+\frac{1}{4}r^2$; now, when that quantity is positive, as in the equation $y^3+6y-20=0$, which was resolved in last article, no difficulty occurs, for its root may be found either exactly or to as great a degree of accuracy as we please.

As, however, the co-efficients $q$ and $r$ are independent of each other, it is evident that $q$ may be negative, and such, that $\frac{1}{27}q^3$ is greater than $\frac{1}{4}r^2$. In this case, the expression $\frac{1}{27}q^3+\frac{1}{4}r^2$ will be negative, and therefore its square root an imaginary quantity. Let us take as an example, this equation, $y^3-6y+4=0$; here $q=-6$, $r=+4$, $\frac{1}{2}r=2$, $\frac{1}{27}q^3=-8$, $\frac{1}{4}r^2=+4$, $\sqrt{\frac{1}{27}q^3+\frac{1}{4}r^2} = \sqrt{-4} = 2\sqrt{-1}$; hence, by recurring to the formulæ (sect. 115), we have $A=2+2\sqrt{-1}$, $B=2-\sqrt{-1}$, and therefore the three roots of the equation are



$$y = \sqrt[3]{2+2\sqrt{-1}} + \sqrt[3]{2-2\sqrt{-1}},$$
$$y = \alpha\sqrt[3]{2+2\sqrt{-1}} + \beta\sqrt[3]{2-2\sqrt{-1}},$$
$$y = \beta\sqrt[3]{2+2\sqrt{-1}} + \alpha\sqrt[3]{2-2\sqrt{-1}}.$$

Here all the roots appear under an imaginary form; but we are certain, from the theory of equations, as explained in Section X. that every cubic equation must have at least one real root. The truth is, as we shall show immediately, that in this case, so far from any of the roots being imaginary, they are all real; for it appears by actual involution, that the imaginary expression $2+2\sqrt{-1}$ is the cube of this other imaginary expression, $-1+\sqrt{-1}$; and in like manner, that $2-2\sqrt{-1}$ is the cube of $-1-\sqrt{-1}$, so that we have

$y = \sqrt[3]{2+2\sqrt{-1}} + \sqrt[3]{2-2\sqrt{-1}} = -1+\sqrt{-1}-1-\sqrt{-1} = 2.$

$y = \dfrac{-1+\sqrt{-3}}{2} \times (-1+\sqrt{-1}) + \dfrac{-1-\sqrt{-3}}{2} \times (-1-\sqrt{-1}) = 1+\sqrt{3}.$

$y = \dfrac{-1-\sqrt{-3}}{2} \times (-1+\sqrt{-1}) + \dfrac{-1+\sqrt{-3}}{2} \times (-1-\sqrt{-1}) = 1-\sqrt{3}.$

118. We shall now prove, that as often as the roots of the equation $x^3+qx+r=0$ are real, $q$ is negative, and $\frac{1}{27}q^3$ greater than $\frac{1}{4}r^2$; and, on the contrary, that if $\frac{1}{27}q^3$ be greater than $\frac{1}{4}r^2$, the roots are all real.

Let us suppose $a$ to be a real root of the proposed equation;

Then $\quad x^3+qx+r=0,$

And $\quad a^3+qa+r=0.$

And therefore, by subtraction, $x^3-a^3+q(x-a)=0$; hence, dividing by $x-a$, we have

$$x^2+ax+a^2+q=0.$$

This quadratic equation is formed from the two remaining roots of the proposed equation, and by resolving it we find

$$x = -\tfrac{1}{2}a \pm \sqrt{-\tfrac{3}{4}a^2-q}.$$

And as, by hypothesis, all the roots are real, it is evident that $q$ must necessarily be negative, and greater than $\frac{3}{4}a^2$; for otherwise the expression $\sqrt{-\frac{3}{4}a^2-q}$ would be imaginary. Let us change the sign of $q$, and put $q=\frac{3}{4}a^2+d$; thus the roots of the equation $x^3-qx+r=0$ will be

$$a, \ -\tfrac{1}{2}a+\sqrt{d}, \ -\tfrac{1}{2}a-\sqrt{d},$$

and here $d$ is a positive quantity.

To find an expression for $r$ in terms of $a$ and $d$, let $\frac{3}{4}a^2+d$ be substituted for $q$ in the equation $a^3-qa+r=0$; we thence find $r=-\frac{1}{4}a^3+ad$; so that to compare together the quantities $q$ and $r$, we have these equations,

$$q=\tfrac{3}{4}a^2+d, \quad r=-\tfrac{1}{4}a^3+ad.$$

In order to make this comparison, let the cube of $\frac{1}{3}q$ be taken, also the square of $\frac{1}{2}r$, the results are

$$\tfrac{1}{27}q^3 = \tfrac{1}{64}a^6+\tfrac{1}{16}a^4d+\tfrac{1}{12}a^2d^2+\tfrac{1}{27}d^3,$$
$$\tfrac{1}{4}r^2 = \tfrac{1}{64}a^6-\tfrac{1}{8}a^4d+\tfrac{1}{4}a^2d^2;$$

and therefore, by subtraction,

$$\tfrac{1}{27}q^3-\tfrac{1}{4}r^2 = \tfrac{3}{16}a^4d-\tfrac{1}{6}a^2d^2+\tfrac{1}{27}d^3,$$
$$=3d(\tfrac{1}{16}a^4-\tfrac{1}{18}a^2d+\tfrac{1}{81}d^2),$$
$$=3d(\tfrac{1}{4}a^2-\tfrac{1}{9}d)^2.$$

Now the square of any real quantity being always positive, it follows that $3d(\frac{1}{4}a^2-\frac{1}{9}d)^2$ will be positive when $d$ is positive; hence it is evident that in this case $\frac{1}{27}q^3$ must be greater than $\frac{1}{4}r^2$, and that the contrary cannot be true, unless $d$ be negative, that is, unless that $-\frac{1}{2}a+\sqrt{d}$, $-\frac{1}{2}a-\sqrt{d}$, the two other roots of the equation, are imaginary. If we suppose $d=0$, then $\frac{1}{27}q^3=\frac{1}{4}r^2$; and the roots of the equations, which in this case are also real, are $a$, $-\frac{1}{2}a$, $-\frac{1}{2}a$.

Upon the whole, therefore, we infer, that since a cubic equation has always one real root, its roots will be all real as often as $q$ is negative, and $\frac{1}{27}q^3$ greater than $\frac{1}{4}r^2$; and consequently, that in this case the formulæ for the roots must express real quantities, notwithstanding their imaginary form.

119. Let $y^3-qy+r=0$ denote any equation of the form which has been considered in last article, namely, that which has its roots all real; then, if we put $a=-\frac{1}{2}r$, $b^2=\frac{1}{27}q^3-\frac{1}{4}r^2$, one of the roots, as expressed by the first formula, sect. 115, will be,

$$y=\sqrt[3]{a+b\sqrt{-1}}+\sqrt[3]{a-b\sqrt{-1}}.$$

This expression, although under an imaginary form, must (as we have shown in last article) represent a real quantity. It may happen, as in last example, sect. 117, that the two surds which compose the root are perfect cubes of the form $(A+B\sqrt{-1})^3$, and $(A-B\sqrt{-1})^3$, and then the value of $y$ becomes

$$A+B\sqrt{-1}+A-B\sqrt{-1}=2A.$$

But the rules for determining when this is the case depend upon trials, and are, besides, troublesome in the application; and if we attempt by a direct process to investigate the numerical values of A and B, we are brought to a cubic equation of the very same form as that whose root is required.

This imaginary expression for a real quantity has greatly perplexed mathematicians; and much pains has been taken to obtain the root under another form, but without success. Accordingly, the case of cubic equations, in which the roots are all real, is now called the *irreducible case.*

120. It is remarkable that the expression

$$\sqrt{a+b\sqrt{-1}}+\sqrt{a-b\sqrt{-1}},$$

and in general,

$$\sqrt[n]{a+b\sqrt{-1}}+\sqrt[n]{a-b\sqrt{-1}},$$

where $n$ is any power of 2, admits of being reduced to another form, in which no impossible quantity is found. Thus, $\sqrt{a+b\sqrt{-1}}+\sqrt{a-b\sqrt{-1}}=\sqrt{2a+2\sqrt{a^2+b^2}}$,

and $\sqrt[4]{a+b\sqrt{-1}}+\sqrt[4]{a-b\sqrt{-1}}=$

$$\sqrt{\left(\sqrt{2a+2\sqrt{a^2+b^2}}+2\sqrt[4]{a^2+b^2}\right)},$$

as is easily proved by first raising the imaginary formulæ to the second and fourth powers, and then taking the square and fourth root of each. But when $n$ is 3, it does not seem that such reduction can possibly take place.

If each of the surds be expanded into an infinite series, and their sum be taken, the imaginary quantity $\sqrt{-1}$ will vanish, and thus the root may be found by a direct process. There are, however, other methods which seem preferable. The following, which is derived from the calculus of sines, seems the best.

121. It will be demonstrated in Sect. XXV., that if $a$ denote an arch of a circle, the relation between the cosine of the arch and the cosine of $\frac{a}{3}$, one-third of that arch, is expressed by the following cubic equation:



$$\text{Cos.}^3\,\frac{a}{3}-\tfrac{3}{4}\cos.\frac{a}{3}=\tfrac{1}{4}\cos.\,a.$$

Let us assume $\cos.\,\frac{a}{3}=\frac{y}{n}$, then, by substitution, the equation is transformed into the following:

$$\frac{y^3}{n^3}-\frac{3y}{4n}=\tfrac{1}{4}\cos.\,a,$$

$$\text{Or}\quad y^3-\frac{3n^2}{4}y=n^3\times\tfrac{1}{4}\cos.\,a;$$

and in this cubic equation, one of the roots is evidently $y=n\times\cos.\frac{a}{3}$. Now from the calculus of sines it appears that $\cos.\,a$, $\cos.\,(360°-a)$, and $\cos.\,(360°+a)$, are all expressed by the same quantity; therefore the equation must have for a root not only $n\times\cos.\frac{a}{3}$, but also $n\times\cos.\frac{360°-a}{3}$, and $n\times\cos.\frac{360°+a}{3}$. But from the calculus of sines, $\cos.\frac{360°-a}{3}=$ $-\sin.\frac{90°-a}{3}$, and $\cos.\frac{360°+a}{3}=-\sin.\frac{90°+a}{3}$; therefore the roots of the equation are

$$n\times\cos.\frac{a}{3},\quad -n\times\sin.\frac{90°-a}{3},\quad -n\times\sin.\frac{90°+a}{3}.$$

Let us next suppose that $y^3-qy=r$ is a cubic equation whose roots are required, and let us compare it with the former equation $y^3-\frac{3n^2}{4}y=n^3\times\frac{1}{4}\cos.\,a$; then it is evident, that if we assume the quantities $n$ and $\cos.\,a$, such, that

$$\frac{3n^2}{4}=q,\quad n^3\times\tfrac{1}{4}\cos.\,a=r,$$

the two equations will become identical, and thus their roots will be expressed by the very same quantities. But from these two assumed equations we find

$$n=\sqrt{\frac{4q}{3}}=\frac{2\sqrt{q}}{\sqrt{3}},\quad \cos.\,a=\frac{4r}{n^3}=\sqrt{\frac{27\,r^2}{4q^3}}=\frac{3r\sqrt{3}}{2q\sqrt{q}};$$

and since the cosine of an arch cannot exceed unity, therefore $\frac{27\,r^2}{4\,q^3}$ must be a proper fraction, that is, $4q^3$ must exceed $27r^2$, or $\frac{1}{27}q^3$ must exceed $\frac{1}{4}r^2$. If we now recollect that $q$ is a negative quantity, it will immediately appear that the proposed equation must necessarily belong to the irreducible case.

The rule, therefore, which we derive from the preceding analysis for resolving that case is as follows:

Let $y^3-qy=r$ be the proposed equation.

Find in the trigonometrical tables an arch $a$, whose natural cosine$=\frac{3r\sqrt{3}}{2q\sqrt{q}}$;

the roots of the equation are

$$y=2\sqrt{\frac{q}{3}}\times\cos.\frac{a}{3},$$

$$y=-2\sqrt{\frac{q}{3}}\times\sin.\frac{90°-a}{3},$$

$$y=-2\sqrt{\frac{q}{3}}\times\sin.\frac{90°+a}{3}.$$

These formulæ will apply, whether $r$ be positive or negative, by proper attention to the signs. If, however, $r$ be negative, or the equation have this form, $y^3-qy=-r$, the following will be more convenient:

Find in the tables an arch $a$, whose sine $=\frac{3r\sqrt{3}}{2q\sqrt{q}}$.

Then the roots of the equation are

$$y=2\sqrt{\frac{q}{3}}\times\sin.\frac{a}{3},$$

$$y=2\sqrt{\frac{q}{3}}\times\cos.\frac{90°+a}{3},$$

$$y=-2\sqrt{\frac{q}{3}}\times\cos.\frac{90°-a}{3}.$$

The last formulæ are derived from the equation

$$\text{Sin.}^3\frac{a}{3}-\frac{3}{4}\sin.\frac{a}{3}=-\sin.a,$$

in the same manner as the former were found from the first equation of last article.

*Ex.* 1. It is required to find the roots of the equation $x^3-3x=1$.

$$\text{Here } \frac{3r\sqrt{3}}{2q\sqrt{q}}=\frac{3\times\sqrt{3}}{6\times\sqrt{3}}=\tfrac{1}{2}=\cos.60°=\cos.a, \text{ and}$$

$$x=2\cos.\frac{60°}{3}=2\cos.20°=1{\cdot}8793852,$$

$$x=-2\sin.\frac{150°}{3}=-2\sin.50°=-1{\cdot}5320888,$$

$$x=-2\sin.\frac{30°}{3}=-2\sin.10°=\cdot3472964.$$

*Ex.* 2. It is required to find the roots of the equation $x^3-3x=-1$.

$$\text{Here } \frac{3r\sqrt{3}}{2q\sqrt{q}}=\frac{3\sqrt{3}}{6\sqrt{3}}=\tfrac{1}{2}=\sin.30°=\sin.a, \text{ and}$$

$$x=2\sin.\frac{30°}{3}=2\sin.10°=\cdot3472964,$$

$$x=2\cos.\frac{120°}{3}=2\cos.40°=1{\cdot}5320888,$$

$$x=-2\cos.\frac{60°}{3}=-2\cos.20°=-1{\cdot}8793852.$$

## Sect. XII.—Of Biquadratic Equations.

122. When a biquadratic equation contains all its terms, it has this form,

$$x^4+Ax^3+Bx^2+Cx+D=0,$$

where A, B, C, D, denote any known quantities whatever.

We shall first consider pure biquadratics, or such as contain only the first and last terms, and therefore are of this form, $x^4=b^4$. In this case it is evident that $x$ may be readily had by two extractions of the square root; by the first we find $x^2=b^2$, and by the second $x=b$. This, however, is only one of the values which $x$ may have; for since $x^4=b^4$, therefore $x^4-b^4=0$; but $x^4-b^4$ may be resolved into two factors $x^2-b^2$ and $x^2+b^2$, each of which admits of a similar resolution; for $x^2-b^2=(x-b)(x+b)$ and $x^2+b^2=(x-b\sqrt{-1})(x+b\sqrt{-1})$. Hence it appears that the equation $x^4-b^4=0$ may also be expressed thus:



$$(x-b)(x+b)(x-b\sqrt{-1})(x+b\sqrt{-1})=0;$$

so that $x$ may have these four values,

$$+b,\quad -b,\quad +b\sqrt{-1},\quad -b\sqrt{-1},$$

two of which are real, and the others imaginary.

123. Next to pure biquadratic equations, in respect of easiness of resolution, are such as want the second and fourth terms, and therefore have this form,

$$x^4+qx^2+s=0.$$

These may be resolved in the manner of quadratic equations; for if we put $y=x^2$, we have

$$y^2+qy+s=0,$$

from which we find $y=\frac{-q\pm\sqrt{q^2-4s}}{2}$, and therefore

$$x=\pm\sqrt{\frac{-q\pm\sqrt{q^2-4s}}{2}}.$$

124. When a biquadratic equation has all its terms, the manner of resolving it is not so obvious as in the two former cases, but its resolution may be always reduced to that of a cubic equation. There are various methods by which such a reduction may be effected. The following, which we select as one of the most ingenious, was first given by Euler in the *Petersburg Commentaries*, and afterwards explained more fully in his *Elements of Algebra.*

We have already explained, sect. 109, how an equation which is complete in its terms may be transformed into another of the same degree, but which wants the second term; therefore any biquadratic equation may be reduced to this form,

$$y^4+py^2+qy+r=0,$$

where the second term is wanting, and where $p$, $q$, $r$, denote any known quantities whatever.

That we may form an equation similar to the above, let us assume $y=\sqrt{a}+\sqrt{b}+\sqrt{c}$, and also suppose that the letters $a$, $b$, $c$, denote the roots of the cubic equation

$$z^3+Pz^2+Qz-R=0;$$

then, from the theory of equations we have

$$a+b+c=-P,\quad ab+ac+bc=Q,\quad abc=R.$$

We square the assumed formula

$y=\sqrt{a}+\sqrt{b}+\sqrt{c}$, and obtain

$y^2=a+b+c+2(\sqrt{ab}+\sqrt{ac}+\sqrt{bc})$,

or, substituting $-P$ for $a+b+c$, and transposing;

$y^2+P=2(\sqrt{ab}+\sqrt{ac}+\sqrt{bc})$.

Let this equation be also squared, and we have

$y^4+2Py^2+P^2=4(ab+ac+bc)+8(\sqrt{a^2bc}+\sqrt{ab^2c}+\sqrt{abc^2})$; and since $ab+ac+bc=Q$, and

$\sqrt{a^2bc}+\sqrt{ab^2c}+\sqrt{abc^2}=\sqrt{abc}\,(\sqrt{a}+\sqrt{b}+\sqrt{c})=\sqrt{R}y$,

the same equation may be expressed thus:

$$y^4+2Py^2+P^2=4Q+8\sqrt{R}y.$$

Thus we have the biquadratic equation

$$y^4+2Py^2-8\sqrt{R}y+P^2-4Q=0,$$

one of the roots of which is $y=\sqrt{a}+\sqrt{b}+\sqrt{c}$, and in which $a$, $b$, $c$, are the roots of the cubic equation $z^3+Pz^2+Qz-R=0$.

125. In order to apply this resolution to the proposed equation $y^4+py^2+qy+r=0$, we must express the assumed co-efficients P, Q, R, by means of $p$, $q$, $r$, the co-

efficients of that equation. For this purpose, let us compare the equations

$$y^4+py^2+qy+r=0,$$
$$y^4+2Py^2-8\sqrt{R}\ y+P^2-4Q=0,$$

and it immediately appears that $2P=p, -8\sqrt{R}=q, P^2-4Q=r$; and from these three equations we find $P=\frac{p}{2}$, $Q=\frac{p^2-4r}{16}$, $R=\frac{q^2}{64}$. Hence it follows that the roots of the proposed equation are generally expressed by the formula $y=\sqrt{a}+\sqrt{b}+\sqrt{c}$; where $a, b, c$, denote the roots of this cubic equation,

$$z^3+\frac{p}{2}z^2+\frac{p^2-4r}{16}z-\frac{q^2}{64}=0.$$

But to find each particular root, we must consider, that as the square root of a number may be either positive or negative, so each of the quantities $\sqrt{a}, \sqrt{b}, \sqrt{c}$, may have either the sign $+$ or $-$ prefixed to it; and hence our formula will give eight different expressions for the root. It is, however, to be observed, that as the product of the three quantities $\sqrt{a}, \sqrt{b}, \sqrt{c}$, must be equal to $\sqrt{R}$ or to $-\frac{q}{8}$, when $q$ is positive, their product must be a negative quantity; and this can only be effected by making either one or three of them negative; again, when $q$ is negative, their product must be a positive quantity; so that in this case they must either be all positive, or two of them must be negative. These considerations enable us to determine, that four of the eight expressions for the root belong to the case in which $q$ is positive, and the other four to that in which it is negative.

126. We shall now give the result of the preceding investigation in the form of a practical rule; and as the co-efficients of the cubic equation which has been found involve fractions, we shall transform it into another, in which the co-efficients are integers, by supposing $z=\frac{v}{4}$. Thus the equation $z^3+\frac{p}{2}z^2+\frac{p^2-4r}{16}z-\frac{q^2}{64}=0$ becomes, after reduction, $v^3+2pv^2+(p^2-4r)v-q^2=0$; it also follows, that since the roots of the former equation are $a, b, c$, the roots of the latter are $\frac{a}{4}, \frac{b}{4}, \frac{c}{4}$, so that our rule may now be expressed thus:

Let $y^4+py^2+qy+r=0$ be any biquadratic equation wanting its second term. Form this cubic equation,

$$v^3+2pv^2+(p^2-4r)v-q^2=0,$$

and find its roots, which, let us denote by $a, b, c$.

Then the roots of the proposed biquadratic equation are,

| when $q$ is negative, | when $q$ is positive, |
|---|---|
| $y=\frac{1}{2}(\sqrt{a}+\sqrt{b}+\sqrt{c})$, | $y=\frac{1}{2}(-\sqrt{a}-\sqrt{b}-\sqrt{c})$, |
| $y=\frac{1}{2}(\sqrt{a}-\sqrt{b}-\sqrt{c})$, | $y=\frac{1}{2}(-\sqrt{a}+\sqrt{b}+\sqrt{c})$, |
| $y=\frac{1}{2}(-\sqrt{a}+\sqrt{b}-\sqrt{c})$, | $y=\frac{1}{2}(\sqrt{a}-\sqrt{b}+\sqrt{c})$, |
| $y=\frac{1}{2}(-\sqrt{a}-\sqrt{b}+\sqrt{c})$. | $y=\frac{1}{2}(\sqrt{a}+\sqrt{b}-\sqrt{c})$. |

127. This resolution of biquadratic equations suggests the following general remarks upon the nature of their roots.

1. It is evident from the form of the roots, that if the cubic equation

$$v^3+2pv^2+(p^2-4r)v-q^2=0,$$

have all its roots real and positive, those of the biquadratic equation will be all real.





2. Since the last term of the cubic equation is negative; when its three roots are real, they must either be all positive, or two of them must be negative and one positive; for the last term is equal to the product of all the roots taken with contrary signs, sect. 100; so that in this last case, two of the three quantities $a, b, c$, must be negative, and therefore all the four roots of the biquadratic equation imaginary. If, however, the two negative roots be equal, they will destroy each other in two of the roots of the biquadratic equation, which will then become real and equal. Let us suppose, for example, that $b$ and $c$ are negative and equal; the first two values of $y$ in each column become then imaginary, and the remaining values of $y$ are in the first set of roots, $y=-\frac{1}{2}\sqrt{a}$, $y=-\frac{1}{2}\sqrt{a}$, and in the second, $y=+\frac{1}{2}\sqrt{a}$, $y=\frac{1}{2}\sqrt{a}$.

3. When the cubic equation has only one real and two imaginary roots, its real roots must necessarily be positive; for the imaginary roots can only come from a quadratic equation having its last term positive, Sect. IX. and therefore are of this form, $v^2+Av+B=0$; hence the simple factor which contains the remaining root must have this form, $v-\gamma$, otherwise the last term of the cubic equation could not be negative.

By resolving the equation $v^2+Av+B=0$, we find

$$v=-\frac{A}{2}\pm\sqrt{\frac{A^2}{4}-B}.$$

Here, the roots being supposed imaginary, $\frac{A^2}{4}-B$ must be a negative quantity. That we may simplify the form of the roots, let us put $-\frac{A}{2}=\alpha$, and $\frac{A^2}{4}-B=-\beta^2$, then

$$v=-\alpha\pm\sqrt{-\beta^2}=-\alpha\pm\beta\sqrt{-1},$$

and $v=-\alpha+\beta\sqrt{-1}$, $v=-\alpha-\beta\sqrt{-1}$.

Hence we have

$$a=\alpha+\beta\sqrt{-1},\quad b=\alpha-\beta\sqrt{-1},\ c=\gamma;$$

so that in two of the four values of $y$, we have a quantity of this form,

$$\sqrt{\alpha+\beta\sqrt{-1}}+\sqrt{\alpha-\beta\sqrt{-1}};$$

but this quantity, although it appears to be imaginary, is indeed real; for if we first square it, and then take its square root, it becomes

$$\sqrt{2\alpha+2\sqrt{\alpha^2+\beta^2}},$$

which is a real quantity. The other two roots involve this other expression,

$$\sqrt{\alpha+\beta\sqrt{-1}}-\sqrt{\alpha-\beta\sqrt{-1}};$$

which being treated in the same manner as the former, becomes

$$\sqrt{2\alpha-2\sqrt{\alpha^2+\beta^2}},$$

an imaginary quantity, and therefore the roots into which it enters are imaginary.

4. We may discover from the co-efficients of the proposed biquadratic equation in what case the roots of the cubic equation are all real. For this purpose, the latter is to be transformed into another which shall want the second term, by assuming $v=u-\frac{2p}{3}$; thus it becomes

$$u^3-\left(\frac{p^3}{3}+4r\right)u-\frac{2p^3}{27}+\frac{8rp}{3}-q^2=0;$$

and in this equation the three roots will be real when $\frac{1}{27}\left(\frac{p^2}{3}+4r\right)^3$ is greater than $\frac{1}{4}\left(\frac{2p^3}{27}-\frac{8rp}{3}+q^2\right)^2$.

128. As an example of the method of resolving a biquadratic equation, let it be required to determine the roots of the following,

$$x^4-25x^2+60x-36=0.$$

Algebra. By comparing this equation with the general formula, we have $p=-25$, $q=+60$, $r=-36$; hence

$$2p=-50,\ p^2-4r=769,\ q^2=3600,$$

and the cubic equation to be resolved is

$$v^3-50v^2+769v-3600=0;$$

the roots of which are found, by the rules for cubics, to be 9, 16, and 25, so that $\sqrt{a}=3$, $\sqrt{b}=4$, $\sqrt{c}=5$. Now in this case $q$ is positive, therefore

$$x=\tfrac{1}{2}(-3-4-5)=-6,$$
$$x=\tfrac{1}{2}(-3+4+5)=+3,$$
$$x=\tfrac{1}{2}(+3-4+5)=+2,$$
$$x=\tfrac{1}{2}(+3+4-5)=+1.$$

129. We have now explained the particular rules by which the roots of equations belonging to each of the first four orders may be determined; and this is the greatest length mathematicians have been able to go in the direct resolution of equations; for as to those of the fifth, and all higher degrees, no general method has hitherto been found, either for resolving them directly, or reducing them to others of an inferior degree.

It even appears that the formulæ which express the roots of cubic equations are not of universal application; for in one case, that is, when the roots are all real, they become illusory, so that no conclusion can be drawn from them. The same observation will also apply to the formulæ for the roots of biquadratic equations, because, before they can be applied, it is always necessary to find the roots of a cubic equation. But in either cubics or biquadratic equations, even when the formulæ involve no imaginary quantities, and therefore can be always applied, it is more convenient in practice to employ some other methods, which we are hereafter to explain.

## Sect. XIII.—Of Reciprocal Equations.

130. Although no general resolution has hitherto been found of equations belonging to the fifth or any higher degree, yet there are particular equations of all orders, which, by reason of certain peculiarities in the nature of their roots, admit of being reduced to others of a lower degree; and thus, in some cases, equations of the higher orders may be resolved by the rules which have been already explained for the resolution of equations belonging to the first four orders.

When the co-efficients of the terms of an equation form the same numerical series, whether taken in a direct or an inverted order, as in this example,

$$x^4+px^3+qx^2+px+1=0,$$

it may always be transformed into another of a degree denoted by half the exponent of the highest power of the unknown quantity, if that exponent be an even number; or half the exponent diminished by unity, if it be an odd number.

The same observation will also apply to any equation of this form,

$$x^4+pax^3+qa^2x^2+pa^3x+a^4=0,$$

where the given quantity $a$ and the unknown quantity $x$ are precisely alike concerned; for by substituting $ay$ for $x$, it becomes

$$a^4y^4+pa^4y^3+qa^4y^2+pa^4y+a^4=0;$$

and dividing by $a^4$,

$$y^4+py^3+qy^2+py+1=0,$$

an equation of the same kind as the former.

131. That we may effect the proposed transformation upon the equation

$$x^4+px^3+qx^2+px+1=0,$$

let every two terms which are equally distant from the extremes be collected into one, and the whole be divided by $x^2$, then

$$x^2+\frac{1}{x^2}+p\left(x+\frac{1}{x}\right)+q=0.$$

Let us assume $x+\frac{1}{x}=z$;

then $x^2+2+\frac{1}{x^2}=z^2$, and $x^2+\frac{1}{x^2}=z^2-2$.

Thus the equation $x^2+\frac{1}{x^2}+p\left(x+\frac{1}{x}\right)+q=0$,

becomes $z^2+pz+q-2=0$;

and since $x+\frac{1}{x}=z$, therefore $x^2-zx+1=0$.

Hence, to determine the roots of the biquadratic equation

$$x^4+px^3+qx^2+px+1=0,$$

we have the following rule:

Form this quadratic equation,

$$z^2+pz+q-2=0,$$

and find its roots, which, let us suppose denoted by $z'$ and $z''$; then the four roots of the proposed equation will be found by resolving two quadratic equations, *viz.*

$$x^2-z'x+1=0,\quad x^2-z''x+1=0.$$

132. It may be observed, respecting these two quadratic equations, that since the last term of each is unity, if we put $a$, $a'$ to denote the roots of the one, and $b$, $b'$ those of the other, we have, from the theory of equations, $a\,a'=1$, and therefore $a'=\frac{1}{a}$; also $b\,b'=1$, and $b'=\frac{1}{b}$: now $a$, $a'$, $b$, $b'$ are also the roots of the equation

$$x^4+px^3+qx^2+px+1=0.$$

Hence it appears that the proposed equation has this peculiar property, that one half of its roots are the reciprocals of the other half; and to that circumstance we are indebted for the simplicity of its resolution.

133. The following equation,

$$x^6+px^5+qx^4+rx^3+qx^2+px+1=0,$$

which is of the sixth order, admits of a resolution in all respects similar to the former; for, by putting it under this form,

$$x^3+\frac{1}{x^3}+p\left(x^2+\frac{1}{x^2}\right)+q\left(x+\frac{1}{x}\right)+r=0,$$

and putting also $x+\frac{1}{x}=z$, so that $x^2-zx+1=0$, we

have $x^2+\frac{1}{x^2}=z^2-2$,

$$x^3+\frac{1}{x^3}=z^3-3\left(x+\frac{1}{x}\right)=z^3-3z.$$

Hence, by substitution, the proposed equation is transformed into the following cubic equation,

$$z^3+pz^2+(q-3)z+r-2p=0;$$

therefore, putting $z'$, $z''$, $z'''$, to denote its roots, the six roots of the proposed equation will be had by resolving these three quadratics,

$$x^2-z'x+1=0,\ x^2-z''x+1=0,\ x^2-z'''x+1=0;$$

and here it is evident, as in the former case, that the roots of each quadratic equation are the reciprocals of each other, so that the one half of the roots of the proposed equation are the reciprocals of the other half.

The method of resolution we have employed in the two preceding examples is general for all equations whatever, in which the terms placed at equal distances from the first and last have the same co-efficients, and which are called *reciprocal equations*, because any such equation has the same form when you substitute for $x$ its reciprocal, $\frac{1}{x}$.

134. If the greatest exponent of the unknown quantity in a reciprocal equation is an odd number, as in this example,

$$x^5+px^4+qx^3+qx^2+px+1=0,$$

the equation will always be satisfied by substituting $-1$ for $x$; hence, $-1$ must be a root of the equation, and therefore the equation must be divisible by $x+1$. Accordingly, if the division be actually performed, we shall have in the present case

$$x^4+(p-1)x^3-(p-q-1)x^2+(p-1)x+1=0,$$

another reciprocal equation, in which the greatest exponent of $x$ is an even number, and therefore resolvable in the manner we have already explained.

135. As an application of the theory of reciprocal equation, let it be proposed to find $x$ from this equation,

$$\frac{x^5+1}{(x+1)^5}=a,$$

where $a$ denotes a given number.

Every expression of the form $x^n+1$ is divisible by $x+1$ when $n$ is an odd number. In the present case, the numerator and denominator being divided by $x+1$, the equation becomes

$$\frac{x^4-x^3+x^2-x+1}{x^4+4x^3+6x^2+4x+1}=a;$$

and this again, by proper reduction,

$$(a-1)x^4+(4a+1)x^3+(6a-1)x^2+(4a+1)x+a-1=0;$$

and, putting $p=\frac{4a+1}{a-1}$, $q=\frac{6a-1}{a-1}$,

$$x^4+px^3+qx^2+px+1=0;$$

a reciprocal equation, resolvable into two quadratics.

## Sect. XIV.—Of Equations which have Equal Roots.

136. When an equation has two or more equal roots, these may always be discovered, and the equation reduced to another of an inferior degree, by a method of resolution which is peculiar to this class of equations.

Although the method of resolution we are to employ will apply alike to equations of every degree, having equal roots, yet, for the sake of brevity, we shall take a biquadratic equation,

$$x^4+px^3+qx^2+rx+s=0,$$

the roots of which may be generally denoted by $a$, $b$, $c$, and $d$. Thus we have, from the theory of equations,

$$(x-a)(x-b)(x-c)(x-d)=x^4+px^3+qx^2+rx+s=0.$$

Let us put

$A=(x-a)(x-b)(x-c)$, $A''=(x-a)(x-c)(x-d)$,
$A'=(x-a)(x-b)(x-d)$, $A'''=(x-b)(x-c)(x-d)$:

then, by actual multiplication, we have

$$A=x^3\left.\begin{matrix}-a\\-b\\-c\end{matrix}\right\}x^2\left.\begin{matrix}+ab\\+ac\\+bc\end{matrix}\right\}x-abc,$$

$$A'=x^3\left.\begin{matrix}-a\\-b\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+ab\\+ad\\+bd\end{matrix}\right\}x-abd,$$

$$A''=x^3\left.\begin{matrix}-a\\-c\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+ac\\+ad\\+bd\end{matrix}\right\}x-acd,$$

$$A'''=x^3\left.\begin{matrix}-b\\-c\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+bc\\+bd\\+cd\end{matrix}\right\}x-bcd;$$

and taking the sum of these four equations;

$$A+A'+A''+A'''=4x^3\left.\begin{matrix}-3a\\-3b\\-3c\\-3d\end{matrix}\right\}x^2\left.\begin{matrix}+2ab\\+2ac\\+2ad\\+2bc\\+2bd\\+2cd\end{matrix}\right\}x\begin{matrix}-abc\\-abd\\-acd\\-bcd.\end{matrix}$$

But since $a$, $b$, $c$, $d$ are the roots of the equation

$$x^4+px^3+qx^2+rx+s=0,$$

we have $-3(a+b+c+d)=3p$,
$2(ab+ac+ad+bc+bd+cd)=2q$,
$-(abc+abd+acd+bcd)=r$;

therefore, by substitution,

$$A+A'+A''+A'''=4x^3+3px^2+2qx+r.$$

137. Let us now suppose that the proposed biquadratic equation has two equal roots, or $a=b$; then $x-a=x-b$, and since one or other of these equal factors enters each of the four products A, A′, A″, A‴, it is evident that $A+A'+A''+A'''$, or $4x^3+3px^2+2qx+r$ must be divisible by $x-a$, or $x-b$. Thus it appears that if the proposed equation

$$x^4+px^3+qx^2+rx+s=0$$

have two equal roots, each of them must also be a root of this equation,

$$4x^3+3px^2+2qx+r=0;$$

for when the first of these equations is divisible by $(x-a)^2$, the latter is necessarily divisible by $x-a$.

138. Let us next suppose that the proposed equation has three equal roots, or $a=b=c$; then, two at least of the three equal factors $x-a$, $x-b$, $x-c$, must enter each of the four products A, A′, A″, A‴; so that in this case, $A+A'+A''+A'''$, or $4x^3+3x^2+2qx+r$, must be twice divisible by $x-a$. Hence it follows, that as often as the proposed equation has three equal roots, two of them must also be equal roots of the equation

$$4x^3+3px^2+2qx+r=0.$$

139. Proceeding in the same manner, it may be shown, that whatever number of equal roots are in the proposed equation

$$x^4+px^3+qx^2+rx+s=0,$$

they will remain, except one, in this equation,

$$4x^3+3px^2+2qx+r=0,$$

which may be derived from the former, by multiplying each of its terms by the exponent of $x$ in that term, and then diminishing the exponent by unity.

140. If we suppose that the proposed equation has two equal roots, or $a=b$, and also two other equal roots, or $c=d$, then, by reasoning as before, it will appear that the equation derived from it must have one root equal to $a$ or $b$, and another equal to $c$ or $d$; so that when the former is divisible both by $(x-a)^2$ and $(x-c)^2$, the latter will be divisible by $(x-a)(x-c)$.

141. The same mode of reasoning may be extended to all equations whatever; so that if we suppose

$$x^m+Px^{m-1}+Qx^{m-2}\ \dots\ +Sx^2+Tx+U=0,$$

an equation of the $m$th degree, to have a divisor of this form,

$$(x-a)^n\,(x-d)^p\,(x-f)^q\dots\text{\&c.}$$

the equation

$$mx^{m-1}+(m-1)Px^{m-2}+(m-2)Qx^{m-3}\ \dots\ +2Sx+T=0,$$

which is of the next lower degree, will have for a divisor

$$(x-a)^{n-1}\,(x-d)^{p-1}\,(x-f)^{q-1}\dots\text{\&c.}$$

and as this last product must be a divisor of both equa-

Algebra. tions, it may always be discovered by the rule which has been given (sect. 20) for finding the greatest common divisor of two algebraic quantities.

142. Again, as this last equation must, in the case of equal roots, have the same properties as the original equation; therefore, if we multiply each of its terms by the exponent of $x$, and diminish that exponent by unity, as before, we have

$m(m-1)\,x^{m-2}+(m-1)\,(m-2)\,Px^{m-3}+(m-2)\,(m-3)\,Qx^{m-4}\ \ldots\ +2S=0,$

a new equation, which has for a divisor

$$(x-a)^{n-2}\,(x-d)^{p-2}\,(x-f)^{q-2},$$

where the exponents of the factors are one less than those of the equation from which it was derived; and as this last divisor is also a divisor of the original equation, it may be discovered in the same manner as the former, namely, by finding the greatest common measure of both equations; and so on we may proceed, as far as we please.

143. As a particular example, let us take this equation,

$$x^5-13x^4+67x^3-171x^2+216x-108=0,$$

and apply to it the method we have explained, in order to discover whether it has equal roots, and if so, what they are. We must therefore seek the greatest common measure of the proposed equation and this other equation, which is formed agreeably to what has been shown, sect. 139,

$$5x^4-52x^3+201x^2-342x+216=0\,;$$

and the operation being performed, we find that they have a common divisor, $x^3-8x^2+21x-18$, which is of the third degree, and consequently may have several factors. Let us therefore try whether the last equation, and the following,

$$20x^3-156x^2+402x-342=0,$$

which is derived from it, as directed in sect. 139, have any common divisor; and, by proceeding as before, we find that they admit of this divisor, $x-3$, which is also a factor of the last divisor, $x^3-8x^2+21x-18$; and therefore the product of remaining factors is immediately found by division to be $x^2-5x+6$, which is evidently resolvable into $x-2$ and $x-3$.

Thus it appears, upon the whole, that the common divisor of the original equation, and that which is immediately derived from it, is $(x-2)\,(x-3)^2$; and that the common divisor of the second and third equations is $x-3$. Hence it follows that the proposed equation has $(x-2)^2$ for one factor, and $(x-3)^3$ for another factor; so that the equation itself may be expressed thus, $(x-2)^2\,(x-3)^3=0$; and the truth of this conclusion may be easily verified by multiplication.

## Sect. XV.—Resolution of Equations whose Roots are Rational.

144. It has been shown in sect. 100, that the last term of any equation is always the product of its roots taken with contrary signs. Hence, when the roots are rational, they may be discovered by the following rule:

Bring all the terms of the equation to one side; find all the divisors of the last term, and substitute them successively for the unknown quantity. Then each divisor, which produces a result equal to 0, is a root of the equation.

*Ex.* 1. Let $x^3-4x^2-7x+10=0$.

The divisors of 10, the last term, are 1, 2, 5, 10, each of which may be taken either positively or negatively; and these being substituted successively for $x$, we obtain the following results: Algebra.

By putting $+1$ for $x$, $\quad 1-\ 4-\ 7+10=\ 0,$
$-1,\quad -1-\ 4+\ 7+10=\ 12,$
$+2,\quad 8-\ 16-14+10=-12,$
$-2,\quad -8-\ 16+14+10=\ 0,$
$+5,\quad 125-100-35+10=\ 0.$

Here the divisors which produce results equal to 0 are $+1$, $-2$, and $+5$; therefore these are the three roots of the proposed equation.

145. When the number of divisors to be tried is considerable, it will be convenient to transform the equation into another, in which the last term has fewer divisors. This may in general be done by forming an equation, the roots of which are greater or less than those of the proposed equation by some determinate quantity; as in the following example:

*Ex.* 2. Let $y^4-4y^3-8y+32=0$ be proposed.

Here the divisors to be tried are 1, 2, 4, 8, 16, 32, each taken either positively or negatively; but to prevent the trouble of so many substitutions, transform the equation, by putting $x+1$ for $y$.

$$\begin{array}{lrl} \text{Then} & y^4= & x^4+4x^3+\ 6x^2+\ 4x+\ 1,\\ & -4y^3= & \quad\ -4x^3-12x^2-12x-\ 4,\\ & -8y= & \qquad\qquad\qquad\ \ -\ 8x-\ 8,\\ & +32= & \qquad\qquad\qquad\qquad\quad +32.\\ \hline \text{Therefore} & & x^4\qquad -\ 6x^2-16x+21=0 \end{array}$$

is the transformed equation, and the divisors of the last term are $+1$, $-1$, $+3$, $-3$, $+7$, $-7$. These being put successively for $x$, we get $+1$ and $+3$ for two roots of the equation; as to the two remaining roots, it is easy to see that they must be imaginary. They may, however, be readily exhibited by considering that the equation $x^4-6x^2-16x+21=0$ is divisible by the product of the two factors $x-1$ and $x-3$, and therefore may be reduced to a quadratic. Accordingly, by performing the division, and putting the quotient equal 0, we have this equation,

$$x^2+4x+7=0,$$

the roots of which are the imaginary quantities $-2+\sqrt{-3}$ and $-2-\sqrt{-3}$; so that, since $y=x+1$, the roots of the equation $y^4-4y^3-8y+32=0$ are these, $y=+2$, $y=+4$, $y=-1+\sqrt{-3}$, $y=-1-\sqrt{-3}$.

If this literal equation were proposed,

$$x^3-(3a+b)x^2+(2a^2+3ab)x-2a^2b=0,$$

by proceeding as before, we should find $x=a$, $x=2a$, $x=b$ for the roots.

146. To avoid the trouble of trying all the divisors of the last term, a rule may be investigated for restricting the number to very narrow limits as follows:

Suppose that the cubic equation $x^3+px^2+qx+r=0$ is to be resolved. Let it be transformed into another, the roots of which are less than those of the proposed equation by unity. This may be done by assuming $y=x-1$, and the last term of the transformed equation will be $1+p+q+r$. Again, by assuming $y=x+1$, another equation will be formed whose roots exceed those of the proposed equation by unity, and the last term of this other transformed equation will be $-1+p-q+r$. And it is to be observed, that these two quantities $1+p+q+r$ and $-1+p-q+r$ are formed from the proposed equation $x^3+px^2+qx+r$ by substituting successively $+1$ and $-1$ for $x$.

Now the values of $x$ are some of the divisors of $r$, which is the term left in the proposed equation, when $x$ is supposed $=0$; and the values of $y$ are some of the divisors of $1+p+q+r$ and $-1+p-q+r$ respectively; and these are in arithmetical progression, increasing by the common difference, unity; because $x-1$, $x$, $x+1$, are in that progression; and it is obvious that the same reasoning will apply to an equation of any degree whatever. Hence the following rule:

Substitute in place of the unknown quantity, successively, three or more terms of the progression 1, 0, —1, &c. and find all the divisors of the sums that result; then take out all the arithmetical progressions that can be found among these divisors, whose common difference is 1, and the values of $x$ will be among these terms of the progressions, which are the divisors of the result arising from the substitution of $x=0$. When the series increases, the roots will be positive; and when it decreases, they will be negative.

*Ex.* 1. Let it be required to find a root of the equation $x^3-x^2-10x+6=0$.

| Substit. | | Result. | Divisors. | Prog. |
|---|---|---|---|---|
| $x=+1$ | $x^3-x^2$ | $-4$ | 1. 2. 4. | 4 |
| $x=\ \ 0$ | $-10x+6$ | $+6$ | 1. 2. 3. 6. | 3 |
| $x=-1$ | | $+14$ | 1. 2. 7. 14. | 2 |

In this example there is only one progression, 4, 3, 2, the term of which opposite to the supposition of $x=0$ being 3, and the series decreasing, we try if —3 substituted for $x$ makes the equation vanish; and as it succeeds, it follows that —3 is one of its roots. To find the remaining roots, if $x^3-x^2-10x+6$ be divided by $x+3$, and the quotient $x^2-4x+2$ put $=0$, they will appear to be $2+\sqrt{2}$, and $2-\sqrt{2}$.

*Ex.* 2. Let the proposed equation be

$$x^4+x^3-29x^2-9x+180=0.$$

To find its roots.

| Sub. | Res. | Divisors. | Progressions. | | | |
|---|---|---|---|---|---|---|
| 2 | 70 | 1. 2. 5. 7. 10. 14. 35. 70. | 1 | 2 | 5 | 7 |
| 1 | 144 | 1. 2. 3. 4. 6. 8. 9. 12, &c. | 2 | 3 | 4 | 6 |
| 0 | 180 | 1. 2. 3. 4. 5. 6. 9. 10, &c. | 3 | 4 | 3 | 5 |
| —1 | 160 | 1. 2. 4. 5. 8. 10. 16. 20, &c. | 4 | 5 | 2 | 4 |
| —2 | 90 | 1. 2. 3. 5. 6. 9. 10. 15, &c. | 5 | 6 | 1 | 3 |

Here there are four progressions, two increasing and two decreasing; hence, by taking their terms, which are opposite to the supposition of $x=0$, we have these four numbers, $+3$, $+4$, $-3$, $-5$, to be tried as roots of the equation, all of which are found to succeed.

147. If any of the co-efficients of the proposed equation be a fraction, the equation may be transformed into another having the co-efficient of the highest power unity, and those of the remaining terms integers by sect. 112, and the roots of the transformed equation being found, those of the proposed equation may be easily derived from them.

For example, if the proposed equation be $x^3-\frac{7}{4}x^2+\frac{35}{4}x-6=0$; let us assume $x=\frac{y}{4}$. Thus the equation is transformed to

$$\frac{y^3}{64}-\frac{7y^2}{64}+\frac{35y}{16}-6=0;$$

or $y^3-7y^2+140y-384=0$,

one root of which is $y=3$; hence $x=\frac{y}{4}=\frac{3}{4}$.

The proposed equation being now divided by $x-\frac{3}{4}$, is reduced to this quadratic, $x^2-x+8=0$, the roots of which are both impossible.

148. When the co-efficients of an equation are integers, and unity that of the highest power of the unknown quantity, if its roots are not found among the divisors of the last term, we may be certain that, whether the equation be pure or adfected, its roots cannot be exactly expressed either by whole numbers or rational fractions. This may be demonstrated by means of the following proposition. If a prime number P be a divisor of the product of two numbers A and B, it will also be a divisor of at least one of the numbers.

Let us suppose that it does not divide B, and that B is greater than P; then, putting $q$ for the greatest number of times that P can be had in B, and B′ for the remainder, we have $\frac{B}{P}=q+\frac{B'}{P}$, and therefore

$$\frac{AB}{P}=qA+\frac{AB'}{P}.$$

Hence it appears, that if P be a divisor of AB, it is also a divisor of AB′. Now B′ is less than P, for it is the remainder which is found in dividing B by P; therefore, seeing we cannot divide B′ by P, let P be divided by B′, and $q'$ put for the quotient, also B″ for the remainder. Again, let P be divided by B″, and $q''$ put for the quotient, and B‴ for the remainder, and so on; and as P is supposed to be a prime number, it is evident that this series of operations may be continued till a remainder be found equal to unity, which will at last be the case; for the divisors are the successive remainders of the divisions, and therefore each is less than the divisor which preceded it. By performing these operations, we obtain the following series of equations;

$$\left.\begin{array}{l} P=q'\,B'+B'', \\ P=q''\,B''+B''', \\ \&c. \end{array}\right\} \text{and therefore} \left\{\begin{array}{l} B'=\dfrac{P-B''}{q'}, \\ B''=\dfrac{P-B'''}{q''}, \\ \&c. \end{array}\right.$$

Hence we have $AB'=\dfrac{AP-AB''}{q'}$ and

$$\frac{q'AB'}{P}=\frac{AP-AB''}{P}=A-\frac{AB''}{P}.$$

Now, if AB be divisible by P, we have shown that AB′, and consequently $q'$AB′, is divisible by P; therefore, from the last equation, it appears that AB″ must also be divisible by P.

Again, from the preceding series of equations, we have $AB''=\dfrac{AP-AB'''}{q''}$, and therefore

$$\frac{q''AB''}{P}=\frac{AP-AB'''}{P}=A-\frac{AB'''}{P};$$

hence we conclude that AB‴ is also divisible by P.

Proceeding in this manner, and observing that the series of quantities B′, B″, B‴, &c. continually decrease till one of them $=1$, it is evident that we shall at last come to a product of this form, $A\times 1$, which must be divisible by P, and hence the truth of the proposition is manifest.

149. It follows from this proposition, that if the prime number P, which we have supposed not to be a divisor of

B, is at the same time not a divisor of A, it cannot be a divisor of AB, the product of A and B.

Let $\frac{b}{a}$ be a fraction in its lowest terms, then the numbers $a$ and $b$ have no common divisor; but from what has been just now shown, it appears, that if a prime number be not a divisor of $a$, it cannot be a divisor of $a \times a$ or $a^2$; and in like manner, that if a prime number is not a divisor of $b$, it cannot be a divisor of $b \times b$, or $b^2$; therefore it is evident that $a^2$ and $b^2$ have no common divisor, and thus the fraction $\frac{b^2}{a^2}$ is also in its lowest terms.

Hence it follows that the square of any fractional quantity is still a fraction, and cannot possibly be a whole number; and, on the contrary, that the square root of a whole number cannot possibly be a fraction; so that all such whole numbers as are not perfect squares can neither have their roots expressed by integers nor by fractions.

Seeing that if a prime number is not a divisor of $a$, it is also not a divisor of $a^2$; therefore, if it is not a divisor of $a$, it cannot be a divisor of $a \times a^2$ or $a^3$; and by reasoning in this way, it is obvious that if a prime number is not a divisor of $a$, it cannot be a divisor of $a^n$; also, that if it is not a divisor of $b$, it cannot be a divisor of $b^n$; therefore if $\frac{b}{a}$ is a fraction in its lowest terms, $\frac{b^n}{a^n}$ is also a fraction in its lowest terms; so that any power whatever of a fraction is also a fraction; and on the contrary, any root of a whole number is also a whole number. Hence it follows, that if the root of a whole number is not expressible by an integer, such root cannot be expressed by a fraction, but is therefore irrational or incommensurable.

150. Let us next suppose that

$$x^n + Px^{n-1} + Qx^{n-2} \dots + Tx + U = 0$$

is any equation whatever, in which P, Q, &c. denote integer numbers; then, if its roots are not integers, they cannot possibly be rational fractions. For, if possible, let us suppose $x = \frac{b}{a}$ a fraction reduced to its lowest terms; then, by substitution,

$$\frac{a^n}{b^n} + P\frac{a^{n-1}}{b^{n-1}} + Q\frac{a^{n-2}}{b^{n-2}} \dots + T\frac{a}{b} + U = 0;$$

and, reducing all the terms to a common denominator,

$$a^n + Pa^{n-1}b + Qa^{n-2}b^2 \dots + Tab^{n-1} + Ub^n = 0;$$

which equation may also be expressed thus,

$$a^n + b(Pa^{n-1} + Qa^{n-2}b^2 \dots + Tab^{n-2} + Ub^{n-1}) = 0,$$

where the equation consists of two parts, one of which is divisible by $b$. But by hypothesis $a$ and $b$ have no common measure, therefore $a^n$ is not divisible by $b$, sect. 149; hence it is evident that the two parts of the equation cannot destroy each other as they ought to do; therefore $x$ cannot possibly be a fraction.

## Sect. XVI.—Resolution of Equations by Approximation.

151. When the roots of an equation cannot be accurately expressed by rational numbers, it is necessary to have recourse to methods of approximation; and by these we can always determine the numerical values of the roots to as great a degree of accuracy as we please.

The application of methods of approximation is rendered easy by means of the following propositions:

I. If two numbers, either whole or fractional, be found, which, when substituted for the unknown quantity in any equation, produce results with contrary signs, we may conclude that at least one root of the proposed equation is between those numbers, and is consequently real.

Let the proposed equation be

$$x^3 - 5x^2 + 10x - 15 = 0,$$

which, by collecting the positive terms into one sum, and the negative into another, may also be expressed thus,

$$x^3 + 10x - (5x^2 + 15) = 0;$$

then, to determine a root of the equation, we must find such a number as, when substituted for $x$, will render

$$x^3 + 10x = 5x^2 + 15.$$

Let us suppose $x$ to increase and to have every degree of magnitude, from 0 upwards in the scale of number; then $x^3 + 10x$ and $5x^2 + 15$ will both continually increase, but with different degrees of quickness, as appears from the following table.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Successive values of $x$; | 0, | 1, | 2, | 3, | 4, | 5, | 6, | &c. |
| ——— of $x^3+10x$; | 0, | 11, | 28, | 57, | 104, | 175, | 276, | &c. |
| ——— of $5x^2+15$; | 15, | 20, | 35, | 60, | 95, | 140, | 195, | &c. |

By inspecting this table, it appears that while $x$ increases from 0 to a certain numerical value, which exceeds 3, the positive part of the equation, or $x^3 + 10x$, is always less than the negative part, or $5x^2 + 15$; so that the expression

$$x^3 + 10x - (5x^2 + 15) \text{ or } x^3 - 5x^2 + 10x - 15$$

must necessarily be negative.

It also appears, that when $x$ has increased beyond that numerical value, and which is evidently less than 4, the positive part of the equation, instead of being less than the negative part, is now greater, and therefore the expression

$$x^3 - 5x^2 + 10x - 15$$

is changed from a negative to a positive quantity.

Hence we may conclude that there is some real and determinate value of $x$, which is greater than 3, but less than 4, and which will render the positive and negative parts of the equation equal to one another; therefore that value of $x$ must be a root of the proposed equation; and as what has been just now shown in a particular case will readily apply to any equation whatever, the truth of the proposition is obvious.

152. Two limits, between which all the roots of any equation are contained, may be determined by this other proposition:

II. Let N be the greatest negative co-efficient in any equation. Change the signs of the terms taken alternately, beginning with the second, and let N′ be the greatest negative co-efficient after the signs are so changed. The positive roots of the equation are contained between 0 and N+1, and the negative roots between 0 and —N′—1.

Suppose the equation to be

$$x^4 - px^3 + qx^2 - rx - s = 0,$$

which may be also expressed thus:

$$x^4\left(1 - \frac{p}{x} + \frac{q}{x^2} - \frac{r}{x^3} - \frac{s}{x^4}\right) = 0.$$

Then, whatever be the values of the co-efficients $p$, $q$, $r$, &c. it is evident that $x$ may be taken so great as to render each of the quantities $\frac{p}{x}$, $\frac{q}{x^2}$, $\frac{r}{x^3}$, $\frac{s}{x^4}$ as small as we please, and therefore their sum, or $-\frac{p}{x} + \frac{q}{x^2} - \frac{r}{x^3} - \frac{s}{x^4}$, less than 1; but in that case the quantity

$$x^4\left(1 - \frac{p}{x} + \frac{q}{x^2} - \frac{r}{x^3} + \frac{s}{x^4}\right),$$

$$\text{or } x^4 - px^3 + qx^2 - rx + s,$$

will be positive, and such, that the first term $x^4$ is greater than the sum of all the remaining terms; therefore also $x^4 + qx^2$, the sum of the positive terms, will be much greater than $px^3 + rx + s$, the sum of the negative terms alone.

Hence it follows, that if a number be found, which when substituted for $x$, renders the expression $x^4 - px^3 + qx^2 - rx - s$ positive, and which is also such, that every greater number has the same property, that number will exceed the greatest positive root of the equation.

Now, if we suppose N to be the greatest negative co-efficient, it is evident that the positive part of the equation, or $x^4+qx^2$, is greater than $px^3+rx+s$, provided that $x^4$ is greater than $N\,x^3+Nx^2+Nx+N$, or $N\,(x^3+x^2+x+1)$; but $x^3+x^2+x+1=\dfrac{x^4-1}{x-1}$, therefore a positive result will be obtained, if for $x$ there be substituted a number such that $x^4 > \dfrac{N(x^4-1)}{x-1}$*, or $x^5-x^4 > Nx^4-N$. Now this last condition will evidently be fulfilled if we take $x^5-x^4=Nx^4$, and from this equation we find $x=N+1$; but it further appears that the same condition will also be fulfilled as often as $x^5-x^4 > Nx^4$, or $x-1 > N$, that is, $x > N+1$, therefore $N+1$ must be a limit to the greatest positive root of the proposed equation, as was to be shown.

If $-y$ be substituted for $+x$, the equation $x^4-px^3+qx^2-rx-s=0$ will be transformed into $y^4+py^3+qy^2+ry-s=0$; which equation differs from the former only in the signs of the second, fourth, &c. terms; and as the positive roots of this last equation are the same as the negative roots of the proposed equation, it is evident that their limit must be such as has been assigned.

153. From the two preceding propositions it will not be difficult to discover, by means of a few trials, the nearest integers to the roots of any proposed numeral equation; and those being found, we may approximate to the roots continually, as in the following example:

$$x^4-4x^3 * -3x+27=0.$$

Here the greatest negative co-efficient being 4, it follows, sect. 152, that the greatest positive root is less than 5. If $-y$ be substituted for $x$, the equation is transformed to

$$y^4+4y^3 * +3y+27=0,$$

an equation having all its terms positive; therefore it can have no positive roots, and consequently the proposed equation can have no negative roots: its real roots must therefore be contained between 0 and $+5$.

To determine the limits of each root in particular, let 0, 1, 2, 3, 4, be substituted successively for $x$; thus we obtain the following corresponding results:

| | | | | | |
|---|---|---|---|---|---|
| Substitutions for $x$, | 0, | 1, | 2, | 3, | 4, |
| Results, | $+27$, | $+21$, | $+5$, | $-9$, | $+15$. |

Hence it appears that the equation has two real roots, one between 2 and 3, and another between 3 and 4.

That we may approximate to the first root, let us suppose $x=2+y$, where $y$ is a fraction less than unity, and therefore its second and higher powers but small in comparison to its first power: hence, in finding an approximate value of $y$, they may be rejected. Thus we have

$$\begin{aligned} x^4 &= +16+32y, \text{ \&c.} \\ -4x^3 &= -32-48y, \text{ \&c.} \\ -3x &= -\ \ 6-\ \ 3y \\ +27 &= +27 \\ \hline \text{Hence } 0 &= \ \ \ 5-19y \text{ nearly,} \end{aligned}$$

and $y=\dfrac{5}{19}=\cdot26$; therefore, for a first approximation we have $x=2\cdot26$.

Let us next suppose $x=2\cdot26+y'$; then, rejecting as before the second and higher powers of $y'$ on account of their smallness, and retaining three decimal places, we have

$$\begin{aligned} x^4 &= +26\cdot087+46\cdot172y', \text{ \&c.} \\ -4x^3 &= -46\cdot172-61\cdot291y', \text{ \&c.} \\ -3x &= -\ \ 6\cdot780-\ \ 3y' \\ +27 &= +27 \\ \hline 0 &= \ \ \ \cdot135-18\cdot119y' \text{ nearly.} \end{aligned}$$

Hence $y'=\dfrac{\cdot135}{18\cdot119}=\cdot0075$, and $x=2\cdot26+y'=2\cdot2675$. This value of $x$ is true to the last figure, but a more accurate value may be obtained by supposing $x=2\cdot2675+y''$, and finding the value of $y''$ in the same manner as we have already found those of $y'$ and $y$; and thus the approximation may be continued till any required degree of accuracy be obtained.

The second root of the equation, which we have already found to be between 3 and 4, may be investigated in the same manner as the first, and will appear to be 3·6797, the approximation being carried on to the fourth figure of the decimal, in determining each root.

154. In the preceding example we have shown how to approximate to the roots of an adfected equation; but the same method will also apply to pure equations.

For example, let it be required to determine $x$ from this equation, $x^3=2$.

Because $x$ is greater than 1 and less than 2, but nearer to the former number than to the latter, let us assume $x=1+y$; then, rejecting the powers of $y$ which exceed the first, we have $x^3=1+3y$, and therefore $2=1+3y$, and $y=\frac{1}{3}=\cdot3$ nearly; hence $x=1\cdot3$ nearly.

Let us next assume $x=1\cdot3+y$, then, proceeding as before, we find $2=2\cdot197+5\cdot07y$, hence $y=-\dfrac{\cdot197}{5\cdot07}=-\cdot039$, and $x=1\cdot3-\cdot039=1\cdot26$ nearly.

To find a still nearer approximation, let us suppose $x=1\cdot26+y$, then, from this assumption we find $y=-\cdot000079$, and therefore $x=1\cdot259921$, which value is true to the last figure.

155. By assuming an equation of any order with literal co-efficients, a general formula may be investigated for approximating to the roots of equations belonging to that particular order.

Let us take for an example the cubic equation

$$x^3+px^2+qx+r=0,$$

and suppose that $x=a+y$, where $a$ is nearly equal to $x$, and $y$ is a small fraction. Then, by substituting $a+y$ for $x$ in the proposed equation, and rejecting the powers of $y$ which exceed the first, on account of their smallness, we have

$$a^3+pa^2+qa+r+(3a^2+2pa+q)y=0.$$

Hence $y=-\dfrac{a^3+pa^2+qa+r}{3a^2+2pa+q}$,

and $x=a-\dfrac{a^3+pa^2+qa+r}{3a^2+2pa+q}=\dfrac{2a^3+pa^2-r}{3a^2+2pa+q}$.

Let it be required to approximate to a root of the cubic equation $x^3+2x^2+3x-50=0$. Here $p=2$, $q=3$, and $r=-50$; and by trials it appears that $x$ is between 2 and 3, but nearest the latter number; therefore, for the first approximation, $a$ may be supposed $=3$, hence we find

$$x=\frac{2a^3+pa^2-r}{3a^2+2pa+q}=\tfrac{122}{42}=\tfrac{61}{21}.$$

By substituting $\frac{61}{21}$ for $a$ in the formula, and proceeding as

* The sign $>$ denotes that the quantities between which it is placed are unequal. Thus $a > b$ signifies that $a$ is greater than $b$, and $a < c$, that $a$ is less than $c$.

before, a value of $x$ would be found more exact than the former, and so on we may go as far as we please.

156. The method we have hitherto employed for approximating to the roots of equations is known by the name of *the method of successive substitutions*, and was first proposed by Newton. It has been since improved by Lagrange, who has given it a form which has the advantage of showing the progress made in the approximation by each operation. This improved form we now proceed to explain.

Let $a$ denote the whole number next less to the root sought, and $\frac{1}{y}$ a fraction, which, when added to $a$, completes the root; then $x=a+\frac{1}{y}$. If this value of $x$ be substituted in the proposed equation, a new equation involving $y$ will be had, which, when cleared of fractions, will necessarily have a root greater than unity.

Let $b$ be the whole number which is next less than that root; then, for a first approximation, we have $x=a+\frac{1}{b}$. But $b$ being only an approximate value of $y$, in the same manner as $a$ is an approximate value of $x$, we may suppose $y=b+\frac{1}{y'}$; then, by substituting $b+\frac{1}{y'}$ for $y$, we shall have a new equation, involving only $y'$, which must be greater than unity. Putting therefore $b'$ to denote the next whole number less than the root of the equation involving $y'$, we have $y=b+\frac{1}{b'}=\frac{bb'+1}{b'}$; and substituting this value in that of $x$, the result is

$$x=a+\frac{b'}{bb'+1}$$

for a second approximate value of $x$.

To find a third value, we may take $y'=b'+\frac{1}{y''}$; then if $b''$ denote the next whole number less than $y''$, we have

$$y'=b'+\frac{1}{b''}=\frac{b'b''+1}{b''}, \text{ whence}$$

$$y=b+\frac{b''}{b'b''+1}=\frac{bb'b''+b''+b}{b'b''+1}, \text{ and}$$

$$x=a+\frac{b'b''+1}{bb'b''+b''+b'},$$

and so on, to obtain more accurate approximations.

We shall apply this method to the following example:

$$x^3-7x+7=0.$$

Here the positive roots must be between 0 and 8; let us therefore substitute successively, 0, 1, 2, . . . to 8, and we obtain the following results:

Substitutions.

0, 1, 2, 3, 4, 5, 6, 7, 8,

Results.

+7, +1, +1, +13, +43, +97, +181, +301, +463.

But as these results have all the same sign, nothing can be concluded respecting the magnitude of the roots from that circumstance alone. It is however observable, that while $x$ increases from 0 to 1, the results decrease; but that whatever successive magnitudes $x$ has greater than 2, the results increase. We may therefore reasonably conclude, that if the equation have any positive roots, they must be between 1 and 2. Accordingly, by substituting 1·2, 1·4, 1·6, and 1·8, successively for $x$, we find these results, +·328, —·056, —·104, +·232; and as there are here two changes of the signs, it follows that the equation has two positive roots, one between 1·2 and 1·4, and another between 1·6 and 1·8.



Hence it appears, that to find either value of $x$, we may assume $x=1+\frac{1}{y}$; then, by substitution, we have

$$y^3-4y^2+3y+1=0.$$

The limit of the positive root of this last equation is 5, and by substituting 0, 1, 2, 3, 4, successively for $y$, it will be found to have two, one between 1 and 2, and the other between 2 and 3. Therefore, for a first approximation, we have

$$x=1+\tfrac{1}{1},\ x=1+\tfrac{1}{2}, \text{ that is, } x=2,\ x=\tfrac{3}{2}.$$

To approach nearer to the first value of $y$, let us take $y=1+\frac{1}{y'}$, and therefore

$$y'^3-2y'^2-y'+1=0.$$

This last equation will be found to have only one real root between 2 and 3; from which it appears that $y=1+\frac{1}{2}=\frac{3}{2}$, and $x=1+\frac{2}{3}=\frac{5}{3}$.

Let us next suppose $y'=2+\frac{1}{y''}$; hence we find

$$y''^3-3y''^2-4y''-1=0,$$

and from this equation, $y''$ is found to be between 4 and 5. Taking the least limit we have

$$y'=2+\tfrac{1}{4}=\tfrac{9}{4},\ y=1+\tfrac{4}{9}=\tfrac{13}{9},\ x=1+\tfrac{9}{13}=\tfrac{22}{13}.$$

It is easy to continue this process, by assuming $y''=4+\frac{1}{y'''}$, and so on, as far as may be judged necessary.

We return to the second value of $x$, which was found $=\frac{3}{2}$ by the first approximation, and which corresponds to $y=2$. Putting $y=2+\frac{1}{y'}$, and substituting this value in the equation $y^3-4y^2+3y+1=0$, which was formerly found, we get

$$y'^3+y'^2-2y'-1=0.$$

This, as well as the corresponding equation employed in determining the other value of $x$, has only one root greater than unity, which root being between 1 and 2, let us take $y'=1$, we thence find

$$y=3, \text{ and } x=1+\tfrac{1}{3}=\tfrac{4}{3}.$$

Put $y'=1+\frac{1}{y''}$, and we thence find by substitution

$$y''^3-3y''^2-4y''-1=0,$$

an equation which gives $y''$ between 4 and 5; hence, as before,

$$y'=\tfrac{5}{4},\ y=\tfrac{14}{5},\ x=\tfrac{19}{14}.$$

That we may proceed in the approximation, we have only to suppose $y''=4+\frac{1}{y'''}$, and so on.

The equation $x^3-7x+7$ has also a negative root between $-3$ and $-4$; and to find a nearer value, put $x=-3-\frac{1}{y}$; hence, $y^3-20y^2-9y-1=0$, and $y>20$, $y<21$; and therefore, for the first approximation, $x=-3-\frac{1}{20}=-\frac{61}{20}$. By putting $y=20+\frac{1}{y'}$, &c. we may obtain successive values of $x$, each of which will be more exact than that which preceded it.

157. The successive equations which involve $y$, $y'$, $y''$, &c. have never more than one root greater than unity,

unless two or more roots of the proposed equation are contained between the limits $a$ and $a+1$; but then, as in the preceding example, some one of the equations involving $y$, $y'$, &c. will have more than one root greater than unity, and from each root a series of equations may be derived, by which we may approximate to the particular roots of the proposed equation contained between the limits $a$ and $a+1$.

## Sect. XVII.—Of Infinite Series.

158. The resolving of any proposed quantity into a series, is a problem of considerable importance in the application of algebra to the higher branches of the mathematics; and there are various methods by which it may be performed, suited to the particular forms of the quantities.

Any rational fraction may be resolved into a series, by the common operation of algebraic division, as in the following examples:

*Ex.* 1. To change $\frac{ax}{a-x}$ into an infinite series.

Operation.

$$\begin{array}{l} a-x)\,ax \quad \left(x+\frac{x^2}{a}+\frac{x^3}{a^2}+\frac{x^4}{a^3}, \text{ \&c.}\right. \\ \underline{ax-x^2} \\ \quad +x^2 \\ \quad \underline{+x^2-\frac{x^3}{a}} \\ \qquad +\frac{x^3}{a} \\ \qquad \underline{+\frac{x^3}{a}-\frac{x^4}{a^2}} \\ \qquad\quad +\frac{x^4}{a^2} \end{array}$$

Thus it appears that

$$\frac{ax}{a-x}=x+\frac{x^2}{a}+\frac{x^3}{a^2}+\frac{x^4}{a^3}+, \text{ \&c.}$$

Here the law of the series being evident, the terms may be continued at pleasure.

*Ex.* 2. By a like process we find

$$\frac{a^2}{(a+x)^2}=1-\frac{2x}{a}+\frac{3x^2}{a^2}-\frac{4x^3}{a^3}+\frac{5x^4}{a^4}-, \text{ \&c.}$$

the law of continuation being evident.

159. A second method by which algebraic quantities, whether rational or irrational, may be converted into series, and which is also of very extensive use in the higher parts of the mathematics, consists in assuming a series with indeterminate co-efficients, and having its terms arranged according to the powers of some quantity contained in the proposed expression.

That we may explain this method, let us suppose that the fraction $\frac{a^2}{a^2+ax+x^2}$ is to be converted into a series proceeding by the powers of $x$. We are therefore to assume

$$\frac{a^2}{a^2+ax+x^2}=A+Bx+Cx^2+Dx^3+Ex^4+, \text{ \&c.}$$

where A denotes those terms of the series into which $x$ does not at all enter, B$x$ the terms which contain only the first power of $x$, C$x^2$ the terms which contain only the second power, and so on. Let both sides of the equation be multiplied by $a^2+ax+x^2$, so as to take away the denominator of the fraction, and let the numerator $a^2$ be transposed to the other side, so that the whole expression may be $=0$; then

$$\left.\begin{array}{l} a^2A+a^2B \\ -a^2+aA \end{array}\right\} x \left.\begin{array}{l} +a^2C \\ +aB \\ +A \end{array}\right\} x^2 \left.\begin{array}{l} +a^2D \\ +aC \\ +B \end{array}\right\} x^3 \left.\begin{array}{l} +a^2E \\ +aD \\ +C \end{array}\right\} x^4, \text{ \&c.}=0.$$

Now the quantities A, B, C, D, &c. being supposed to be entirely independent of any particular value of $x$, it follows that the whole expression can only be $=0$, upon the supposition that the terms which multiply the same powers of $x$ are separately $=0$; for if that were not the case, it would follow that $x$ had a determinate relation to the quantities A, B, C, &c. which is contrary to what we have supposed. To determine the quantities A, B, C, &c. therefore, we have this series of equations,

$$\begin{array}{ll} a^2A-a^2 \quad =0, & \text{hence } A=1; \\ a^2B+aA \quad =0, & B=-\frac{A}{a}=-\frac{1}{a}; \\ a^2C+aB+A=0, & C=-\frac{B}{a}-\frac{A}{a^2}=0; \\ a^2D+aC+B=0, & D=-\frac{C}{a}-\frac{B}{a^2}=\frac{1}{a^3}; \\ a^2E+aD+C=0, & E=-\frac{D}{a}-\frac{C}{a^2}=-\frac{1}{a^4}, \\ \text{\&c.} & \text{\&c.} \end{array}$$

Here the law of relation which takes place among the quantities A, B, C, D, &c. is evident, viz. that if P, Q, R denote any three co-efficients which immediately follow each other,

$$a^2R+aQ+P=0;$$

and from this equation, by means of the co-efficients already determined, we find $F=0$, $G=\frac{1}{a^6}$, $H=-\frac{1}{a^7}$, $K=0$, &c.

Therefore, resuming the assumed equation, and substituting for A, B, C, &c. their respective values, we have

$$\frac{a^2}{a^2+ax+x^2}=1-\frac{x}{a} * +\frac{x^3}{a^3}-\frac{x^4}{a^4} * +\frac{x^6}{a^6}-\frac{x^7}{a^7} * +, \text{\&c.}$$

As a second example of the method of indeterminate co-efficients, let it be required to express the square root $a^2-x^2$ by means of a series. For this purpose we might assume

$$\sqrt{a^2-x^2}=A+Bx+Cx^2+Dx^3+Ex^4+, \text{ \&c.};$$

but as we would then find the co-efficients of the odd powers of $x$ to be each $=0$, let us rather assume

$$\sqrt{a^2-x^2}=A+Bx^2+Cx^4+Dx^6+, \text{ \&c.}$$

then, squaring both sides, and transposing, we have

$$0=\left\{\begin{array}{l} A^2+2AB \\ \quad + \quad 1 \\ -a^2 \end{array}\right\} x^2 \left.\begin{array}{l} +2AC \\ \\ +B^2 \end{array}\right\} x^4 \left.\begin{array}{l} +2AD \\ \\ +2BC \end{array}\right\} x^6+, \text{ \&c.}$$

$$\begin{array}{lll} \text{Hence } A^2-a^2 & =0, & \text{and } A=a; \\ 2AB+1 & =0, & B=-\frac{1}{2A}=-\frac{1}{2a}; \\ 2AC+B^2 & =0, & C=-\frac{B^2}{2A}=-\frac{1}{8a^3}; \\ AD+BC & =0, & D=-\frac{BC}{A}=-\frac{1}{16a^5}; \\ \text{\&c.} & & \text{\&c.} \end{array}$$

Algebra. and substituting for A, B, C, &c. their values;

$$\sqrt{a^2-x^2}=a-\frac{x^2}{2a}-\frac{x^4}{8a^3}-\frac{x^6}{16a^5}-, \text{\&c.}$$

This method of resolving a quantity into any infinite series will be found more expeditious than any other, as often as the operations of division and evolution are to be performed at the same time, as in these expressions,

$$\frac{1}{\sqrt{a^2+x^2}}, \text{ or } \frac{\sqrt{a^2-x^2}}{\sqrt[3]{a^3+x^3}}.$$

160. The binomial theorem affords a third method of resolving quantities into series; but we must first show how the theorem itself may be investigated.

Let $a+x$ be any binomial quantity which is to be raised to a power denoted by $\frac{m}{n}$, where $m$ and $n$ are any numbers either positive or negative.

Because $a+x=a\left(1+\frac{x}{a}\right)$, if we put $\frac{x}{a}=y$, then $(a+x)^{\frac{m}{n}}$ $=a^{\frac{m}{n}}\times(1+y)^{\frac{m}{n}}$; therefore, instead of $a+x$, we may consider $1+y$, which is somewhat more simple in its form.

By considering some integer powers of $1+x$, as

$$\begin{aligned}(1+x)&=1+x,\\(1+x)^2&=1+2x+x^2,\\(1+x)^3&=1+3x+3x^2+x^3,\\(1+x)^4&=1+4x+6x^2+4x^3+x^4,\\&\text{\&c.}\end{aligned}$$

it may be inferred that all powers of $1+x$ have this form,

$$1+Ax+Bx^2+Cx^3+Dx^4+Ex^5+, \text{\&c.}$$

where the co-efficients A, B, C, D, E, &c. are numbers which are altogether independent of any particular value of $x$. It also appears that the series cannot contain any negative power of $x$; for if any of its terms had this form, $\frac{Q}{x^r}$, then the supposition of $x=0$ would render that term indefinitely great; whereas the whole series ought in that case to be reduced to unity.

Let us therefore assume

$$(1+y)^{\frac{m}{n}}=1+Ay+By^2+Cy^3+Dy^4+, \text{\&c.}$$

Then we have also

$$(1+z)^{\frac{m}{n}}=1+Az+Bz^2+Cz^3+Dz^4+Ez^5+, \text{\&c.}$$

Let us put $(1+y)^{\frac{1}{n}}=u$, $(1+z)^{\frac{1}{n}}=v$, and therefore $(1+y)^{\frac{m}{n}}=u^m$, $(1+z)^{\frac{m}{n}}=v^m$; then, taking the difference between the two series, we have

$$u^m-v^m=A(y-z)+B(y^2-z^2)+C(y^3-z^3)+D(y^4-z^4)+E(y^5-z^5)+, \text{\&c.}$$

Because $u^n=1+y$ and $v^n=1+z$, by subtracting the latter equation from the former, we have $u^n-v^n=y-z$; hence, and from the last series, it follows that

$$\frac{u^m-v^m}{u^n-v^n}=\frac{A(y-z)}{y-z}+\frac{B(y^2-z^2)}{y-z}+\frac{C(y^3-z^3)}{y-z}+\frac{D(y^4-z^4)}{y-z}+\frac{E(y^5-z^5)}{y-z}+, \text{\&c.}$$

But every expression of the form $u^m-v^m$ is divisible by $u-v$, when $m$ is a whole number. Thus we have

$$\left.\begin{aligned}u^m-v^m&=(u-v)\,(u^{m-1}+u^{m-2}v\ldots+uv^{m-2}+v^{m-1})\\u^n-v^n&=(u-v)\,(u^{n-1}+u^{n-2}v\ldots+uv^{n-2}+v^{n-1})\end{aligned}\right\}$$

so that if we substitute for $\frac{u^m-v^m}{u^n-v^n}$ its value as found from these equations, and divide each term of the series by the denominator $y-z$, we have Algebra.

$$\frac{u^{m-1}+u^{m-2}v\ldots+uv^{m-2}+v^{m-1}}{u^{n-1}+u^{n-2}v\ldots+uv^{n-2}+v^{n-1}}=$$
$$A+B(y+z)+C(y^2+yz+z^2)+D(y^3+y^2z+yz^2+z^3)+E(y^4+y^3z+y^2z^2+yz^3+z^4)+, \text{\&c.}$$

Now, as this last equation must be true, whatever be the values of $y$ and $z$, we may suppose $y=z$, but in that case $1+y=1+z$, or $u^n=v^n$, and therefore $u=v$. Thus the equation is reduced to

$$\frac{mu^{m-1}}{nu^{n-1}}=A+2By+3Cy^2+4Dy^3+5Ey^4+, \text{\&c.}$$

or to the following:

$$\frac{m}{n}u^m=u^n\,(A+2\,By+3\,Cy^2+4\,Dy^3+5\,Ey^4+, \text{\&c.});$$

so that, putting for $u^m$ and $u^n$ their values $(1+y)^{\frac{m}{n}}$ and $1+y$, we have

$$\frac{m}{n}(1+y)^{\frac{m}{n}}=(1+y)(A+2By+3Cy^2+4Dy^3+5Ey^4+, \text{\&c.})$$
$$=\begin{cases}A+2\,By+3\,Cy^2+4\,Dy^3+5\,Ey^4+, \text{\&c.}\\ \quad+Ay+2\,By^2+3\,Cy^3+4\,Dy^4+, \text{\&c.}\end{cases}$$

But from the equation originally assumed we have

$$\frac{m}{n}(1+y)^{\frac{m}{n}}=$$
$$\frac{m}{n}+\frac{m}{n}Ay+\frac{m}{n}By^2+\frac{m}{n}Cy^3+\frac{m}{n}Dy^4+, \text{\&c.}$$

Therefore

$$\frac{m}{n}+\frac{m}{n}Ay+\frac{m}{n}By^2+\frac{m}{n}Cy^3+\frac{m}{n}Dy^4+, \text{\&c.}$$
$$=\begin{cases}A+2By+3Cy^2+4Dy^3+5Ey^4+, \text{\&c.}\\ \quad+Ay+2By^2+3Cy^3+4Dy^4+, \text{\&c.}\end{cases}$$

And as the co-efficients of the terms have no connection with any particular value of $y$, it follows that the co-efficient of any power of $y$ on the one side of the equation must be equal to the co-efficient of the same power of $y$ on the other side. Therefore, to determine A, B, C, &c. we have the following series of equations:

$$A=\frac{m}{n}, \qquad \text{hence } A=\frac{m}{n};$$

$$2B+A=\frac{m}{n}A, \qquad B=\frac{A\left(\frac{m}{n}-1\right)}{2}=\frac{A\,(m-n)}{2n};$$

$$3C+2B=\frac{m}{n}B, \qquad C=\frac{B\left(\frac{m}{n}-2\right)}{3}=\frac{B\,(m-2n)}{3n};$$

$$4D+3C=\frac{m}{n}C, \qquad D=\frac{C\left(\frac{m}{n}-3\right)}{4}=\frac{C\,(m-3n)}{4n};$$

$$5E+4D=\frac{m}{n}D, \qquad E=\frac{D\left(\frac{m}{n}-4\right)}{5}=\frac{D\,(m-4n)}{5n};$$

&c. &c.

Or, substituting for A, B, C, &c. their values as determined from the preceding equations:

$$A=\frac{m}{n},$$

$$B=\frac{m\,(m-n)}{1\ \ 2n^2},$$

$$C=\frac{m\,(m-n)\,(m-2n)}{1\cdot 2\cdot 3\ \ n^3},$$

$$D=\frac{m(m-n)(m-2n)(m-3n)}{1\cdot 2\cdot 3\cdot 4\ n^4},$$

$$E=\frac{m(m-n)(m-2n)(m-3n)(m-4n)}{1.2\ 3\ 4.5\ n^5},$$

&c.

Resuming now the assumed equation

$$(1+y)^{\frac{m}{n}}=1+Ay+By^2+Cy^3+,\ \&c.$$

and observing that $\frac{x}{a}=y$, and $(a+x)^{\frac{m}{n}}=a^{\frac{m}{n}}(1+y)^{\frac{m}{n}}$, we have $(a+x)^{\frac{m}{n}}$ expressed by the series

$$a^{\frac{m}{n}}\left(1+\frac{m}{n}\frac{x}{a}+\frac{A(m-n)}{2n}\frac{x^2}{a^2}+\frac{B(m-2n)}{3n}\frac{x^3}{a^3}+\frac{C(m-3n)}{4n}\frac{x^4}{a^4}+\frac{D(m-4n)}{5n}\frac{x^5}{a^5}+,\ \&c.\right)$$

where A, B, C, &c. denote the co-efficients of the preceding terms, or

$$(a+x)^{\frac{m}{n}}=a^{\frac{m}{n}}+\frac{m}{n}a^{\frac{m-n}{n}}x+\frac{m(m-n)}{1\cdot 2\ n^2}a^{\frac{m-2n}{n}}x^2+\frac{m(m-n)(m-2n)}{1\cdot 2\cdot 3\ n^3}a^{\frac{m-3n}{n}}x^3+\frac{m(m-n)(m-2n)(m-3n)}{1\cdot 2\cdot 3\cdot 4\ n^4}{}^{\frac{m-4n}{n}}ax^4+,\ \&c.;$$

and either of these formulæ may be considered as a general theorem for raising a binomial quantity $a+x$ to any power whatever.

161. In determining the value of the expression $\frac{u^m-v^m}{u^n-v^n}$, when $u=v$, it has been assumed that $\frac{m}{n}$ is positive; but the same conclusion will be obtained when $\frac{m}{n}$ is negative. For, changing $+m$ into $-m$, and observing that

$$u^{-m}-v^{-m}=\frac{1}{u^m}-\frac{1}{v^m}=\frac{v^m-u^m}{u^mv^m},$$

we have

$$\frac{u^{-m}-v^{-m}}{u^n-v^n}=\frac{1}{u^mv^m}\left(\frac{v^m-u^m}{u^n-v^n}\right)=-\frac{1}{u^mv^m}\left(\frac{u^m-v^m}{u^n-v^n}\right).$$

Now we have already found, that when $u=v$, the fraction $\frac{u^m-v^m}{u^n-v^n}$ becomes $\frac{mu^{m-1}}{nu^{n-1}}$; therefore, in the same case,

$$\frac{u^{-m}-v^{-m}}{u^n-v^n}=\frac{-1}{u^{2m}}\times\frac{mu^{m-1}}{nu^{n-1}}=\frac{-mu^{-m-1}}{nu^{n-1}};$$

and from this last expression we derive the same value for $u^{-m}$ or $(1+y)^{\frac{-m}{n}}$ as before, regard being had to the change of the sign of the exponent.

162. If we suppose $m$ to be a positive integer, and $n=1$, the series given in last article for the powers of $a+x$ will always terminate, as appears also from the operation of involution; but if $m$ be negative, or $\frac{m}{n}$ a fraction, the series will consist of an indefinite number of terms. Examples of the application of the theorem have been already given upon the first supposition, when treating of involution; we now proceed to show how it is to be applied to the expansion of algebraic quantities into series upon either of the last two hypotheses.

*Ex.* 1. It is required to express $\frac{r^3}{(r+z)^3}$ by means of a series.

Because $\frac{r}{r+z}=\frac{1}{1+\frac{z}{r}}$,

therefore $\frac{r^3}{(r+z)^3}=\frac{1}{\left(1+\frac{z}{r}\right)^3}=\left(1+\frac{z}{a}\right)^{-3}$

Let $\left(1+\frac{z}{r}\right)^{-3}$ be compared with $(a+x)^{\frac{m}{n}}$, and we have $a=1$, $x=\frac{z}{r}$, $m=-3$, $n=1$.

Hence, by substituting these values of $a$, $x$, $m$, $n$, in the first general formula of sect. 160, we have

$$\frac{r^3}{(r+z)^3}\begin{cases}=1-\frac{3z}{r}+\frac{3\cdot 4z^2}{1\cdot 2r^2}-\frac{3\cdot 4\cdot 5z^3}{1\cdot 2\cdot 3r^3}+,\ \&c.\\ =1-\frac{3z}{r}+\frac{6z^2}{r^2}-\frac{10z^3}{r^3}+\frac{15z^4}{r^4}-,\ \&c.\end{cases}$$

*Ex.* 2. It is required to express $\sqrt[3]{a+b}$ in the form of a series.

Because $a+b=a\left(1+\frac{b}{a}\right)$,

therefore $\sqrt[3]{a+b}=\sqrt[3]{a}\times\sqrt[3]{1+\frac{b}{a}}=a^{\frac{1}{3}}\left(1+\frac{b}{a}\right)^{\frac{1}{3}}$.

By comparing $\left(1+\frac{b}{a}\right)^{\frac{1}{3}}$ with $(a+x)^{\frac{m}{n}}$, we have $a=1$, $x=\frac{b}{a}$, $m=1$, $n=3$, and $\sqrt[3]{a+b}$

$$=a^{\frac{1}{3}}\left(1+\frac{1\cdot b}{3a}-\frac{1\cdot 2b^2}{3\cdot 6a^2}+\frac{1\cdot 2\cdot 5b^3}{3\cdot 6\cdot 9a^3}-\frac{1\cdot 2\cdot 5\cdot 8b^4}{3\cdot 6\cdot 9\cdot 12a^4}+,\ \&c.\right)$$

$$=a^{\frac{1}{3}}\left(1+\frac{b}{3a}-\frac{b^2}{9a^2}+\frac{5b^3}{81a^3}-\frac{10b^4}{243a^4}+,\ \&c.\right)$$

*Ex.* 3. It is required to resolve $\frac{r^2}{(r^3+z^3)^{\frac{2}{3}}}$ into a series.

Because $\frac{r^2}{(r^3+z^3)^{\frac{2}{3}}}=r^2(+z3)^{-\frac{2}{3}}$ if we raise $r^3+z^3$ to the $-\frac{2}{3}$ power, and multiply the resulting series by $r^2$, we shall have the series required. Or the given quantity may be reduced to a more simple form thus: because

$$r^3+z^3=r^3\times\left(1+\frac{z^3}{r^3}\right),$$

therefore $(r^3+z^3)^{\frac{2}{3}}=r^2\left(1+\frac{z^3}{r^3}\right)^{\frac{2}{3}}$,

and $\frac{r^2}{(r^3+z^3)^{\frac{2}{3}}}=\frac{1}{\left(1+\frac{z^3}{r^3}\right)^{\frac{2}{3}}}=\left(1+\frac{z^3}{r^3}\right)^{-\frac{2}{3}}$.

Hence $\frac{r^2}{(r^3+z^3)^{\frac{2}{3}}}=\left(1+\frac{z^3}{r^3}\right)^{-\frac{2}{3}}$

$$=1-\frac{2z^3}{3r^3}+\frac{2\cdot 5z^6}{3\cdot 6r^6}-\frac{2\cdot 5\cdot 8z^9}{3\cdot 6\cdot 9r^9}+\frac{2\cdot 5\cdot 8\cdot 11z^{12}}{3\cdot 6\cdot 9\cdot 12r^{12}}-,\ \&c.$$

$$=1-\frac{2z^3}{3r^3}+\frac{5z^6}{9}-\frac{40z^9}{81r^9}+\frac{110z^{12}}{243r^{12}}-.\ \&c.$$

*Ex.* 4. It is required to find a series equal to $\frac{\sqrt{a^2+x^2}}{\sqrt{a^2-x^2}}$

By the binomial theorem, we have

$$\sqrt{a^2+x^2}=(a^2+x^2)^{\frac{1}{2}}=a+\frac{x^2}{2a}-\frac{x^4}{8a^3}+\frac{x^6}{16a^5}-,\ \&c.$$

$$\frac{1}{\sqrt{a^2-x^2}}=(a^2-x^2)^{-\frac{1}{2}}=\frac{1}{a}+\frac{x^2}{2a^3}+\frac{3x^4}{8a^5}+\frac{5x^6}{16a^7}+, \&c.$$

Therefore, by taking the product of the two series, and proceeding in the operation only to such terms as involve the 6th power of $x$, we find

$$\frac{\sqrt{a^2+x^2}}{\sqrt{a^2-x^2}}=1+\frac{x^2}{a^2}-\frac{x^4}{2a^4}+\frac{x^6}{2a^6}, \&c.$$

## Sect. XVIII.—Of the Reversion of Series.

163. The method of indeterminate co-efficients, which we have already employed when treating of infinite series, may also be applied to what is called the reverting of series; that is, having any quantity expressed by an infinite series composed of the powers of another quantity, to express, on the contrary, the latter quantity by means of an infinite series composed of the powers of the former.

Let $y=n+ax+bx^2+cx^3+dx^4+$, &c.

Then, to revert the series, we must find the value of $x$ in terms of $y$. For this purpose, we transpose $n$, and put $z=y-n$; then

$$z=ax+bx^2+cx^3+dx^4+, \&c.$$

Now, when $x=0$, it is evident that $z=0$; therefore we may assume for $x$ a series of this form,

$$x=Az+Bz^2+Cz^3+Dz^4+, \&c.$$

where the co-efficients A, B, C, D, &c. denote quantities as yet unknown, but which are entirely independent of the quantity $x$. To determine these, let the first, second, third, &c. powers of the series

$$Az+Bz^2+Cz^3+Dz^4+, \&c.$$

be found by multiplication, and substituted for $x$, $x^2$, $x^3$, &c. respectively, in the equation

$$0=-z+ax+bx^2+cx^3, \&c.$$

thus we have

$$\left.\begin{array}{lllll}
-z & =-z & & & \\
+ax & =aAz & +aB\,z^2 & +\;aCz^3 & +\;aDz^4+, \&c. \\
+bx^2 & = & +bA^2z^2 & +2bABz^3 & +2bACz^4+, \&c. \\
 & & & & +\;bB^2z^4 \\
+cx^3 & = & & +\;cA^3z^3 & +3cA^2Bz^4+, \&c. \\
+dx^4 & = & & & +\;dA^4z^4+, \&c. \\
\&c. & & & &
\end{array}\right\}=0$$

Hence, putting the co-efficients of $z$, $z^2$, $z^3$, &c. each $=0$,

$$aA-1=0,\quad aB+bA^2=0,\quad aC+2bAB+cA^3=0,$$
$$aD+2bAC+bB^2+3cA^2B+dA^4=0, \&c.$$

these equations give

$$A=\frac{1}{a},$$

$$B=-\frac{b}{a^3},$$

$$C=\frac{2b^2-ac}{a^5},$$

$$D=-\frac{5b^3-5abc+a^2d}{a^7},$$

&c.

Therefore $$x=\frac{1}{a}z-\frac{b}{a^3}z^2+\frac{2b^2-ac}{a^5}z^3-\frac{5b^3-5abc+a^2d}{a^7}z^4+, \&c.$$

As an example of the application of this formula, let it be required to determine $x$ from the equation

$$y=x-\frac{x^2}{2}+\frac{x^3}{3}-\frac{x^4}{4}+, \&c.$$

In this case we have

$$z=y,\ a=1,\ b=-\tfrac{1}{2},\ c=\tfrac{1}{3},\ d=-\tfrac{1}{4}, \&c.$$

Therefore, substituting these values, we have

$$x=y+\frac{y^2}{2}+\frac{y^3}{6}+\frac{y^4}{24}+, \&c.$$

In the equation

$$ay+by^2+cy^3+, \&c. = a'x+b'x^2+c'x^3+, \&c.$$

in which both sides are expressed by series, and it is required to find $y$ in terms of $x$, we must assume, as before,

$$y=Ax+Bx^2+Cx^3+Dx^4+, \&c.$$

and substitute this series and its powers for $y$ and its powers in the proposed equation; afterwards, by bringing all the terms to one side, and making the co-efficients of each power of $y=0$, a series of equations will be had by which the quantities A, B, C, D, &c. may be determined.

## Sect. XIX.—Of Logarithms and Exponential Quantities.

164. All positive numbers may be considered as powers of any one given affirmative number. The powers of 2, for instance, may become equal, either exactly, or nearer than by any assignable difference, to all numbers whatever, from 1 upwards. If the exponents be integers, we shall have only the numbers which form the geometrical progression, 1, 2, 4, 8, 16, &c.; but the intermediate numbers may be expressed, at least nearly, by means of fractional exponents. Thus, the numbers from 1 to 10 may be expressed by the powers of 2 as follows:

| | |
|---|---|
| $2^0=1$ | $2^{2\cdot585}=6$ |
| $2^1=2$ | $2^{2\cdot807}=7$ |
| $2^{1\cdot585}=3$ | $2^{3\cdot}=8$ |
| $2^2=4$ | $2^{3\cdot170}=9$ |
| $2^{2\cdot322}=5$ | $2^{3\cdot322}=10$ |

In like manner may fractions be expressed by the powers of 2. Thus,

$$\cdot1=\frac{1}{2^{3\cdot322}}=2^{-3\cdot322},\quad \cdot2=\frac{1}{2^{2\cdot322}}=2^{-2\cdot322},$$

$$\cdot3=\frac{1}{2^{1\cdot737}}=2^{-1\cdot737}, \&c.$$

where it is observable that the exponents are now negative.

In the same manner may all numbers be expressed by the powers of 10.

| | |
|---|---|
| $10^0=1$ | $10^{-1}=\cdot1$ |
| $10^{\cdot301}=2$ | $10^{-\cdot699}=\cdot2$ |
| $10^{\cdot477}=3$ | $10^{-\cdot523}=\cdot3$ |
| &c. | &c. |

Even a fraction might be taken in place of 2, or 10, in the preceding examples; and such exponents might be found as would give its powers equal to all numbers, from 0 upwards. There are therefore no limitations with respect to the magnitude of the number, by the powers of which all other numbers may be expressed, except that it must neither be unity nor a negative quantity. If it were $=1$, then all its powers would also be $=1$; and if it were negative, there are numbers to which none of its powers could possibly be equal.

165. If therefore $y$ denote any number whatever, and $r$ a given number, a number $x$ may be found, such, that $r^x=y$, and $x$, that is, the exponent of $r$ which gives a number equal to $y$, is called the *logarithm* of $y$.

The given number $r$, by the powers of which all other numbers are expressed, is called the *radical number* of the logarithms, which are the indices of those powers.

166. From this definition of logarithms their properties are easily deduced as follows:

1. The sum of two logarithms is equal to the logarithm of their product. Let $y$ and $y'$ be two numbers, and $x$ and $x'$ their logarithms, so that $r^x=y$, and $r^{x'}=y'$; then $r^x\times r^{x'}=yy'$, or $r^{x+x'}=yy'$; hence, from the definition, $x+x'$ is the logarithm of $yy'$, that is, the sum of the logarithms of $y$ and $y'$ is the logarithm of $yy'$.

2. The difference of the logarithms of two numbers is equal to the logarithm of their quotient; for if $r^x=y$ and $r^{x'}=y'$, then $\frac{r^x}{r^{x'}}=\frac{y}{y'}$ or $r^{x-x'}=\frac{y}{y'}$, therefore, by the definition, $x-x'$ is the logarithm of $\frac{y}{y'}$; that is, the difference of the logarithms of $y$ and $y'$ is the logarithm of $\frac{y}{y'}$.

3. Let $n$ be any number whatever, then log. $y^n=n\times$ log. $y$. For $y^n$ is $y$ multiplied into itself $n$ times, therefore the logarithm of $y^n$ is equal to the logarithm of $y$ added to itself $n$ times, or to $n\times$ log. $y$.

167. From these properties of logarithms it follows, that if we possess tables by which we can assign the logarithm corresponding to any given number, and also the number corresponding to any given logarithm, the operations of multiplication and division of numbers may be reduced to the addition and subtraction of their logarithms, and the operations of involution and evolution, to the more simple operations of multiplication and division. Thus, if two numbers $x$ and $y$ are to be multiplied together, by taking the sum of their logarithms, we obtain the logarithm of their product, and, by inspecting the table, the product itself. A similar observation applies to the quotient of two numbers, and also to any power or to any root of a number.

168. The general properties of logarithms are independent of any particular value of the radical number, and hence there may be various systems of logarithms, according to the radical number employed in their construction. Thus, if the radical number be 10, we shall have the *common* or Briggs's system of logarithms; but if it were 2·7182818, we should have the logarithms first constructed by Lord Napier, which are sometimes called *hyperbolic logarithms.*

We have already observed (sect. 165), that the relation between any number and its logarithm is expressed by the equation $r^x=y$, where $y$ denotes a number, $x$ its logarithm, and $r$ the radical number of the system; and any two of these three quantities being given, the remaining one may be found. If either $y$ or $r$ were the quantity required, the problem would involve no difficulty; if, however, the exponent $x$ were considered as the unknown quantity, while $r$ and $y$ were supposed given, the equation to be resolved would be of a different kind from any we have hitherto considered. Equations of this form are called *exponential* equations. To resolve such an equation is evidently the same thing as to determine the logarithm of a given number.

169. We therefore resume the equation $r^x=y$, where $r$, $x$, and $y$ denote as before. We are now to find a value of $x$ in terms of $r$ and $y$. Let us suppose $r=1+a$ and $y=1+v$, then our equation will stand thus:

$$(1+a)^x=1+v.$$

So that, by raising both sides to a power $n$, where $n$ denotes an indeterminate number, which is to disappear in the course of the investigation, we have $(1+a)^{nx}=(1+v)^n$; and resolving both sides of the equation into series by means of the binomial theorem,

$$1+nxa+\frac{nx(nx-1)}{1\cdot 2}a^2+\frac{nx(nx-1)(nx-2)}{1\cdot 2\cdot 3}a^3$$
$$+\frac{nx(nx-1)(nx-2)(nx-3)}{1\cdot 2\cdot 3\cdot 4}a^4+,\ \&c.$$
$$=1+nv+\frac{n(n-1)}{1\cdot 2}v^2+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}v^3$$
$$+\frac{n(n-1)(n-2)(n-3)}{1\cdot 2\cdot 3\cdot 4}v^4+,\ \&c.$$

Therefore, subtracting unity from both sides, and dividing by $n$, we have

$$xa+\frac{x(nx-1)}{1\cdot 2}a^2+\frac{x(nx-1)(nx-2)}{1\cdot 2\cdot 3}a^3$$
$$+\frac{x(nx-1)(nx-2)(nx-3)}{1\cdot 2\cdot 3\cdot 4}a^4+,\ \&c.$$
$$=v+\frac{n-1}{2}v^2+\frac{(n-1)(n-2)}{2\cdot 3}v^3$$
$$+\frac{(n-1)(n-2)(n-3)}{2\cdot 3\cdot 4}v^4+,\ \&c.;$$

and by supposing the factors which constitute the terms of each series to be actually multiplied, and the products arranged according to the power of $n$, the last equation will have this form,

$$xa+\left(Pn-\frac{x}{2}\right)a^2+\left(P'n+Qn^2+\frac{x}{3}\right)a^3$$
$$+\left(P''n+Q'n^2+Rn^3-\frac{x}{4}\right)a^4+,\ \&c.$$
$$=v+(pn-\tfrac{1}{2})v^2+(p'n+qn^2+\tfrac{1}{3})v^3$$
$$+(p''n+q'n^2+rn^3-\tfrac{1}{4})v^4+,\ \&c.$$

Here the co-efficients of the power $n$, viz. P, P′, P″, &c. Q, Q′, &c. R, &c. also $p$, $p'$, $p''$, &c. $q$, $q'$, &c. $r$, &c. are expressions which denote certain combinations of the powers of $x$ in the first series, and certain numbers in the second; but as they are all to vanish in the course of the investigation, it is not necessary that they should be expressed in any other way than by a single letter.

Now each side of this last equation may evidently be resolved into two parts, one of which is entirely free from the quantity $n$, and the other involves that quantity; hence the same equation may also stand thus:

$$\left.\begin{array}{l} xa-\frac{x}{2}a^2+\frac{x}{3}a^3-\frac{x}{4}a^4+,\ \&c. \\ +Pna^2+(P'n+Qn^2)a^3+(P''n+Q'n^2+Rn^3)a^4+,\ \&c. \end{array}\right\}$$
$$=\left\{\begin{array}{l} +v-\tfrac{1}{2}v^2+\tfrac{1}{3}v^3-\tfrac{1}{4}v^4+,\ \&c. \\ +pnv^2+(p'n+qn^2)v+(p''n+q'n^2+rn^3)v^4+,\ \&c. \end{array}\right.$$

This equation must hold true, whatever be the value of $n$, which is a quantity entirely arbitrary, and therefore ought to vanish from the equation expressing the relation between $x$ and $v$; hence it follows that the terms on each side of the equation, which involve $n$, ought to destroy each other, and thus there will remain only the part of each side which does not involve $n$; that is,

$$xa-\frac{xa^2}{2}+\frac{xa^3}{3}-\frac{xa^4}{4}+,\ \&c.$$
$$=v-\frac{v^2}{2}+\frac{v^3}{3}-\frac{v^4}{4}+,\ \&c.$$
$$\text{or } (a-\frac{a^2}{2}+\frac{a^3}{3}-\frac{a^4}{4}+,\ \&c.)x$$
$$=v-\frac{v^2}{2}+\frac{v^3}{3}-\frac{v^4}{4}+\frac{v^5}{5}-,\ \&c.$$

Let us now put A to denote the constant multiplier

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$$a-\frac{a^2}{2}+\frac{a^3}{3}-\frac{a}{4}+, \&c.$$

$$=(r-1)-\frac{(r-1)^2}{2}+\frac{(r-1)^3}{3}-\frac{(r-1)^4}{4}+, \&c.$$

and substitute for $v$ its value, $y-1$; thus we find $x=$

$$\text{log.}\ y=\frac{1}{A}(y-1)-\frac{(y-1)^2}{2}+\frac{(y-1)^3}{3}-\frac{(y-1)^4}{4}+, \&c.$$

and by this formula, the logarithm of any number a little greater than unity may be readily found.

170. If $y$ be nearly $=2$, the series will converge too slowly to be of use, and if it exceed 2, the series will diverge, and therefore cannot be directly applied to the finding of its logarithm. But a series which converges faster, and is applicable to every case, may be investigated as follows:

Because $\text{log.}\ (1+v)=\frac{1}{A}(v-\frac{v^2}{2}+\frac{v^3}{3}-\frac{v^4}{4}+, \&c.)$;

by substituting $-v$ for $+v$, we have

$$\text{log.}\ (1-v)=\frac{1}{A}\left(-v-\frac{v^2}{2}-\frac{v^3}{3}-\frac{v^4}{4}-, \&c.\right)$$

Now, $\text{log.}\ (1+v)-\text{log.}\ (1-v)=\text{log.}\ \frac{1+v}{1-v}$; therefore, subtracting the latter series from the former, we have

$$\text{log.}\ \frac{1+v}{1-v}=\frac{2}{A}\left(v+\frac{v^3}{3}+\frac{v^5}{5}+\frac{v^7}{7}+, \&c.\right)$$

Put $\frac{1+v}{1-v}=y$, then $v=\frac{y-1}{y+1}$, and the last series becomes

$$\text{log.}\ y=\frac{2}{A}\left\{\frac{y-1}{y+1}+\frac{1}{3}\left(\frac{y-1}{y+1}\right)^3+\frac{1}{5}\left(\frac{y-1}{y+1}\right)^5+, \&c.\right\}$$

This series will always converge, whatever be the value of $y$; and by means of it the logarithms of small numbers may be found with great facility.

171. When a number is composite, its logarithm will most easily be found, by adding together the logarithms of its factors; but if it be a prime number, its logarithm may be derived from that of some convenient composite number, either greater or less, and an infinite series. Let $n$ be a number of which the logarithm is already found; then, substituting $\frac{n+z}{n}$ for $y$ in the last formula, we have

$$\text{log.}\ \frac{n+z}{n}=\frac{1}{A}\left(\frac{2z}{2n+z}+\frac{1}{3}\,\frac{2z^3}{(2n+z)^3}+\frac{1}{5}\,\frac{2z^5}{(2n+z)^5}+, \&c.\right)$$

But $\text{log.}\ \frac{n+z}{n}=\text{log.}\ (n+z)-\text{log.}\ n$, therefore $\text{log.}\ (n+z)=$

$$\text{log.}\ n+\frac{1}{A}\left(\frac{2z}{2n+z}+\frac{1}{3}\,\frac{2z^3}{(2n+z)^3}+\frac{2z^5}{(2n+z)^5}+, \&c.\right)$$

This series gives the logarithm of $n+z$ by means of the logarithm of $n$, and converges very fast when $n$ is considerable.

172. It appears, from the series which have been found for log. $y$, that the logarithm of a number is always the product of two quantities: one of these is variable, and depends upon the number itself; but the other, viz. $\frac{1}{A}$, is constant, and depends entirely on the radical number of the system. This quantity has been called by writers on logarithms the *modulus* of the system.

173. The most simple system, in respect to facility of computation, is that in which $\frac{1}{A}=1$ or $A=1$. The logarithms of this system are the same as those first invented by Napier. They have been called *Hyperbolic* Logarithms, because they serve to express the area of an hyperbola; but this may be done by logarithms of any system. We shall therefore distinguish them by calling them *Napierian Logarithms*. The Napierian logarithm of any number $y$ is therefore

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$$(y-1)-\tfrac{1}{2}(y-1)^2+\tfrac{1}{3}(y-1)^3-\tfrac{1}{4}(y-1)^4+, \&c.$$

and that of $r$, the radical number of any system, is

$$(r-1)-\tfrac{1}{2}(r-1)^2+\tfrac{1}{3}(r-1)^3-\tfrac{1}{4}(r-1)^4+, \&c.$$

But this last series is the same as we have denoted by A; hence it follows, that the *modulus* of any system is the reciprocal of the Napierian logarithm of the radical number of that system. Thus it appears that the logarithms of numbers, according to any proposed system, may be readily found from the Napierian logarithm of the same numbers, and the Napierian logarithm of the radical number of that system.

174. Let L denote the Nap. log. of any number, and $l$, $l'$ the logarithms of the same number according to two other systems whose *moduli* are $m$ and $m'$; then

$$l=mL,\ l'=m'L;$$

therefore, $\frac{l}{m}=\frac{l'}{m'}$, and $m:m'::l:l'$.

That is, the logarithms of the same number, according to different systems, are directly proportional to the *moduli* of these systems, and therefore have a given ratio to one another.

175. We shall now apply the series here investigated to the calculation of Napier's logarithm of 10, the reciprocal of which is the *modulus* of the common system of logarithms; and also to the calculation of the common logarithm of 2. The Nap. log. of 10 may be obtained by substituting 10 for $y$ in the formula

$$\text{Nap. log.}\ y=\frac{2(y-1)}{y+1}+\frac{2}{3}\left(\frac{y-1}{y+1}\right)+\frac{2}{5}\left(\frac{y-1}{y+1}\right)+, \&c.;$$

but the resulting series $\frac{2\cdot9}{11}+\frac{2\cdot9^3}{3\cdot11^3}+\frac{2\cdot9^5}{5\cdot11^5}+$, &c. converges too slowly to be of any practical utility: it will therefore be better to derive the logarithm of 10 from those of 2 and 5. By substituting 2 in the formula, we have

$$\text{Nap. log.}\ 2=2\left(\frac{1}{3}+\frac{1}{3\cdot3^3}+\frac{1}{5\cdot3^5}+\frac{1}{7\cdot3^7}+, \&c.\right)$$

This series converges very fast, so that by reducing its terms to decimal fractions, and taking the sum of the first seven terms, we find the Nap. log. of 2 to be ·6931472.

The Nap. log. of 5 may be found in the same manner, but more easily from the formula given in sect. 171. For the log. of 2 being given, that of $4=2^2$ is also given (sect. 166); therefore, substituting log. $4=2$ log. 2 for log. $n$, and 1 for $z$, in the series

Nap. log. $(n+z)=$ Nap. log. $n$

$$+2\left(\frac{z}{2n+z}+\tfrac{1}{3}\,\frac{z^3}{(2n+z)^3}+\tfrac{1}{5}\,\frac{z^5}{(2n+z)^5}+, \&c.\right)$$

we have

$$\text{Nap. log.}\ 5=2\ \text{Nap. log.}\ 2+2\left(\frac{1}{9}+\frac{1}{3\cdot9^3}+\frac{1}{5\cdot9^5}+, \&c.\right)$$

The first three terms of this series are sufficient to give the result true to the seventh decimal, so that we have

Nap. log. 5=1.6094379, and

Nap. log. 10= Nap. log. 2+Nap. log. 5=2·3025851.

Hence the *modulus* of the common system of logarithms, or $\frac{1}{\text{Nap. log. }10}$, is found $=$ ·4342945. The same number, because of its great utility in the construction of tables of logarithms, has been calculated to a much greater number of decimals. A celebrated calculator of the last century, Mr A. Sharp, found it to be

0·434294481903251827651128918916605082294397005803666566114454.

Having found the Nap. log. of 2 to be ·6931472, the common logarithm of 2 is got immediately, by multiplying the Nap. log. of 2 by the modulus of the system: thus, we find

com. log. $2=4·342945\times·6931472=·3010300$.

We have seen, sect. 169, that to determine the logarithm of a given number, is the same problem as to determine the value of $x$ in an equation of this form, $a^x=b$, where the unknown quantity is an exponent. But in order to resolve such an equation, it is not necessary to have recourse to series; for a table of logarithms being once supposed constructed, the value of $x$ may be determined thus: It appears, from sect. 166, that $x\times\log. a=\log. b$; hence it follows, that $x=\frac{\log. b}{\log. a}$. The use of this formula will appear in next Section, which treats of computations relative to interest and annuities.

176. The theory of logarithms requires the solution of this other problem. Having given the radical number of a system, and a logarithm, to determine the corresponding number. Or, having given the equation $r^x=y$ (where $r$, $x$, and $y$ denote, as in sect. 165), to find a series which shall express $y$ in terms of $r$ and $x$.

For this purpose, let us suppose $r=1+a$, then our equation becomes $y=(1+a)^x$, which may also be expressed thus:

$$y=[(1+a)^n]^{\frac{x}{n}},$$

where $n$ is an arbitrary quantity, which is to disappear in the course of the investigation.

By the binomial theorem we have

$$(1+a)^n=1+na+\frac{n(n-1)}{1\cdot 2}a^2+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}a^3+, \&c.$$

This equation, by multiplying together the factors which compose the terms of the series, and arranging the results according to the powers of $n$, may also be expressed thus:

$$(1+a)^n=1+An+Bn^2+Cn^3+, \&c.$$

where it will readily appear that

$$A=a-\frac{a^2}{2}+\frac{a^3}{3}-\frac{a^4}{4}+, \&c.$$

As to the values of B, C, &c. it is of no importance to know them, for they will all disappear in the course of the investigation. Hence, by substituting for $(1+a)^n$ its value, as expressed by this last series, we have

$$y=(1+An+Bn^2+Cn^3+, \&c.)^{\frac{x}{n}};$$

and expanding the latter part of this equation by means of the binomial theorem, it becomes

$$y=1+\frac{x}{n}(An+Bn^2+, \&c.)+\frac{x(x-n)}{1\cdot 2\,n^2}(An+Bn^2+, \&c.)^2$$
$$+\frac{x(x-n)(x-2n)}{1\cdot 2\cdot 3n^3}(An+Bn^2+, \&c.)^3+, \&c.$$

But $An+Bn^2+, \&c. = n\,(A+Bn+, \&c.)$,
$(An+Bn^2+, \&c.)^2=n^2\,(A+Bn+, \&c.)^2$,
$(An+Bn^2+, \&c.)^3=n^3\,(A+Bn+, \&c.)^3$, &c.;

therefore, by leaving out of each term of the series the powers of $n$, which are common to the numerator and denominator, the equation will stand thus:

$$y=1+x(A+Bn+, \&c.)+x\frac{(x-n)}{1\cdot 2}(A+Bn+, \&c.)^2$$
$$+\frac{x(x-n)(x-2n)}{1\cdot 2\cdot 3}(A+Bn+, \&c.)^3+, \&c.$$

Now $n$ is here an arbitrary quantity, and ought, from the nature of the original equation, to disappear from the value of $y$; the terms of the equation which are multiplied by $n$ ought therefore to destroy each other, and then the equation is reduced to

$$r^x=y=1+\frac{xA}{1}+\frac{x^2A^2}{1\cdot 2}+\frac{x^3A^3}{1\cdot 2\cdot 3}+\frac{x^4A^4}{1\cdot 2\cdot 3\cdot 4}+, \&c.;$$

and since we have found

$$A=a-\frac{a^2}{2}+\frac{a^3}{3}-\frac{a^4}{4}+, \&c.$$
$$=(r-1)-\frac{(r-1)^2}{2}+\frac{(r-1)^3}{3}-\frac{(r-1)^4}{4}+, \&c.$$

it is evident, from sect. 173, that A is Napier's logarithm of the radical number of the system.

177. If, in the equation $r^x=y$, we suppose $x=1$, the value of $y$ becomes

$$r=1+\frac{A}{1}+\frac{A^2}{1·2}+\frac{A^3}{1·2·3}+, \&c.$$

Here the radical number is expressed by means of its Napierian logarithm. Again, if we suppose $x=\frac{1}{A}$, then

$$r^{\frac{1}{A}}=1+\frac{1}{1}+\frac{1}{1·2}+\frac{1}{1·2·3}+\frac{1}{1·2·3·4}+, \&c.$$

Thus it appears that the quantity $r^{\frac{1}{A}}$ is equal to a constant number, which, by taking the sum of a sufficient number of terms of the series, will be found $=$ 2.718281828459045 ... Let us denote this number by $e$, then $r^{\frac{1}{A}}=e$, and hence $r=e^A$. Now, if we remark that A is the Nap. log. of $r$, it must be evident (sect. 165 and 173), that $e$ is the radical number of Napier's system of logarithms.

Again, since $r^{\frac{1}{A}}=e$, therefore $\frac{1}{A}\times\log. r=\log. e$, and $A=\frac{\log. r}{\log. e}$. Here log. $r$ and log. $e$ denote logarithms taken according to any system whatever.

178. If we now resume the equation

$$r^x=y=1+\frac{xA}{1}+\frac{x^2A^2}{1\cdot 2}+\frac{x^3A^3}{1·2·3}+, \&c.$$

and substitute for A its value $\frac{\log. r}{\log. e}$, we shall have the following general expression for any exponential quantity whatever:

$$r^x=1+\frac{x}{1}\left(\frac{\log. r}{\log. e}\right)+\frac{x^2}{1·2}\left(\frac{\log. r}{\log. e}\right)^2+\frac{x^3}{1·2·3}\left(\frac{\log. r}{\log. e}\right)^3+, \&c.$$

which, by supposing $r=e$, becomes

$$e^x=1+\frac{x}{1}+\frac{x^2}{1·2}+\frac{x^3}{1·2·3}+, \&c.$$

## Sect. XX.—Of Interest and Annuities.

179. The theory of logarithms admits of extensive application to calculations relating to interest and annuities: these we now proceed to explain. There are two hypotheses, according to either of which money put out at interest may be supposed to be improved. We

may suppose that the interest, which is always proportional to the sum lent, or principal, is also proportional to the time during which the principal is employed; and on this hypothesis, the money is said to be improved at *simple* interest. Or we may suppose that the interest which ought to be paid to the lender at successive stated periods is added to the principal, instead of being actually paid, and thus their amount converted into a new principal. When money is lent according to this second hypothesis, it is said to be improved at *compound* interest.

180. In calculations relating to interest, the things to be considered are the *principal*, or sum lent; the *rate of interest*, or sum paid for the use of L.100 for one year; the *time* during which the principal is lent; and the *amount*, or sum of the principal and interest, at the end of that time.

Let $p$ denote the principal, L.1 being the unit;
$r$ the interest of L.1 for one year, at the given rate;
$t$ the time, one year being the unit;
$a$ the amount.

We shall now examine the relations which subsist between these quantities, according to each of the two hypotheses of simple and compound interest.

*Simple Interest.*

181. Because the interest of L.1 for one year is $r$, the interest of L.1 for $t$ years must be $rt$, and the interest of $p$ pounds for the same time $prt$; hence we have this formula,

$$p+prt=a,$$

from which we find

$$p=\frac{a}{1+rt} \qquad r=\frac{a-p}{pt} \qquad t=\frac{a-p}{pr}.$$

As the manner of applying these formulæ to questions relating to simple interest is sufficiently obvious, we proceed to consider compound interest.

*Compound Interest.*

182. In addition to the symbols already assumed, let $R=1+r$ = amount of L.1 in one year; then, from the nature of compound interest, R is also the principal at the beginning of the second year. Now, interest being always proportional to the principal, we have

$$1:r::R:rR= \text{ the interest of R for a year,}$$

and $R+rR=(1+r)R=R^2=$ amount of R in a year; therefore $R^2$ is the amount of L.1 in two years, which sum being assumed as a new principal, we find, as before, its interest for a year to be $rR^2$, and its amount $R^2+rR^2=(1+r)R^2=R^3$; so that $R^3$ is the amount of L.1 in three years. Proceeding in this manner, we find, in general, that the amount of L.1 in $t$ years is $R^t$, and of $p$ pounds, $pR^t$; hence we have this formula,

$$pR^t=a;$$

which, from the nature of logarithms, may also be expressed thus:

$$\log. p+t\times\log. R=\log. a.$$

We have also

$$p=\frac{a}{R^t} \qquad R=\sqrt[t]{\frac{a}{p}};$$

or, by logarithms,

$$\log. p=\log. a-t\times\log. R. \quad \log. R=\frac{\log. a-\log. p}{t}$$

$$t=\frac{\log. a-\log. p}{\log. R}.$$

*Ex.* 1. As an example of the use of these formulæ, let it be required to determine what sum improved at 5 per cent. compound interest will amount to L.500 in 42 years. In this case we have given $a=500$, $r=\cdot05$, $R=1\cdot05$, $t=42$, to find $p$.

| | | |
|---|---|---|
| From | $\log. a=\log. 500=$ | 2·6989700 |
| subtract | $t\times\log. R=42\times\log. 1\cdot05=$ | 0·8899506 |
| remains $\log. p$. | | 1·8090194 |

therefore $p$=L.64·42=L.64. 8s. 5d. the sum required.

*Ex.* 2. In what time will a sum laid out at 4 per cent. compound interest be doubled?

Let any sum be expressed by unity; then we have given $p=1$, $r=\cdot04$, $R=1\cdot04$, $a=2$, to find $t$.

From the formula, $t=\frac{\log. a-\log. p}{\log. R}=\frac{\log. 2}{\log. 1\cdot04}$, we find $t=\frac{\cdot3010300}{\cdot0170333}=17\cdot7$ years nearly.

In treating of compound interest, we have supposed the interest to be joined to the principal at the end of the year. But we might have supposed it to be added at the end of every half-year, or every quarter, or even every instant; and suitable rules might have been found for performing calculations, according to each hypothesis. As such suppositions are, however, never made in actual business, we shall not at present say any thing more of them.

*Annuities.*

183. An annuity is a payment made annually for a term of years; and the chief problem relating to it is to determine its present worth, that is, the sum a person ought to pay immediately to another, upon condition of receiving from the latter a certain sum annually for a given time. In resolving this problem, it is supposed that the buyer improves his annuity from the time he receives it, and the seller the purchase-money, in a certain manner, during the continuance of the annuity, so that at the end of the time the amount of each may be the same. There may be various suppositions as to the way in which the annuity and its purchase-money may be improved; but the only one commonly applied to practice is the highest improvement possible of both, viz. by compound interest. As the taking of compound interest is, however, prohibited by law, the realizing of this supposed improvement requires punctual payment of interest, and therefore the interest in such calculations is usually made low.

184. Let A denote the annuity,
P the present worth, or purchase-money,
$t$ the time of its continuance;
let $r$ and R denote as before.

The seller, by improving the price P at compound interest during the time $t$, has $PR^t$.

The purchaser is supposed to receive the first annuity A at the end of one year, which, being improved for $t-1$ years, amounts to $AR^{t-1}$. He receives the second year's annuity at the end of the second year, which, being improved for $t-2$ years, amounts to $AR^{t-2}$. In like manner, the third year's annuity becomes $AR^{t-3}$, and so on, to the last year's annuity, which is simply A. Therefore, the whole amount of the improved annuities is the geometrical series

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$$A+AR+AR^2+AR^3 \ldots +AR^{t-1},$$

the sum of which, by sect. 56, is $A\,\frac{R^t-1}{R-1}=A\,\frac{R^t-1}{r}$; and since this sum must be equal to the amount of the purchase-money, or $PR^t$, we have

$$PR^t=A\,\frac{R^t-1}{r};$$

and from this equation we find

$$P=\frac{A}{r}\left(1-\frac{1}{R^t}\right).\quad A=\frac{rPR^t}{R-1}.\quad t=\frac{\log. A-\log. (A-rP)}{\log. R}.$$

As to $r$, it can only be found by the resolution of an equation of the $t$ order.

185. To find the present value of an annuity in *reversion*, that is, an annuity which is to commence at the end of $n$ years, and continue during $t$ years; first find its value for $n+t$ years, and then for $n$ years, and subtract the latter from the former; we thus obtain the following formula:

$$P=\frac{A}{rR^n}\left(1-\frac{1}{R^t}\right).$$

186. If the annuity is to commence immediately, and to continue for ever, then, because in this case $R^t$ is infinitely great, and therefore $\frac{1}{R^t}=0$, the formula $P=\frac{A}{r}\left(1+\frac{1}{R}\right)$ becomes simply $P=\frac{A}{r}$.

And if the annuity is to commence after $n$ years, and continue for ever, the formula $P=\frac{A}{rR^n}\left(1-\frac{1}{R^t}\right)$ becomes

$$P=\frac{A}{rR^n}.$$

*Note.* The subject of life annuities forms by itself a distinct article.

## Sect. XXI.—Of Continued Fractions.

187. Every quantity which admits of being expressed by a common fraction may also be expressed in the form of what is called a *continued fraction*. The nature of such fractions will be easily understood by the following example.

Let the common fraction be $\frac{314159}{100000}$, or, which is the same, $3+\frac{14159}{100000}$. Since $100000=7\times 14159+887$, therefore $\frac{14159}{100000}=\frac{14159}{7\times 14159+887}=\cfrac{1}{7+\cfrac{887}{14159}}$, and

$$\frac{314159}{100000}=3+\cfrac{1}{7+\cfrac{887}{14159}}.$$

Now $\frac{887}{14159}=\frac{887}{15\times 887+854}=\cfrac{1}{15+\cfrac{854}{887}}$, and substituting this for $\frac{887}{14159}$ in the value of $\frac{314159}{100000}$, already found, we have

$$\frac{314159}{100000}=3+\cfrac{1}{7+\cfrac{1}{15+\cfrac{854}{887}}}.$$

Again, $\frac{854}{887}=\frac{854}{854+33}=\cfrac{1}{1+\cfrac{33}{854}}$, which being substituted as before, gives

$$\frac{314159}{100000}=3+\cfrac{1}{7+\cfrac{1}{15+\cfrac{1}{1+\cfrac{33}{854}}}}.$$

By operations similar to the preceding, we find $\frac{33}{854}=\cfrac{1}{25+\cfrac{29}{33}}$, $\frac{29}{33}=\cfrac{1}{1+\cfrac{4}{29}}$, $\frac{4}{29}=\cfrac{1}{7+\cfrac{1}{4}}$; therefore, by substitution,

$$\frac{314159}{100000}=3+\cfrac{1}{7+\cfrac{1}{15+\cfrac{1}{1+\cfrac{1}{25+\cfrac{1}{1+\cfrac{1}{7+\cfrac{1}{4}}}}}}}.$$

By an operation in all respects the same as has been just now performed, may any fraction whatever be reduced to the form

$$a+\cfrac{1}{b+\cfrac{1}{c+\cfrac{1}{d+\text{, \&c.}}}}$$

and it is then called a *continued fraction.*

188. It is easy to see in what manner the inverse of the preceding operation is to be performed, or a continued fraction reduced to a common fraction.

Thus, if the continued fraction be

$$a+\cfrac{1}{b+\cfrac{1}{c+\cfrac{1}{d}}},$$

it will evidently be reduced to a common fraction by adding the reciprocal of $d$ to $c$, and the reciprocal of that sum to $b$, and again the reciprocal of this last sum to $a$: now the reciprocal of $d$, or $\frac{1}{d}$, added to $c$, is $c+\frac{1}{d}=\frac{cd+1}{d}$; again, the reciprocal of this sum, or $\frac{d}{cd+1}$, added to $b$, is $b+\frac{d}{cd+1}=\frac{bcd+b+d}{cd+1}$, and the reciprocal of this last quantity, viz. $\frac{cd+1}{bcd+b+d}$, when added to $a$, gives

$$\frac{abcd+ab+ad+cd+1}{bcd+b+d}=a+\cfrac{1}{b+\cfrac{1}{c+\cfrac{1}{d}}}.$$

189. This manner of expressing a fraction enables us to find a series of other fractions, that approach in value to any given one, and each of them expressed in the smallest numbers possible. Thus, in the example $\frac{314159}{100000}$, which has been resolved into a continued fraction, sect. 187, and which is known to express nearly the proportion of the diameter of a circle to its circumference, if we take only the first two terms of the continued fraction, and

put $\pi$ for $\frac{314159}{100000}$, we shall have $\pi=3+\frac{1}{7}=\frac{22}{7}$ nearly; and this is the proportion which was found by Archimedes.

Again, by taking the first three terms, we have

$$\pi=3+\cfrac{1}{7+\cfrac{1}{15}}=3+\frac{15}{106}=\frac{333}{106},$$

which is nearer the truth than the former.

And by taking the first four terms, we have

$$\pi=3+\cfrac{1}{7+\cfrac{1}{15+\cfrac{1}{1}}}=\frac{355}{113},$$

which is the proportion assigned by Metius, and is more exact than either of the preceding. The results are alternately greater and less than the truth.

190. Among continued fractions, those have been particularly distinguished in which the denominators, after a certain number of changes, are continually repeated in the same order. Such, for example, is the fraction

$$1+\cfrac{1}{2+\cfrac{1}{3+\cfrac{1}{2+\cfrac{1}{3+}}}}, \&c.$$

The value of this fraction, though continued *ad infinitum*, may be easily found; for leaving out the first term, which is an integer, let us suppose

$$x=\cfrac{1}{2+\cfrac{1}{3+\cfrac{1}{2+\cfrac{1}{3+}}}}, \&c.$$

Then, since after the second, all the terms return in the same order, it follows that their amount is also $=x$. Thus we have

$$x=\cfrac{1}{2+\cfrac{1}{3+x}};$$

hence $x=\frac{3+x}{6+2x+1}$, and $x^2+3x=\frac{3}{2}$, and $x=\frac{-3+\sqrt{15}}{2}$:

therefore $x+1$, or the sum of the series, $=\frac{-1+\sqrt{15}}{2}$.

In general, if $x=\cfrac{1}{a+\cfrac{1}{b+\cfrac{1}{a+}}}$, &c.

we find $x=-\frac{b}{2}\pm\sqrt{\frac{b^2}{4}+\frac{b}{a}}$. Though the denominators did not return in the same order till after a greater interval, the value of the fraction would still be expressed by the root of a quadratic equation. And conversely, the roots of all quadratic equations may be expressed by periodical continued fractions, and may often by that means be very readily approximated in numbers, without the trouble of extracting the square root.

191. The reduction of a decimal into the form of a continued fraction sometimes renders the law of its continuation evident. Thus we know that $\sqrt{2}=1{\cdot}4121356\ldots$; but from the bare inspection of this decimal we discover no rule for its further continuation. If, however, it be reduced into a continued fraction, it becomes

$$=1+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+}}}, \&c.$$

and hence we see in what way it may be continued to any degree of accuracy.



When the root of any equation is found by the method explained in sect. 156, the value of the unknown quantity is evidently expressed by a continued fraction

For if $x$ be the root sought. we have $x=a+\frac{1}{y}$, $y=b+\frac{1}{y'}$, $y'=b'+\frac{1}{y''}$, $y''=b''+\frac{1}{y'''}$, &c. where $a, b', b'', b'''$, &c. denote the whole numbers, which are next less than the true values of $x, y, y', y''$, &c. If, therefore, in the value of $x$ we substitute $b+\frac{1}{y'}$ for $y$, it becomes

$$x=a+\cfrac{1}{b+\cfrac{1}{y'}}.$$

Again, if in this second value of $x$ we substitute $b'+\frac{1}{y''}$ for $y$, it becomes

$$x=a+\cfrac{1}{b+\cfrac{1}{b'+\cfrac{1}{y''}}}.$$

The next value of $x$ is in like manner found to be

$$x=a+\cfrac{1}{b+\cfrac{1}{b'+\cfrac{1}{b''+\cfrac{1}{y'''}}}};$$

and so on continually.

## Sect. XXII.—Of Indeterminate Problems.

192. When the conditions of a question are such that the number of equations exceeds the number of unknown quantities, that question will admit of innumerable solutions, and is therefore said to be indeterminate. Thus, if it be required to find two numbers subject to no other limitation than that their sum be 10, we have two unknown quantities $x$ and $y$, and only one equation, viz. $x+y=10$, which may evidently be satisfied by innumerable different values of $x$ and $y$, if fractional solutions be admitted. It is, however, usual, in such questions as this, to restrict values of the numbers sought to positive integers, and therefore, in this case, we can have only these nine solutions,

$$x = 1, 2, 3, 4, 5, 6, 7, 8, 9;$$
$$y = 9, 8, 7, 6, 5, 4, 3, 2, 1;$$

which indeed may be reduced to five; for the first four become the same as the last four, by simply changing $x$ into $y$, and the contrary.

193. Indeterminate problems are of different orders, according to the dimensions of the equation which is obtained after all the unknown quantities but two have been exterminated by means of the given equations. Those of the first order lead always to equations of this form,

$$ax+by=c,$$

where $a, b, c$, denote given whole numbers, and $x, y$, two numbers to be found, so that both may be integers. That this condition may be fulfilled, it is necessary that the coefficients $a, b$, have no common divisor which is not also a divisor of $c$; for if $a=md$ and $b=me$, then $ax+by=mdx$

$+ mey = c$, and $dx + ey = \frac{c}{m}$; but $d, e, x, y$, are supposed to be whole numbers, therefore $\frac{c}{m}$ is a whole number; hence $m$ must be a divisor of $c$.

We proceed to illustrate the manner of resolving indeterminate equations of the first order, by some numerical examples.

*Ex.* 1. Given $2x + 3y = 25$, to determine $x$ and $y$ in whole positive numbers.

From the given equation we have $x = \frac{25-3y}{2} = 12 - y + \frac{1-y}{2}$. Now, since $x$ must be a whole number, it follows that $\frac{1-y}{2}$ must be a whole number. Let us assume $\frac{1-y}{2} = z$, then $1 - y = 2z$ and $y = 1 - 2z$; and since $x = 12 - y + \frac{1-y}{2} = 12 - y + z$, therefore $x = 12 - 1 + 2z + z$; hence we have

$$x = 11 + 3z, \qquad y = 1 - 2z,$$

where $z$ might be any whole number whatever, if there were no limitation as to the signs of $x$ and $y$. But since these quantities are required to be positive, it is evident, from the value of $y$, that $z$ must be either 0 or negative, and from the value of $x$, that, abstracting from the sign, it must be less than 4; hence $z$ may have these three values, 0, — 1, — 2, — 3.

$$\text{If } z = 0, \quad z = -1, \quad z = -2, \quad z = -3;$$
$$\text{Then} \begin{cases} x = 11, & x = 8, \quad x = 5, \quad x = 2, \\ y = 1, & y = 3, \quad y = 5, \quad y = 7. \end{cases}$$

*Ex.* 2. It is required to divide 100 into such parts that the one may be divisible by 7 and the other by 11.

Let $7x$ be the first part, and $11y$ the second; then, by the question, $7x + 11y = 100$, and

$$x = \frac{100 - 11y}{7} = 14 - y + \frac{2 - 4y}{7}.$$

Hence it appears, that $\frac{2 - 4y}{7}$ must be a whole number. Let us assume $\frac{2-4y}{7} = z$, then $x = 14 - y + z$, and $4y = 2 - 7z$, or $y = \frac{2 - 7z}{4} = \frac{2 - 3z}{4} - z$; therefore $\frac{2 - 3z}{4}$ must be a whole number. Assume $\frac{2-3z}{4} = t$, then $y = t - z$, and $3z = 2 - 4t$, or $z = \frac{2 - 4t}{3} = \frac{2 - t}{3} - t$; therefore $\frac{2-t}{3}$ must be a whole number.

Assume now $\frac{2-t}{3} = v$, then $z = v - t$, and $t = 2 - 3v$.

Here it is evident that $v$ may be any whole number taken at pleasure: so that to determine $x$ and $y$ we have the following series of equations:

$$\begin{aligned} t &= 2 - 3v, \\ z &= v - t = 4v - 2, \\ y &= t - z = 4 - 7v, \\ x &= 14 - y + z = 11v + 8. \end{aligned}$$

From the value of $y$, it appears that $v$ must either be $= 0$ or negative; but from the value of $x$, $v$ cannot be a negative whole number; therefore $v$ can only be $= 0$; hence the only values which $a$ and $y$ can have in whole numbers, are $x = 8$, $y = 4$.

*Ex.* 3. It is required to find all the possible ways in which L.60 can be paid in guineas and moidores only.

Let $x$ be the number of guineas, and $y$ the number of moidores. Then the value of the guineas, expressed in shillings, is $21x$, and that of the moidores $27y$; therefore, from the nature of the question, $21x + 27y = 1200$, or, dividing the equation by 3, $7x + 9y = 400$; hence $x = \frac{400 - 9y}{7} = 57 - y + \frac{1 - 2y}{7}$, so that $\frac{1-2y}{7}$ must be a whole number.

Assume $\frac{1-2y}{7} = z$, then $x = 57 - y + z$, and $2y = 1 - 7z$ or $y = \frac{1 - 7z}{2} = \frac{1 - z}{2} - 3z$; therefore $\frac{1-z}{2}$ must be a whole number.

Assume $\frac{1-z}{2} = v$, then $y = v - 3z$, and $z = 1 - 2v$; therefore $v$ may be taken any whole number at pleasure, and $x$ and $y$ may be determined by the following equations:

$$\begin{aligned} z &= 1 - 2v, \\ y &= v - 3z = 7v - 3, \\ x &= 57 - y + z = 61 - 9v. \end{aligned}$$

From the value of $x$, it appears that $v$ cannot exceed 6, and from the value of $y$, that it cannot be less than 1.

$$\begin{array}{llllllll} \text{Hence if } & v = & 1, & 2, & 3, & 4, & 5, & 6, \\ \text{we have } & x = & 52, & 43, & 34, & 25, & 16, & 7, \\ & y = & 4, & 11, & 18, & 25, & 32, & 39. \end{array}$$

194. In the foregoing examples the unknown quantities $x$ and $y$ have each a determinate number of positive values; and this will evidently be the case as often as the proposed equation is of this form, $ax + by = c$. If, however, $b$ be negative, that is, if the equation be of this form, $ax - by = c$, or $ax = by + c$, we shall have questions of a different kind, admitting each of an infinite number of solutions; these, however, may be resolved in the same manner as the preceding, as will appear from the following example.

*Ex.* 4. A person buys some horses and oxen: he pays 31 crowns for each horse, and 20 crowns for each ox, and he finds that the oxen cost him seven crowns more than the horses. How many did he buy of each?

Let $x$ be the number of horses, and $y$ that of the oxen; then, by the question,

$$20x = 31y + 7, \text{ and } x = \frac{31y + 7}{20} = y + \frac{11y + 7}{20}.$$

Therefore $\frac{11y+7}{20}$ must be a whole number.

Let $\frac{11y+7}{20} = v$, then $x = y + v$, and $y = \frac{20v - 7}{11} = v + \frac{9v - 7}{11}$; hence $\frac{9v-7}{11}$ must be a whole number.

Let $\frac{9v - 7}{11} = t$, then $y = v + t$, and $v = \frac{11t + 7}{9} = t + \frac{2t+7}{9}$; therefore $\frac{2t+7}{9}$ is a whole number.

Let $\frac{2t+7}{9} = s$, then $v = t + s$, and $t = \frac{9s - 7}{2} = 4s + \frac{s - 7}{2}$; therefore $\frac{s-7}{2}$ is a whole number.

Put $\frac{s-7}{2}=r$, then $t=4s+r$ and $s=2r=7$.

Having now no longer any fractions, we return to the values of $x$ and $y$ by the following series of equations:

$$\begin{aligned}
s&=2r+7,\\
t&=4s+r=\ 9r+28,\\
v&=\ t+s=11r+35,\\
y&=\ v+t=20r+63=\text{ number of oxen},\\
x&=\ y+v=31r+98=\text{ number of horses.}
\end{aligned}$$

The least positive values of $x$ and $y$ will evidently be obtained by making $r=-3$, and innumerable other values may be had by putting $r=-2$, $r=-1$, $r=0$, $r=+1$, &c. Thus we have

$x=5,\ 36,\ 67,\ 98,\ 129,\ 160,\ 191,\ 222$, &c.
$y=3,\ 23,\ 43,\ 63,\ 83,\ 103,\ 123,\ 143$, &c.

each series forming an arithmetical progression, the common difference in the first being 31, and in the second 20.

195. If we consider the manner in which the numbers $x$, $y$, in this example, are determined from the succeeding quantities $v$, $t$, &c. we shall immediately perceive that the co-efficients of those quantities are the same as the successive quotients which arise in the arithmetical operation for finding the greatest common measure of 20 and 31, the co-efficients of the given equation $20x=31y+7$. The operation performed at length will stand thus:

```
20)31(1
   20
   --
   11)20(1
      11
      --
       9)11(1
          9
          --
          2)9(4
            8
            --
            1)2(2
              2
              --
              0
```

Hence we may form a series of numeral equations which, when compared with the series of literal equations expressing the relations between $x$, $y$, $v$, &c. as put down in the following table, will render the method of determining the latter from the former sufficiently obvious.

$$\begin{array}{ll}
31=1\times20+11 & x=1\times y+v,\\
20=1\times11+\ 9 & y=1\times v+t,\\
11=1\times\ 9+\ 2 & v=1\times t+s,\\
9=4\times\ 2+\ 1 & t=4\times s+r,\\
2=2\times\ 1+\ 0 & s=2\times r+7.
\end{array}$$

And as every question of this kind may be analyzed in the same manner, we may hence form the following general rule for resolving indeterminate problems of the first order.

196. Let $bx=ay+n$ be the proposed equation, in which $a$, $b$, $n$, are given integers, and $x$, $y$, numbers to be found. Let $a$ be the greatest of the two numbers $a$, $b$, and let A denote the greatest multiple of $b$ which is contained in $a$, and $c$ the remainder; also let B denote the greatest multiple of $c$ contained in $b$, and $d$ the remainder; and C the greatest multiple of $d$ contained in $c$, and $e$ the remainder; and so on, till one of the remainders be found equal to 0. The numbers A, B, C, afford a series of equations from which another series may be derived, as in the following table:



$$\begin{array}{ll}
a=\mathrm{A}b+c,\ \text{hence we find} & x=\mathrm{A}y+v,\\
b=\mathrm{B}c+d & y=\mathrm{B}v+t,\\
c=\mathrm{C}d+e & v=\mathrm{C}t+s,\\
d=\mathrm{D}e+f & t=\mathrm{D}s+r,\\
e=\mathrm{E}f+g & s=\mathrm{E}r+q,\\
f=\mathrm{F}g+0 & r=\mathrm{F}q\pm n.
\end{array}$$

And in the last equation of the second series any number whatever may be put for $q$. It is also to be observed, that the given number $n$ is to have the sign $+$ prefixed to it, if the number of equations be odd, but $-$ if that number be even. Having formed the second series of equations, the values of $x$ and $y$ may be thence found as in the foregoing examples. We proceed to show the application of the rule.

*Ex.* 5. Required a number which, being divided by 11, leaves the remainder 3, but being divided by 19, leaves the remainder 5.

Let N be the number, and $x$, $y$, the quotients which arise from the respective divisions; then we have $\mathrm{N}=11x+3$, also $\mathrm{N}=19y+5$; hence $11x+3=19y+5$, and $11x=19y+2$, an equation which furnishes the following table:

$$\begin{array}{ll}
19=1\times11+8 & x=\ y+v,\\
11=1\times\ 8+3 & y=\ v+t,\\
8=2\times\ 3+2 & v=2t+s,\\
3=1\times\ 2+1 & t=\ s+r,\\
2=2\times\ 1+0 & s=2r+2.
\end{array}$$

Here $r$ may be assumed of any value whatever Hence we have

$$\begin{aligned}
s&=2r+2,\\
t&=\ s+r=\ 3r+\ 2,\\
v&=2t+s=\ 8r+\ 6,\\
y&=\ v+t=11r+\ 8,\\
x&=\ y+v=19r+14;
\end{aligned}$$

and the number required, $\mathrm{N}=209u+157$, where it is evident that the least number which can express N is 157.

*Ex.* 6. Given $\left.\begin{cases}3x+\ 5y+\ 7z=560\\ 9x+25y+49z=2920\end{cases}\right\}$ To determine $x, y, z$, in whole numbers.

From 7 times the first equation subtract the second; thus we have $12x+10y=1000$, or $6x+5y=500$; and from this last equation, by proceeding as in the foregoing example, we find

$$x=500-5v, \qquad y=6v-500.$$

Let these values of $x$ and $y$ be substituted in either of the original equations; in the first, for example, as being the most simple, and we find $7z+15v=1560$. This last equation being resolved in the same manner, we find

$$\begin{aligned}
v&=1560-7t,\\
z&=15t\ -3120,\\
y&=8860-42t,\\
x&=35t\ -7300;
\end{aligned}$$

and hence it appears that the only values which $t$ can have, so as to give whole positive numbers for $x$, $y$, $z$, are 209 and 210: thus we have

$$\begin{array}{lll}
x=15 & y=82 & z=15,\\
\text{or } x=50 & y=40 & z=30.
\end{array}$$

197. If an equation were proposed involving three unknown quantities, as $ax+by+cz=d$, by transposition we have $ax+by=d-cz$, and, putting $d-cz=d'$, $ax+by=d'$. From this last equation we may find values of $x$ and $y$ of this form,

$$x=mr+nd',\ y=m'r+n'd',$$
$$\text{or } x=mr+n(d-cz),\ y=m'r+n'(d-cz);$$

where $z$ and $r$ may be taken at pleasure, except in so far as the values of $x, y, z$, may be required to be all positive; for from such restriction the values of $z$ and $r$ may be confined within certain limits to be determined from the given equation.

198. We proceed to indeterminate problems of the second degree. These produce equations of the three following forms:

$$\text{I. } y=\frac{a}{b+cx}, \quad \text{II. } y=\frac{a+bx}{c+dx}, \quad \text{III. } y=\sqrt{a+bx+cx^2}.$$

In all these equations $a, b, c$, denote given numbers. In the first two, $x$ is to be determined so that $y$ may be an integer; and in the third, $x$ is to be determined so that $y$ may be a rational quantity.

In the equation $y=\frac{a}{b+cx}$, it is evident, $b+cx$ must be a divisor of $a$; let $d$ be one of its divisors, then $b+cx=d$, and $x=\frac{d-b}{c}$: hence, to find $x$ we must search among the divisors of $a$ for one such, that if $b$ be subtracted from it, the remainder may be divisible by $c$, and the quotient will be such a value of $x$ as is required.

When $y=\frac{a+bx}{c+dx}$, if $d$ be a divisor of $b$, $x$ will be taken out of the numerator if we divide it by $c+dx$, and this form is then reduced to the preceding. But if $d$ is not a divisor of $b$, multiply both sides by $d$, then $dy=\frac{da+dbx}{c+dx}$ or $dy=b+\frac{ad-bc}{c+dx}$, and so $x$ is found by making $c+dx$ equal to a divisor of $ad-bc$.

*Example.* Given $x+y+2xy=195$, to determine $x$ and $y$ in whole numbers.

From the given equation, $y=\frac{195-x}{1+2x}$, therefore $2y=\frac{390-2x}{1+2x}=-1+\frac{391}{1+2x}$. Now $391=17\times 23$, hence we must assume $1+2x=17$, or $1+2x=23$: the first supposition gives us $x=8$, $y=11$; and the second $x=11$, $y=8$, the same result in effect as the former.

199. We are next to consider the formula $y=\sqrt{a+bx+cx^2}$, where $x$ is to be found, so that $y$ may be a rational quantity; but as the condition of having $x$ and $y$ also integers would add greatly to the difficulty of the problem, and produce researches of a very intricate nature, we must be satisfied for the most part with fractional values. The possibility of rendering the proposed formula a square depends altogether upon the co-efficients $a, b, c$; and there are four cases of the problem, the solution of each of which is connected with some peculiarity in its nature.

*Case* 1. Let $a$ be a square number; then, putting $g^2$ for $a$, we have $y=\sqrt{g^2+bx+cx^2}$. Suppose $\sqrt{g^2+bx+cx^2}=g+mx$; then $g^2+bx+cx^2=g^2+2gmx+m^2x^2$, or $bx+cx^2=2gmx+m^2x^2$, that is, $b+cx=2gm+m^2x$; hence

$$x=\frac{2gm-b}{c-m^2}, \; y=\sqrt{g^2+bx+cx^2}=\frac{cg-bm+gm^2}{c-m^2}.$$

Here $m$ may be any rational quantity, either whole or fractional.

*Case* 2. Let $c$ be a square number $=g^2$; then, putting $\sqrt{a+bx+g^2x^2}=m+gx$, we find $a+bx+g^2x^2=m^2+2mgx+g^2x^2$, or $a+bx=m^2+2mgx$; hence we find

$$x=\frac{m^2-a}{b-2mg}, \; y=\sqrt{a+bx+g^2x^2}=\frac{bm-gm^2-ag}{b-2mg}.$$

Here $m$, as before, may be taken at pleasure.

*Case* 3. When neither $a$ nor $c$ is a square number, yet if the expression $a+bx+cx^2$ can be resolved into two simple factors, as $f+gx$ and $h+kx$, the irrationality may be taken away as follows.

Assume $\sqrt{a+bx+cx^2}=\sqrt{(f+gx)(h+kx)}=m(f+gx)$, then $(f+gx)(h+kx)=m^2(f+gx)^2$, or $h+kx=m^2(f+gx)$; hence we find

$$x=\frac{fm^2-h}{k-gm^2}, \; y=\sqrt{(f+gx)(h+kx)}=\frac{(fk-gh)m}{k-gm^2};$$

and in these formulæ $m$ may be taken at pleasure.

*Case* 4. The expression $a+bx+cx^2$ may be transformed into a square as often as it can be resolved into two parts, one of which is a complete square, and the other a product of two simple factors; for then it has this form, $p^2+qr$, where $p, q$, and $r$ are quantities which contain no power of $x$ higher than the first. Let us assume $\sqrt{p^2+qr}=p+mq$; thus we have $p^2+qr=p^2+2mpq+m^2q^2$ and $r=2mp+m^2q$, and as this equation involves only the first power of $x$, we may by proper reduction obtain from it rational values of $x$ and $y$, as in the three foregoing cases.

200. If we can by trials discover any one value of $x$ which renders the expression $\sqrt{a+bx+cx^2}$ rational, we may immediately reduce the quantity under the radical sign to the above-mentioned form, and thence find a general expression from which as many more values of $x$ may be determined as we please. Thus, let us suppose that $p$ is a value of $x$ which satisfies the condition required, and that $q$ is the corresponding value of $y$; then

$$y^2=a+bx+cx^2$$
$$q^2=a+bq+cp^2.$$

Therefore, by subtraction,

$$y^2-q^2=b(x-p)+c(x^2-p^2)=(b+cp+cx)(x-p)$$

and $y=\sqrt{q^2+(b+cp+cx)(x-p)}$. The quantity under the radical sign being now reduced to the prescribed form, it may be rendered rational by the substitution pointed out in the last article.

The application of the preceding general methods of resolution to any particular case is very easy; we shall therefore conclude with a very few examples.

*Ex.* 1. It is required to find two square numbers whose sum is a given square number.

Let $a^2$ be the given square number, and $x^2, y^2$, the numbers required; then, by the question, $x^2+y^2=a^2$, and $y=\sqrt{a^2-x^2}$. This equation is evidently of such a form as to be resolvable by the method employed in case 1. Accordingly, by comparing $\sqrt{a^2-x^2}$ with the general expression $\sqrt{g^2+bx+cx^2}$, we have $g=a$, $b=0$, $c=-1$, and substituting these values in the formulæ of sect. 199, also $-n$ for $+m$, we find

$$x=\frac{2an}{n^2+1}, \; y=\frac{a(n^2-1)}{n^2+1};$$ hence the numbers required are

$$x^2=\frac{4a^2n^2}{(n^2+1)^2} \quad y^2=\frac{a^2(n^2-1)^2}{(n^2+1)^2}.$$

If $a=n^2+1$, where $n$ is any number whatever, the square numbers $x^2$ and $y^2$ will both be integers, viz. $x^2=4n^2$ and $y^2=(n^2-1)^2$. Let us suppose $n=2$, then $a=n^2+1=5$, and $a^2=25$, hence $x^2=4n^2=16$, $y=(n^2-1)^2=9$. Thus it appears that the square number 25 may be resolved into two other square numbers, 9 and 16.

Algebra.

*Ex.* 2. It is required to find two square numbers whose difference shall be equal to a given square number $b^2$.

This question may be resolved in the same manner as the last. Or, without referring to any former investigation, let $(x+n)^2$ and $x^2$ be the numbers sought, then $(x+n)^2 - x^2 = b^2$; that is, $2nx + n^2 = b^2$, hence $x=\frac{b^2-n^2}{2n}$ and $x+n=\frac{b^2+n^2}{2n}$. So that the numbers sought are

$$\frac{(b^2+n^2)^2}{4n^2}, \qquad \frac{(b^2-n^2)}{4n^2},$$

where $n$ may be any number whatever. If, for example, $b^2=25$ and $n=1$, then $x=12$ and $x+n=13$; so that the numbers required are 144 and 169.

*Ex.* 3. It is required to determine $x$, so that $\frac{x^2+x}{2}$ may be a rational square.

Let $y$ be the side of the square required; then $\frac{x^2+x}{2}=y^2$ and $4x^2+4x=8y^2$. Let the first part of this equation be completed into a square by adding 1 to each side, then $4x^2+4x+1=1+8y^2$; and taking the root, $2x+1=\sqrt{1+8y^2}$, so that we have to make $1+8y^2$ a square. Assume

$1+8y^2=\left(1+\frac{p}{q}y\right)^2=1+\frac{2p}{q}y+\frac{p^2}{q^2}y^2$, then $8y=\frac{2p}{q}+\frac{p^2}{q^2}y$. Hence, by proper reduction, $y=\frac{2pq}{8q^2-p^2}$, and since $2x+1=\sqrt{1+8y^2}=\frac{8q^2+p^2}{8q^2-p^2}$, therefore $x=\frac{p^2}{8q^2-p^2}$, and $\frac{x^2+x}{2}=\frac{4p^2\,q^2}{(8q^2-p^2)^2}$, a rational square, as was required.

## Sect. XXIII.—Of the Resolution of Geometrical Problems.

201. When a geometrical problem is to be resolved by algebra, the figure which is to be the subject of investigation must be drawn, so as to exhibit as well the known quantities connected with the problem, as the unknown quantities which are to be found. The conditions of the problem are next to be attentively considered, and such lines drawn, or produced, as may be judged necessary to its resolution. This done, the known quantities are to be denoted by symbols in the usual manner, and also such unknown quantities as can most easily be determined; which may be either those directly required, or others from which they can be readily found. We must next proceed to deduce from the known geometrical properties of the figure a series of equations, expressing the relations between the known and unknown quantities; these equations must be independent of each other, and as many in number as there are unknown quantities. Having obtained a suitable number of equations, the unknown quantities are to be determined in the same manner as in the resolution of numerical problems.

No general rule can be given for drawing the lines, and selecting the quantities most proper to be represented by symbols, so as to bring out the simplest conclusion; because different problems require different methods of solution. The best way to gain experience in this matter, is to try the solution of the same problem in different ways, and then apply that which succeeds best to other cases of the same kind, when they afterwards occur. The following particular directions, however, may be of some use.

Algebra.

1. In preparing the figure by drawing lines, let them be either parallel or perpendicular to other lines in the figure, so as to form similar triangles. And if an angle be given, it will be proper to let the perpendicular be opposite to that angle, and to fall from one end of a given line, if possible.

2. In selecting the quantities for which symbols are to be substituted, those are to be chosen, whether required or not, which lie nearest the known or given parts of the figure, and by means of which the next adjacent parts may be expressed by addition and subtraction only, without the intervention of surds.

3. When two lines, or quantities, are alike related to other parts of the figure, or problem, the best way is to substitute for neither of them separately, but to substitute for their sum, or difference, or rectangle, or the sum of their alternate quotients, or some line or lines in the figure, to which they have both the same relation.

4. When the area or the perimeter of a figure is given, or such like parts of it as have only a remote relation to the parts required, it is sometimes of use to assume another figure similar to the proposed one, having one side equal to unity, or some other known quantity. For thence the other parts of the figure may be found by the known proportions of like sides or parts, and so an equation will be obtained.

202. We shall now give the algebraical solutions of some geometrical problems.

Prob. 1. In a right-angled triangle, having given the base, and the sum of the hypothenuse and perpendicular, to find both these sides.

Let ABC (Plate XVIII. fig. 1) represent the proposed triangle, right-angled at B. Let AB, the given base, be denoted by $b$, and AC+BC, the sum of the hypothenuse and perpendicular, by $s$; then if $x$ be put for BC the perpendicular, the hypothenuse AC will be $=s-x$. But from the nature of a right-angled triangle, $AC^2=AB^2+BC^2$, that is,

$$b^2+x^2=(s-x)^2=s^2-2sx+x^2.$$

Hence $b^2=s^2-2sx$, and $x=\frac{s^2-b^2}{2s}=BC$.

Also $s-x=s-\frac{s^2-b^2}{2s}=\frac{s^2+b^2}{2s}=AC$. Thus the perpendicular and hypothenuse are expressed by means of the known quantities $b$ and $s$, as required.

If a solution in numbers be required, we may suppose $AB=b=3$, and $AC+CB=s=9$; then

$$BC=\frac{s^2-b^2}{2s}=4, \text{ and } AC=\frac{s^2+b^2}{2s}=5.$$

Prob. 2. In a right-angled triangle, having given the hypothenuse, also the sum of the base and perpendicular, it is required to determine these two sides.

Let ABC (fig. 1) represent the proposed triangle, right-angled at B. Put $a$=AC the given hypothenuse, and $s$=AB+BC the given sum of the sides; then, if $x$ be put for AB the base, $s-x$ will denote BC the perpendicular.

Now, from the nature of right-angled triangles, $AC^2=AB^2+BC^2$; therefore $x^2+(s-x)^2=a^2$, or $x^2+s^2-2sx+x^2=a^2$; hence we have this quadratic equation, $x^2-sx=\frac{a^2-s^2}{2}$, which being resolved, by completing the square, we find $x=\frac{s\pm\sqrt{2a^2-s^2}}{2}=$ AB, and $s-x=\frac{s\mp\sqrt{2a^2-s^2}}{2}=$ BC. Thus it appears, that either of the two quantities $\frac{s+\sqrt{2a^2-s^2}}{2}$, $\frac{s-\sqrt{2a^2-s^2}}{2}$, may be taken for AB; but whichever of the two be taken, the remaining one is necessarily equal to BC.

Prob. 3. It is required to inscribe a square in a given triangle.

Let ABC (fig. 2) be the given triangle, and EFHG the inscribed square. Draw the perpendicular AD, cutting EF, the side of the square, in K; then, because the triangle is given, the perpendicular AD may be considered as given. Let BC$=b$, AD$=p$, and considering AK as the unknown quantity (because from it the square may be readily determined), let AK$=x$; then KD$=$EF$=p-x$.

The triangles ABC, AEF, are similar; therefore AD : BC : : AK : EF, that is, $p:b::x:p-x$. Hence, by taking the product of the extremes and means, $p^2-px=bx$, and $x=\frac{p^2}{p+b}=$ AK. If the side of the square be required, it may be immediately found by subtracting AK from AD the perpendicular. Thus we have $p-\frac{p^2}{p+b}=\frac{pb}{p+b}=$KD$=$EF. Hence it appears that we may either take AK, a third proportional to AD+BC and AD, or take DK, a fourth proportional to AD+BC, AD and BC; and the point K being found, the manner of describing the square is sufficiently obvious.

Prob. 4. Having given the area of a rectangle inscribed in a given triangle; it is required to determine the sides of the rectangle.

Let ABC (fig. 3) be the given triangle, and EDGF the rectangle whose sides are required. Draw the perpendicular CI, cutting DG in H. Put AB$=b$, CI$=p$, DG$=$EF$=x$, DE$=$HI$=y$; then CH$=p-y$. Let $a^2$ denote the given area.

The triangles CDG, CAB, are similar; hence

CH : DG : : CI : AB, or $p-y:x::p:b$.

So that to determine $x$ and $y$, we have these two equations,

$$xy=a^2, \quad bp-by=px.$$

From the first equation we find $y=\frac{a^2}{x}$, and from the second, $y=\frac{bp-px}{b}$, therefore $\frac{bp-px}{b}=\frac{a^2}{x}$; hence $x^2-bx=-\frac{a^2b}{p}$, and from this quadratic equation, by completing the square, &c. we find

$$x=\frac{b}{2}\pm\sqrt{\frac{b^2}{4}-\frac{a^2b}{p}}, \text{ and } y=\frac{a^2}{x}=\frac{p}{2}\pm\sqrt{\frac{p^2}{4}-\frac{pa^2}{b}}.$$

Hence it appears, that if $\frac{a^2b}{p}$ be less than $\frac{b^2}{4}$, that is, if $a^2$ be less than $\frac{pb}{4}$, there are two different rectangles, having the same area, which may be inscribed in the given triangle. It also appears that, to render the problem possible, the given space $a^2$ must not be greater than $\frac{pb}{4}$, that is, than half the area of the given triangle.



Prob. 5. In a triangle, there are given the base, the vertical angle, and the sum of the sides about that angle; to determine each of these sides.

Let us suppose that ABC (fig. 4) is the triangle, of which there is given the base AC, the vertical angle ABC, and the sum of the sides AB, BC. Put AC$=a$, AB+BC$=b$, cosine of $\angle$ABC$=c$; and let AB, BC, the sides required, be denoted by $x$ and $y$.

Let CD be drawn from either of the angles at the base perpendicular to the opposite side AB; then, rad. : cos. B : : CB : BD; therefore BD$=$cos. B$\times$CB$=cy$.

Now, from the principles of geometry, AC$^2=$AB$^2$+BC$^2-2$AB$\times$BD. Hence, and from the question, we have these two equations,

$$x+y=b, \quad x^2-2cxy+y^2=a^2.$$

From the square of the first of these equations, viz. $x^2+2xy+y^2=b^2$, let the second be subtracted; thus we have $2(1+c)xy=b^2-a^2$, and $2xy=\frac{b^2-a^2}{1+c}$. Again, from the square of the first equation let the double of this last equation, viz. $4xy=\frac{2(b^2-a^2)}{1+c}$, be subtracted, and the result is $x^2-2xy+y^2=\frac{2a^2-(1-c)b^2}{1+c}$; so that by taking the square root of this last equation, we obtain

$$x-y=\sqrt{\frac{2a^2-(1-c)b^2}{1+c}}.$$

Thus we have found the difference between the sides, now their sum is given $=b$; hence, by adding $\frac{1}{2}$ the difference to $\frac{1}{2}$ the sum, we find

$$x=\frac{b}{2}+\tfrac{1}{2}\sqrt{\frac{2a^2-(1-c)b^2}{1+c}};$$

and subtracting $\frac{1}{2}$ the difference from $\frac{1}{2}$ the sum,

$$y=\frac{b}{2}-\tfrac{1}{2}\sqrt{\frac{2a^2-(1-c)b^2}{1+c}}.$$

If the angle at B be a right angle, this problem becomes the same as prob. 2.

Prob. 6. To draw a straight line through a given point P (fig. 5), so as to form with AB, AC, two straight lines given in position, a triangle DAE equal to a given space.

Draw PF parallel to AC, one of the lines; and DH, PG, perpendicular to AB, the other line: then PF will be given in position; and AF, PG, will be given in magnitude.

Put the known magnitudes AF$=a$, PG$=b$, and AE, a side of the triangle which is to be determined, $=x$. Also, let the given space to which the triangle ADE is to be equal, be $c^2$.

By similar triangles, FE : PG : : AE : DH;

that is, $x-a:b::x:$DH;

hence DH $=\frac{bx}{x-a}$; and triangle ADE$=\frac{bx^2}{2x-2a}$.

Therefore $\frac{bx^2}{2x-2a}=c^2$, and $bx^2=2c^2x-2ac^2$.

and $x^2-\frac{2c^2}{b}x=-\frac{2ac^2}{b}$.

This is a quadratic equation, which, by completing the square, becomes

$$x^2-\frac{2c^2}{b}x+\frac{c^4}{b^2}=\frac{c^2(c^2-2ab)}{b^2}.$$

Hence, by taking the square root, and transposing,

$$x=\frac{c^2\pm c\sqrt{c^2-2ab}}{b}.$$

It appears, from this expression, that $x$ will have two values, viz.

$$x=\frac{c^2+c\sqrt{c^2-2ab}}{b},\quad x=\frac{c^2-c\sqrt{c^2-2ab}}{b};$$

therefore there are two positions of the line DE, which will satisfy the problem. It further appears, that the problem will only be possible when $c^2 > 2ab$; for if $c^2 < 2ab$, then $c^2-2ab$ will be a negative quantity, and can have no real square root. Since, then, $c^2$ cannot be less than $2ab$, it follows that the least triangle which can be formed by drawing a line throughout P, a point in the angle CAB, is equal to $2ab$, that is, to $2\text{AF}\times\text{PG}$.

If the point P were in the angle DAB′, adjacent to DAE (fig. 6), the solution would be the same; but in this case, the same notation being employed,

$$x=\frac{c^2\pm c\sqrt{c^2+2ab}}{b}.$$

The quantity under the radical sign is always positive, therefore there is no limitation to the problem.

Prob. 7. To find the area of a triangle whose sides are given.

In the triangle ABC (fig. 7) draw the perpendicular CD; put $\text{BC}=a$, $\text{AC}=b$, $\text{AB}=c$, $\text{CD}=p$.

By the elements of Geometry (see Geometry),

$$\text{CB}^2=\text{BA}^2+\text{CA}^2-2\text{AB}\cdot\text{AD};$$

that is, $a^2=c^2+b^2-2c\times\text{AD}$;

hence $\text{AD}=\dfrac{c^2+b^2-a^2}{2c}$; and since

$$p^2=\text{AC}^2-\text{AD}^2=b^2-\left(\frac{c^2+b^2-a^2}{2c}\right)^2,$$

therefore $4c^2p^2=4c^2b^2-(c^2+b^2-a^2)^2$.

The second side of this equation is the difference of two squares; therefore it admits of being resolved into the product of the sum and difference of the roots, thus,

$$[c^2+2cb+b^2-a^2]\,[a^2-(c^2-2cb+b^2)];$$

$$\text{or, } [(c+b)^2-a^2]\,[a^2-(c-b)^2].$$

Again, $(c+b)^2-a^2=(a+b+c)(c+b-a)$;

and $a^2-(c-b)^2=(a+c-b)(a-c+b)$;

therefore,

$$4c^2p^2=(a+b+c)(a+b-c)(a-b+c)(b+c-a).$$

If we put $s=\frac{1}{2}(a+b+c)$, then

$$a+b+c=2s,\quad a+b-c=2(s-c),$$
$$a-b+c=2(s-b),\quad b+c-a=2(s-a).$$

We have now

$$\frac{c^2p^2}{4}=s(s-a)(s-b)(s-c);$$

and hence, observing that $\dfrac{cp}{2}=$ area of triangle,

$$\text{area}=\sqrt{[s(s-a)(s-b)(s-c)]}.$$

203. By a method of investigation in all respects similar to that which has been employed in these examples, any proposed geometrical problem may be reduced to an algebraic equation, the roots of which will exhibit arithmetical values of that geometrical magnitude which constitutes the unknown quantity in the equation. But the roots of algebraic equations may also be expressed by geometrical magnitudes, and hence a geometrical construction of a problem may be derived from its algebraic solution. For example, quadratic equations, which all belong to one or other of these three forms,



$$x^2+ax=bc,\quad x^2-ax=bc,\quad x^2-ax=-bc,$$
$$\text{or, } x(x+a)=bc,\quad x(x-a)=bc,\quad x(a-x)=bc,$$

may be constructed as follows.

*Construction of the first and second forms.*—Let a circle EABD (fig. 8) be described with a radius $=\frac{1}{2}a$, in which, from any point A in the circumference, apply a chord $\text{AB}=b-c$, ($b$ being supposed greater than $c$) and produce AB so that $\text{BC}=c$; then $\text{AC}=b$.

Let H be the centre of the circle; join CH cutting the circumference in D and E, then, in the first case, the positive value of $x$ will be represented by CD, and in the second by CE; for by construction $\text{DE}=a$; therefore, if CD be called $x$, then $\text{CE}=x+a$; but if $\text{CE}=x$, then $\text{CD}=x-a$. Now, by the elements of geometry, $\text{EC}\times\text{CD}=\text{AC}\times\text{CB}$; that is, $x(x\pm a)=bc$, or $x^2\pm ax=bc$, which equation comprehends the first and second cases.

If the negative roots be required, that of the first case will be CE and that of the second CD.

When $b$ and $c$ are equal, the construction will be rather more simple; for then AB vanishing, AC will coincide with the tangent CF. Therefore, if a right-angled triangle HFC be constructed, whose legs HF and FC are equal respectively to $\frac{1}{2}a$ and $b$, then will CD, the value of $x$ in the first case, be equal to CH—HF, and CE, the value of $x$ in the latter, $=\text{CH}+\text{HF}$.

*Construction of the third form.*—Let a circle EADB (fig. 9) be described with a radius $=\frac{1}{2}a$ as before, in which apply a chord $\text{AB}=b+c$, and take $\text{AC}=b$. Through C draw the diameter DCE, then either DC or EC will be positive roots of the equation. For since $\text{ED}=a$, if either EC or $\text{CD}=x$, the remaining part of the diameter will be $a-x$; now by the nature of the circle $\text{EC}\times\text{CD}=\text{AC}\times\text{CB}$, that is, $x(a-x)=bc$, or $x^2-ax=-bc$; hence it is evident that the roots are rightly determined.

If $b$ and $c$ are equal, the construction will be the same, only it will then not be necessary to describe the whole circle; for since AC will be perpendicular to the diameter, if a right-angled triangle HCA be constructed, having its hypothenuse $\text{HA}=\frac{1}{2}a$ and base $\text{AC}=b$, the roots of the equation will be expressed by AH+HC and AH—HC.

If $b$ and $c$ be so unequal that $b-c$ in the first two cases, or $b+c$ in the third, is greater than $a$, then, instead of these quantities, $\frac{1}{2}b$ and $2c$, or in general $\frac{b}{n}$ and $nc$ (where $n$ is any number whatever) may be used. Or a mean proportional may be found between $b$ and $c$, and the construction performed as directed in each case when $b$ and $c$ are equal.

It appears from this section, that every geometrical problem which produces a quadratic equation may be constructed by means of a straight line and a circle, or is a *plane* problem; hence, on the contrary, if a problem can be constructed by straight lines and circles, its algebraic resolution will not produce an equation higher than a quadratic. Cubic and biquadratic equations may be constructed geometrically by means of any two conic sections; hence it follows that every geometrical problem which requires for its construction two conic sections, will, when resolved by algebra, produce a cubic or biquadratic equation.

## Sect. XXIV. Of the Loci of Equations.

204. When an equation contains two indeterminate quantities $x$ and $y$, then for each particular value of $x$

Algebra. there may be as many values of $y$ as it has dimensions in that equation. So that if in an indefinite line AE (fig. 10) there be taken a part AP to represent $x$, and a perpendicular PM be drawn to represent $y$, there will be as many points M, M′, &c. the extremities of these perpendiculars, as there are dimensions of $y$ in the proposed equation; and the values of PM, PM′, &c. will be the roots of the equation, which are found by substituting for $x$ its value in any particular case. Hence it appears that in any particular equation we may determine as many points M as we please; and a line which passes through all these points is called the *locus* of the equation. The line AP, which expresses any value of $x$, is called an *absciss;* and PM, which expresses the corresponding value of $y$, is called an *ordinate.* Any two corresponding values of $x$ and $y$ are also called *co-ordinates.*

205. When the equation that arises by substituting for $x$ any particular value AP has all its roots positive, the points M, M′, &c. will lie all on one side of AE; but if any of them be negative, these must be set off on the other side of AE towards $m$.

If $x$ be supposed to become negative, then the line A$p$, which represents it, is to be taken in a direction the opposite to that which represents the positive values of $x$; the points M, $m$, are to be taken as before, and the *locus* is only complete when it passes through all the points M, $m$, so as to exhibit a value of $y$ corresponding to every possible value of $x$.

If in any case one of the values of $y$ vanish, then the point M coincides with P, and the *locus* meets AE in that point. If one of the values of $y$ becomes infinite, then it shows that the curve has an infinite arc, and in that case the line PM becomes an *asymptote* to the curve, or touches it at an infinite distance, if AP itself is finite.

If, when $x$ is supposed infinitely great, a value of $y$ vanish, then the curve approaches to AE as an asymptote.

If any values of $y$ become impossible, then so many points M vanish.

206. From these observations, and the theory of equations, it appears that when an equation is proposed involving two indeterminate quantities $x$ and $y$, there may be as many intersections of the curve which is the *locus* of the equation, and of the line PM, as there are dimensions of $y$ in the equation; and as many intersections of the curve and the line AE as there are dimensions of $x$ in the equation.

207. A curve line is called *geometrical,* or *algebraic,* when the equation which expresses the relation between $x$ and $y$ (any absciss and its corresponding ordinate), consists of a finite number of terms, and contains, besides these quantities, only known quantities. Algebraic curves are divided into *orders,* according to the dimensions of the equations which express the relations between their abscisses and ordinates, or according to the number of points in which they can intersect a straight line.

*Straight lines* themselves constitute the first order of lines; and when the equation expressing the relation between $x$ and $y$ is only of one dimension, the points M, &c. must be all found in a straight line which contains with AE a given angle. Suppose, for example, that the given equation is $ay-bx-cd=0$, and that its *locus* is required.

Since $y=\frac{bx+cd}{a}$, it follows that APM (fig. 11) being a right angle, if AN be drawn making the angle NAP such that its cosine is to its sine as $a$ to $b$, and drawing AD parallel to the ordinates PM, and equal to $\frac{cd}{a}$, if DF be drawn parallel to AN, then will DF be the *locus* required; where it is to be observed that AD and PN are to be taken on the same side of AE if $bx$ and $cd$ have the same sign, but on opposite sides of AE if they have contrary signs. Algebra.

Curves whose equations are of two dimensions constitute the *second* order of lines, and the *first* kind of curves. Their intersections with a straight line can never exceed two (sect. 204).

Curves whose equations are of three dimensions form the *third* order of lines and the *second* kind of curves, and their intersections with a straight line can never exceed three; and after the same manner curves of the higher orders are denominated.

Some curves, if they were completely described, would cut a straight line in an infinite number of points; but these belong to none of the orders we have mentioned, for the relation between their ordinates and abscisses cannot be expressed by a finite equation, involving only ordinates and abscisses with determinate quantities. Curves of this kind are called *mechanical* or *transcendental.*

208. As the roots of an equation become impossible always in pairs, so the intersections of a curve and its ordinate PM must vanish in pairs, if any of them vanish. Let PM (fig. 12) cut the curve in the points M and $m$, and, by moving parallel to itself, come to touch it in the point N, then the two points of intersection M and $m$ go to form one point of contact N. If PM still move on, parallel to itself, the points of intersection will, beyond N, become imaginary, as the two roots of an equation first become equal, and then imaginary.

The curves of the 3d, 5th, 7th orders, and all whose dimensions are odd numbers, have always one real root at least; and consequently for every value of $x$ the equation by which $y$ is determined must have at least one real root; so that as $x$ or AP may be increased *in infinitum* on both sides, it follows that M must go off on both sides without limit.

In curves whose dimensions are even numbers, as the roots of their equations may become all impossible, it follows that the figure of the curve may be like a circle, or oval, that is, limited within certain bounds, beyond which it cannot extend.

209. When two roots of the equation by which $y$ is determined become equal, either the ordinate PM touches the curve, two points of intersection in that case going into a point of contact; or the point M is a *punctum duplex* in the curve, two of its arcs intersecting each other there; or some oval that belongs to that kind of curve becoming infinitely little in M, it vanishes into what is called a *punctum conjugatum.*

If, in the equation, $y$ be supposed $=0$, then the roots of the equation by which $x$ is determined will give the distances of the points where the curve meets AE from A; and if two of those roots be found equal, then either the curve touches the line AE, or AE passes through a *punctum duplex* in the curve. When $y$ is supposed $=0$, if one of the values of $x$ vanish, the curve in that case passes through A; if two vanish, then either AE touches the curve in A, or A is a *punctum duplex.*

As a *punctum duplex* is determined from the equality of two roots, so is a *punctum triplex* from the equality of three roots.

210. To illustrate these observations, we shall take a few examples.

*Ex.* 1. It is required to describe the line that is the *locus* of this equation, $y^2=ax+ab$, or $y^2-ax-ab=0$, where $a$ and $b$ denote given quantities. Since $y^2$

$= \pm\sqrt{ax+ab}$; if AP $= x$ (fig. 13) be assumed of a known value, and PM, P$m$, set off on each side equal to $\sqrt{ax+ab}$, the points M, $m$, will belong to the *locus* required; and for every positive value of AP there may thus be found a point of the *locus* on each side. The greater that AP or $x$ is taken, the greater does $\sqrt{ax+ab}$ become, and consequently PM and P$m$ the greater; and if AP be supposed infinitely great, PM and P$m$ will also become infinitely great; therefore the *locus* has two infinite arcs, that go off to an infinite distance from AE and from AD. If $x$ be supposed to vanish, then $y = \pm\sqrt{ab}$, so that $y$ does not vanish in that case, but passes through D and $d$, taking AD and A$d$ each $= \sqrt{ab}$.

If P be supposed to move on the other side of A, then $x$ becomes negative, and $y = \pm\sqrt{ab - ax}$, so that $y$ will have two values as before, while $x$ is less than $b$; but if AB $= b$, and the point P be supposed to come to B, then $ab = ax$, and $y = \pm\sqrt{ab - ax} = 0$; that is, PM and P$m$ vanish, and the curve there meets the line AE. If P be supposed to move from A beyond B, then $x$ becomes greater than $b$, and $ax$ greater than $ab$, so that $ab - ax$ being negative, $\sqrt{ab - ax}$ becomes imaginary; that is, beyond B there are no ordinates which meet the curve, and consequently, on that side the curve is limited at B.

All this agrees very well with what is known by other methods, that the curve whose equation is $y^2 = ax + ab$ is a parabola whose vertex is B, axis BE, and parameter equal to $a$. For since $b \pm x =$ BP, and $y =$ PM, from the equation $ab \pm ax = y^2$, or $a(b \pm x) = y^2$, we have $a \times \text{BP} = \text{PM}^2$, which is the well-known property of the parabola.

*Ex.* 2. It is required to describe the line that is the *locus* of the equation $xy + ay + cy = bc + bx$, or

$$y = \frac{bc + bx}{a + c + x}.$$

Here it is evident (fig. 14) that the ordinate PM can meet the curve in one point only, there being but one value of $y$ corresponding to each value of $x$. When $x = 0$, then $y = \frac{bc}{a+c}$; so that the curve does not pass through A. If $x$ be supposed to increase, then $y$ will increase, but will never become equal to $b$, since $y = b \times \frac{c+x}{a+c+x}$, and $a+c+x$ is always greater than $c+x$. If $x$ be supposed infinite, then the terms $a$ and $c$ vanish compared with $x$, and consequently $y = b \times \frac{x}{x} = b$; from which it appears, that taking AD $= b$, and drawing GD parallel to AE, it will be an asymptote, and touch the curve at an infinite distance. If $x$ be now supposed negative, and AP be taken on the other side of A, then $y = b \times \frac{c-x}{a+c-x}$; and if $x$ be taken on that side $= c$, then $y = b \times \frac{c-c}{a} = 0$; so that the curve must pass through B, if AB $= c$. If $x$ be supposed greater than $c$, then will $c - x$ become negative, and the ordinate will become negative, and lie on the other side of AE, till $x$ become equal to $a+c$, and then $y = b\frac{-a}{0}$, that is, because the denominator is 0, $x$ becomes *infinite*; so that if AK be taken $= a+c$, the ordinate KF will be an asymptote to the curve.

If $x$ be taken greater than $a+c$, or AP greater than AK, then both $c - x$ and $a+c-x$ become negative, and consequently $y = b \times \frac{x-c}{x-a-c}$ becomes a positive quantity; and since $x-c$ is always greater than $x-a-c$, it follows that $y$ will be always greater than $b$ or KG, and consequently the rest of the curve lies in the angle FGH. And as $x$ increases, since the ratio of $x-c$ to $x-a-c$ approaches still nearer to a ratio of equality, it follows that PM approaches to an equality with PN, therefore the curve approaches to its asymptote GH on that side also.

The curve is the common hyperbola, for since $b(c+x) = y(a+c+x)$, by adding $ab$ to both sides, $b(a+c+x) = y(a+c+x) + ab$, and $(b-y)(a+c+x) = ab$, that is, NM $\times$ GN $=$ GC $\times$ BC, which is the property of the common hyperbola.

*Ex.* 3. It is required to describe the *locus* of the equation $ay^2 - xy^2 = x^3 + bx^2$.

Here $y^2 = \frac{x^3 + bx^2}{a - x}$, and therefore $y = \pm\sqrt{\frac{x^3 + bx^2}{a - x}}$, hence PM and PM (fig. 15) are to be taken on each side, and equal to $\sqrt{\frac{x^3 + bx^2}{a - x}}$. This expression, by supposing $x = a$, becomes infinite, because its denominator is then $= 0$; therefore if AB be taken $= a$, and BK be drawn perpendicular to AB, the line BK will be an asymptote to the curve. If $x$ be supposed greater than $a$, or AP greater than AB, then $a - x$ being negative, the fraction $\frac{x^3 + bx^2}{a - x}$ will become negative, and its square root impossible; so that no part of the *locus* can lie beyond B. If $x$ be supposed negative, or P taken on the other side of A, then $y = \pm\sqrt{\frac{-x^3 + bx^2}{a + x}}$; hence the values of $y$ will be real and equal as long as $x$ is less than $b$; but if $x = b$, then $y = \sqrt{\frac{-x^3 + bx^2}{a + x}} = \sqrt{\frac{-b^3 + b^3}{a + b}} = 0$, and consequently if AD be taken $= b$, the curve will pass through D, and there touch the ordinate. If $x$ be taken greater than $b$, then $\pm\sqrt{\frac{-x^3 - bx^2}{a + x}}$ becomes imaginary, so that no part of the curve is found beyond D. The portion between A and D is called a *nodus*. If $y$ be supposed $= 0$, then will $x^3 + bx^2 = 0$ be an equation whose roots are $-b$, 0, 0; from which it appears that the curve passes twice through A, and has in A a *punctum duplex*. This *locus* is a line of the third order.

If $b$ is supposed to vanish in the supposed equation, so that $ay^2 - xy^2 = x^3$, then will A and D coincide (fig. 16) and the *nodus* vanish, and the curve will have in the point A a *cuspis*, the two arcs AM and A$m$, in this case, touching one another in that point. This is the same curve which the ancients called the *Cissoid of Diocles*.

If, instead of supposing $b$ positive, or equal to 0, we suppose it negative, the equation will be $ay^2 - xy^2 = x^3 - bx^2$; the curve will in this case pass through D as before (fig. 17), and taking AB $= a$, BK will be its asymptote. It will have a *punctum conjugatum* in A, because when $y$ vanishes, two values of $x$ vanish, and the third becomes $= b$, or AD. The whole curve, except this point, lies between DQ and BK. These remarks are demonstrated after the same manner as in the first case.

211. If an equation have this form,

$$y=ax^n+bx^{n-1}+cx^{n-2}+, \text{ \&c.}$$

and $n$ is an even number, then will the *locus* of the equation have two infinite arcs lying on the same side of AE (fig. 18); for if $x$ become infinite, whether positive or negative, $x^n$ will be positive and $ax^n$ have the same sign in either case; and as $ax^n$ becomes infinitely greater than the other terms $bx^{n-1}$, &c. it follows that the infinite values of $y$ will have the same sign in these cases, and consequently the two infinite arcs of the curve will lie on the same side of AE.

But if $n$ be an odd number, then when $x$ is negative, $x^n$ will be negative, and $ax^n$ will have the contrary sign to what it has when $x$ is positive; and therefore the two infinite arcs will in this case lie on different sides of AE, as in fig. 19, and tend towards parts directly opposite.

212. If an equation have this form, $yx^n=a^{n+1}$, and $n$ be an odd number, then when $x$ is positive, $y=\dfrac{a^{n+1}}{x^n}$; but when $x$ is negative, $y=-\dfrac{a^{n+1}}{x^n}$; so that this curve must all lie in the vertically opposite angles KAE, FA$e$ (fig. 20), as the common hyperbola, FK, E$c$ being asymptotes.

But if $n$ be an even number, then $y$ is always positive, whether $x$ be positive or negative, because $x^n$ in this case is always positive; and therefore the curve must all lie in the two adjacent angles KAE and KA$e$ (fig. 21), and have AK and AE for its asymptotes.

213. If an equation be such as can be reduced into two other equations of lower dimensions, without affecting $y$ or $x$ with any radical sign, then the *locus* will consist of the two *loci* of those inferior equations. Thus, the *locus* of the equation $y^2-2xy+by+x^2-bx=0$, which may be resolved into these two, $x-y=0$, $y-x+b=0$, is found to be two straight lines cutting the absciss AE (fig. 22) in angles of 45° in the points A, B, whose distance AB$=b$. In like manner some cubic equations can be resolved into three simple equations, and then the *locus* is three straight lines; or may be resolved into a quadratic and simple equation, and then the *locus* is a straight line and a conic section. In general, curves of the superior orders include all the curves of the inferior orders, and what is demonstrated generally of any one order is also true of the inferior orders. Thus, for example, any general property of the conic sections holds true of two straight lines as well as a conic section, particularly, that the rectangles of the segments of parallels bounded by them will always be to one another in a given ratio.

214. From the analogy which subsists between algebraic equations and geometrical curves, it is easy to see that the properties of the former must suggest corresponding properties of the latter. Hence the principles of algebra admit of the most extensive application to the theory of curve lines. It may be demonstrated, for example, that the *locus* of every equation of the second order is a conic section; and, on the contrary, the various properties of the diameters, ordinates, tangents, &c. of the conic sections may be readily deduced from the theory of equations.

## Sect. XXV. Arithmetic of Sines.

215. The calculus of sines is one of the mathematical theories which have been produced by the application of algebra to geometry. It treats of the relations which sines, cosines, tangents, &c. of angles have one to another.

216. The geometrical principles of this theory were known to the ancients. They may be deduced from the beautiful property of a quadrilateral inscribed in a circle, namely, that the rectangle contained by its diagonals is equal to the sum of the rectangles contained by its opposite sides; which we find in the writings of Ptolemy, and which was employed in the trigonometry of the Greeks. In comparatively modern times we find the same propositions distinctly recognised in the *Opus Palatinum*, the great work on triangles begun by Rhetius, and finished by Otho, who published it in 1596; also in the trigonometry of Pitiscus, first printed in 1599; and probably they may be found in still earlier works. Montucla, in his *Histoire des Mathématiques*, says, "I do not see that any one before the beginning of this century (the 18th) had thought of seeking formulæ proper to express the sines or cosines, tangents or co-tangents, of the sum or difference of arcs of a circle, or their powers, &c. It seems to me to have been very natural; and that there must have been frequently occasion to know what was the sine or cosine, the tangent or co-tangent, of an arc, that was the sum or difference of two arcs of which the sines or cosines, or tangents or co-tangents, were known. The first theorems on this subject appear to be the work of Frederic-Christian Mayer, one of the first members of the Petersburg Academy." Montucla, however, seems to have overlooked the trigonometry of Pitiscus, who, in problems 8 and 9 of his second book, gives rules for finding the sines and cosines of the sum and difference of two arcs, when the sines and cosines of the arcs are given. These are in the edition of 1612. The formula which expresses the tangent of the sum of several arcs by the tangent of the arcs themselves, was given, for the first time, we believe, by John Bernoulli, in the Leipsic Acts for July 1722. Both these are prior to Mayer's Memoir, which is in the Petersburg Commentaries with the date 1727. It was probably here, however, that the first essay of analytical trigonometry was given. Euler, who stands pre-eminent in every branch of the mathematics, has contributed more especially to this doctrine, as in his *Subsidium Calculi Sinuum*, in the New Petersburg Commentaries, vol. v. (for 1754 and 1755), and his *Introductio in Analysin Infinitorum*. The doctrine of spherical trigonometry was given in an analytic form by the same writer, in a memoir entitled *Trigonometria Spherica universa ex primis principiis derivata*, in the Petersburg Acts for 1779; and also by De Gua in the volume of the Academy of Sciences for 1783; and, lastly, by Lagrange in a memoir of the *Journal Polytechnique*, vol. ii.

217. The calculus of sines is of great importance as a branch of analysis. It enables us in a great measure to dispense with the complicated diagrams which the earlier writers on geometry, and on the physico-mathematical theories, employed in their investigations and demonstrations. In geometry, when combined with the modern analysis, it gives the power of expressing the most complicated relations of figure, and magnitude, and position, almost without the help of graphic representations. As an example, we may give the fine discovery by Gauss, of formulæ by which a regular polygon of seventeen sides may be inscribed in a circle by a geometrical construction. In algebra it has served to extend greatly the theory of equations; in astronomy, when applied to the theories of the planets and comets, it gives elegant and convenient expressions for their angular motions, and compact formulæ for computing the elements of their orbits, and their true and apparent positions; and in statics and dynamics, it gives, without diagrams, the relations of forces which produce rest or motion, and the laws of the motions. The precious invention of logarithms abridged the irksome

labour of calculation, even in the simplest applications of geometry; but this, combined with the trigonometrical tables, and the theory of the calculus of sines, affords a still more powerful instrument for abridging labour; just as two mechanical inventions, which apart can overcome considerable resistance, yet are vastly more potent when united.

218. In the calculus of sines, as well as in other applications of algebra to geometry, all quantities, whether lines or angles, are considered as expressed by numbers; some line or angle is assumed as a *unit*, and the number of times that unit is contained in the line or angle is its numerical value.

The magnitude of the unit is altogether arbitrary; and since, in general, the magnitude to be expressed in numbers may not contain the unit an exact number of times, it ought to be so small, that the remainders may, in respect of the wholes, be rejected.

219. The primary unit, by which angles are expressed in numbers, is one ninetieth part of a right angle, that is, one 360th part of four right angles. Each of these is called a *degree*, and is conceived to contain 60 units of a lower order, called *minutes;* and each minute, again, 60 units of the next lower order, called *seconds;* and so on to *thirds*, &c.

The degrees, minutes, &c. in an angle, are usually written thus: $12° 15' 10'' 25'''$. This means an angle of 12 degrees, 15 minutes, 10 seconds, and 25 thirds. It is not common to estimate angles to a greater degree of accuracy than seconds and tenths of a second: thus $3{\cdot}4''$ means three seconds and four tenths of a second.

The French mathematicians attempted, in the time of the Revolution, to introduce a new unit for angles. They supposed a right angle to be divided into 100 equal parts, called degrees; and each degree to be subdivided into 100 minutes; and each minute into 100 seconds; and so on. This division, however, was not adopted out of France. Unfortunately, Laplace had employed it in his *Mécanique Céleste*, to the inconvenience of its readers; but now the French mathematicians themselves have almost all returned to the old sexagenary division.

220. Although an angle and a circle are not necessarily related, because we can form a distinct notion of each independently of the other; yet there is such an analogy between them, as to make it convenient to consider them together. Therefore (Plate XVIII. fig. 23), let PO, QO, be straight lines which contain an angle whose vertex is O. Let OQ, one of the lines, be given in position, and let OE, a segment of the other line adjacent to O, be an *invariable magnitude.* Let us now suppose the line PO to coincide at first with QO, and, departing from that position, to turn about O as a centre: the line PO will now generate an angle POQ, and E, the extremity of the constant radius, will describe an arc AE. When the line has made a complete revolution about the centre O, it will have generated four right angles, and the point E will have described a complete circle; and it is manifest that any angle POQ will have the same ratio to four right angles that the arc AE has to the whole circumference. Hence it follows that the arc may conveniently serve as a *geometrical measure* of the angle; and if we suppose the circumference to be divided into 360 equal parts, called degrees, and each of these to be subdivided into 60 minutes, and so on, then the angle and arc will be expressed by the same number of degrees, minutes, &c.

221. Let the diameters AC, BD, be perpendicular to each other. These divide the circumference into four *quadrants*, and the circle into four regions AOB, BOC, COD, DOA. The difference between an angle and a right angle, or between an arc and a quadrant, is called the *complement* of the angle or arc; and the difference between an angle and two right angles, or between an arc and a semicircle, is called the *supplement* of the angle or arc. Thus, the angle POB is the complement of POQ, and POC is its supplement; and the arc BE is the complement of AE, and CE its supplement.



222. Assuming A as the origin of the variable arc AE, a straight line EF, drawn from its extremity E, perpendicular to the diameter AC, is called the *sine* of the arc AE; and a straight line EG, drawn perpendicular to BD (which is the sine of the arc EB, the complement of AE), is called the *cosine* of the arc AE. Hence it appears that the cosine of an arc is equal to the distance of the sine from the centre of the circle.

223. Supposing now the arc AE to increase continually by the revolving of the radius OE, departing from the position OA, and moving in the direction ABCD, &c. the sine EF, which at first is $=0$, will increase until the arc become a quadrant; afterwards, while the arc increases from one to two quadrants, the sine E′F′ will decrease, and at last again become $=0$. The arc continuing to increase, the sine will be reproduced; but its direction F″E″ will now be the opposite to its first direction FE. It will increase in magnitude, until the arc become three quadrants ABCD; and it will again decrease, while the arc is increasing from three to four quadrants: and when the radius has made a complete revolution, the sine will have decreased to *zero.* We may, however, suppose the revolving radius OE still to proceed: there will thus be generated an arc, ABCDAE, greater than a complete circumference, of which EF will be the sine; and, in the second and every succeeding revolution, the sine will pass through the same changes as in the first.

224. We may trace the changes in the magnitude and direction of the cosine just in the same way. While the arc AE increases from zero to a quadrant, the cosine OF, at first equal to the radius OA, decreases, and at last vanishes; and while the arc continues to increase, and has any value ABE′ between one and two quadrants, the cosine OF′ is reproduced, with a direction the opposite to the first. When the arc is exactly two quadrants, the cosine becomes in magnitude OC, equal to OA, but opposite in direction. The arc still increasing to ACE″, the cosine decreases to OF″; and when the arc becomes ABCD, three quadrants, the cosine again becomes $=0$: between three and four quadrants the cosine OF‴ re-appears in its original direction; and when the revolution is completed, the cosine acquires its first value OA. In a second revolution the same changes are repeated, and so on continually.

We may suppose the radius to turn round O in the contrary direction ADC, and the very same changes will be produced on the direction and magnitude of the sine and cosine of the generated arc AE‴.

225. In conformity to the principles of analytic geometry, the contrary position of the arcs AE, AE′, and the sines EF, E′F′, in respect of the position of the arcs AE″, AE‴, and the sines E″F″, E‴F‴, may be indicated by the signs $+$ and $-$; and the same is true of the cosines OF, OF‴, which are opposed in direction to the cosines OF′, OF″, the arcs and sines on opposite sides of the diameter AC being regarded as having opposite signs, and a like contrariety being supposed in the cosines on opposite sides of the diameter BD, which is perpendicular to AC. The arc AE being regarded as positive, it does not signify whether we reckon the sines and cosines positive or negative in the beginning, provided we change the signs,

when, after having decreased to *zero*, they are reproduced with a contrary direction.

Let us suppose the sine and cosine of any positive arc AE in the first quadrant to be positive; then, from what has been explained, the sine will continue to be positive in the second quadrant, but the cosine will have become negative; in the third the sine and cosine will both be negative; and in the fourth the sine will be negative, but the cosine positive.

Again, if the radius OE turn about O in the contrary direction, ADCB, &c. the arc AE‴, &c. thus generated will be negative; the sines will also be negative in the first semicircle, but the cosines positive in the quadrant AD, and negative in DC, and so on; the changes from + to —, and from — to +, following each other exactly as in the generation of a positive arc.

226. Let a straight line AH, perpendicular to the diameter AC, meet the radius OE produced in H (fig. 24): the line AH is called the *tangent* of the arc AE, and the line OH the *secant* of that arc.

227. A line BK, perpendicular to OB (which is at right angles to OA), and which meets OH in K, will be the tangent of the complement of the arc AE; and OK will be its secant. The former is therefore called the *co-tangent* of the arc AE, and the latter its *co-secant*.

228. The segment AF of the diameter, between the beginning of the arc and its sine, is called the versed sine of the arc; and, similarly, the segment BG, the versed sine of the complement, is its *co-versed sine*.

229. Since the arc AE is assumed as a geometrical measure of the angle POQ, we may regard the lines which are the sine, tangent, secant, &c. of the arc, as also the sine, tangent, secant, &c. of the angle; or, since all quantities in this calculus are to be expressed in numbers, we may take any numbers proportional to these lines. Hence we may assume the fraction $\frac{arc\ AE}{rad.OA}$ as the measure of the angle POQ, and, similarly, $\frac{EF}{OE}$ as the sine of the angle POQ, $\frac{OF}{OE}$ its cosine, $\frac{HA}{OA}$ its tangent, and $\frac{OH}{OA}$ its secant; then $\frac{BK}{OB}=\frac{AO}{AH}$ will be the co-tangent, and $\frac{OK}{OB}=\frac{HO}{AH}$ will be the co-secant of the angle. These quantities will have among themselves the same ratios as the lines which bear the same designations; and it is evident, from the nature of similar figures, that supposing the angle POQ to remain of the same magnitude, its sine, tangent, secant, &c. thus defined, are the same, whatever be the magnitude of the circle, which now serves merely to connect them as related quantities.

We may consider OA, the radius of the circle, as a unit, and then the sines, tangents, &c. will be expressed in parts of that unit, according to the decimal notation. This is the common form in which they are given in the trigonometrical tables.

230. The power of algebra, as an instrument of investigation, depends greatly on the proper employment of conventional signs: it is common to express the sine of an arc $a$ by the abbreviation *sin. a*, its cosine by *cos. a*, its tangent by *tan. a*, its secant by *sec. a*, its co-tangent by *cot. a*, its co-secant by *cosec. a*, and its versed sine by *ver. sin. a*.

231. From the definition given of an angle by the ancient geometers, its measure cannot exceed half the circumference of a circle. When, however, we regard an angle as generated by the rotation of a line about a fixed point, the arc, which is its measure, may be regarded as capable of continual increase. In astronomy, the angular motion of the sun and planets is reckoned from an angle or arc of 0° forward to 360°. We are thus led to consider the sines of arcs which exceed 180°, and even which exceed a whole circumference, or any number of circumferences.

232. Let $\pi$ denote half the circumference of the circle which is assumed as a scale for measuring angles. It is easy, by induction, to infer from what has been explained, that $a$ being any arc,

$$\begin{array}{ll}
\text{Cos.}\ (\ \pi+a)=-\text{cos.}\ a, & \text{Sin.}\ (\ \pi+a)=-\text{sin.}\ a,\\
\text{Cos.}\ (2\pi+a)=+\text{cos.}\ a, & \text{Sin.}\ (2\pi+a)=+\text{sin.}\ a,\\
\text{Cos.}\ (3\pi+a)=-\text{cos.}\ a, & \text{Sin.}\ (3\pi+a)=-\text{sin.}\ a,\\
\text{Cos.}\ (4\pi+a)=+\text{cos.}\ a, & \text{Sin.}\ (4\pi+a)=+\text{sin.}\ a,\\
\&c. & \&c.
\end{array}$$

And in general, $n$ being 0, or any whole number,

$$\left.\begin{array}{l}
\text{Cos.}\ [(2n+1)\ \pi+a]=-\text{cos.}\ a,\\
\text{Cos.}\ [\ 2n\pi+a]\ \ldots\ldots=+\text{cos.}\ a,\\
\text{Sin.}\ [(2n+1)\ \pi+a]=-\text{sin.}\ a,\\
\text{Sin.}\ [\ 2n\pi+a]\ \ldots\ldots=+\text{sin.}\ a.
\end{array}\right\}\ (1)$$

It is also evident that

$$\begin{array}{ll}
\text{Cos.}\ (\ \pi-a)=-\text{cos.}\ a, & \text{Sin.}\ (\ \pi-a)=+\text{sin.}\ a,\\
\text{Cos.}\ (2\pi-a)=+\text{cos.}\ a, & \text{Sin.}\ (2\pi-a)=-\text{sin.}\ a,\\
\text{Cos.}\ (3\pi-a)=-\text{cos.}\ a, & \text{Sin.}\ (3\pi-a)=+\text{sin.}\ a,\\
\text{Cos.}\ (4\pi-a)=+\text{cos.}\ a, & \text{Sin.}\ (4\pi-a)=-\text{sin.}\ a,\\
\&c. & \&c.
\end{array}$$

And in general that

$$\left.\begin{array}{l}
\text{Cos.}\ [(2n+1)\pi-a]=-\text{cos.}\ a,\\
\text{Cos.}\ [\ 2n\pi-a]\ \ldots\ldots=+\text{cos.}\ a,\\
\text{Sin.}\ [(2n+1)\ \pi-a]=+\text{sin.}\ a,\\
\text{Sin.}\ [\ 2n\pi-a]\ \ldots\ldots=-\text{sin.}\ a.
\end{array}\right\}\ (2)$$

When the arc $a=0$, we have

$$\begin{array}{ll}
\text{Cos.}\ (2n+1)\ \pi=-1, & \text{Sin.}\ (2n+1)\ \pi=0,\\
\text{Cos.}\ 2n\pi\ \ \ =+1, & \text{Sin.}\ 2n\pi\ \ \ =0.
\end{array}$$

233. If $a$ and $\alpha$ be arcs which differ by a quadrant, that is, if $\alpha=\frac{1}{2}\pi+a$; then it will appear by inspection of figure 23, and a little consideration, that

$$\text{Cos.}\ \alpha=-\text{sin.}\ a,\qquad \text{Sin.}\ \alpha=+\text{cos.}\ a.$$

Now, by changing $a$ into $\alpha$, formulæ (1) of last section become

$$\begin{array}{l}
\text{Cos.}\ [(2n+1)\pi+\alpha]=-\text{cos.}\ \alpha,\\
\text{Cos.}\ [\ 2n\pi+\alpha]\ \ldots\ldots=+\text{cos.}\ \alpha,\\
\text{Sin.}\ [(2n+1)\pi+\alpha]=-\text{sin.}\ \alpha,\\
\text{Sin.}\ [\ 2n\pi+\alpha]\ \ldots\ldots=+\text{sin.}\ \alpha.
\end{array}$$

In these substitute $\frac{1}{2}\pi+a$ for $\alpha$, $-$sin. $a$ for cos. $\alpha$, and cos. $a$ for sin. $\alpha$, and they become

$$\left.\begin{array}{l}
\text{Cos.}\ [(4n+3)\ \frac{\pi}{2}+a]=+\text{sin.}\ a,\\
\text{Cos.}\ [(4n+1)\ \frac{\pi}{2}+a]=-\text{sin.}\ a,\\
\text{Sin.}\ [(4n+3)\ \frac{\pi}{2}+a]=-\text{cos.}\ a,\\
\text{Sin.}\ [(4n+1)\ \frac{\pi}{2}+a]=+\text{cos.}\ a.
\end{array}\right\}\ (3)$$

If, again, there be two arcs $a$ and $\alpha$, whose sum is a quadrant, that is, $\alpha=\frac{1}{2}\pi-a$, then

$$\text{Cos.}\ \alpha=\text{sin.}\ a,\qquad \text{Sin.}\ \alpha=\text{cos.}\ a.$$

If, in the above formulæ, we now put $\frac{1}{2}\pi-a$ for $\alpha$, and sin. $a$ for cos. $\alpha$, and cos. $a$ for sin. $\alpha$, we shall have

$$\left.\begin{array}{l}
\text{Cos.}\ [(4n+3)\ \frac{\pi}{2}-a]=-\text{sin.}\ a,\\
\text{Cos.}\ [(4n+1)\ \frac{\pi}{2}-a]=+\text{sin.}\ a,\\
\text{Sin.}\ [(4n+3)\ \frac{\pi}{2}-a]=-\text{cos.}\ a,\\
\text{Sin.}\ [(4n+1)\ \frac{\pi}{2}-a]=+\text{cos}\ a.
\end{array}\right\}\ (4)$$

234. The formulæ investigated in the last two sections may be brought together in an abridged form, as in the following table:

$$\text{Cos.}\,[(2n+1)\pi\pm a]=-\text{cos.}\,a, \quad (1)$$
$$\text{Cos.}\,[\,2n\pi\pm a]\ \ldots =+\text{cos.}\,a, \quad (2)$$
$$\text{Sin.}\,[(2n+1)\pi\pm a]=\mp\,\text{sin.}\,a, \quad (3)$$
$$\text{Sin.}\,[\,2n\pi\pm a]\ \ldots =\pm\,\text{sin.}\,a; \quad (4)$$

$$\text{Cos.}\,[(4n+1)\tfrac{\pi}{2}\pm a]=\mp\,\text{sin.}\,a, \quad (5)$$

$$\text{Cos.}\,[(4n+3)\tfrac{\pi}{2}\pm a]=\pm\,\text{sin.}\,a, \quad (6)$$

$$\text{Sin.}\,[(4n+1)\tfrac{\pi}{2}\pm a]=+\,\text{cos.}\,a, \quad (7)$$

$$\text{Sin.}\,[(4n+3)\tfrac{\pi}{2}\pm a]=-\,\text{cos.}\,a. \quad (8)$$

235. The perfection of the modern analysis consists in the employment of the fewest possible principles, and in deducing from these all the truths which can be extracted by the power of the analysis itself. We have therefore occasion for very few of the simplest propositions in geometry, and these only at the outset.

By the nature of a right-angled triangle (fig. 24),

$$OF^2+FE^2=OE^2;\ OA^2+AH^2=OH^2;\ OB^2+BK^2=OK^2.$$

The triangles OFE, OAH, OBK, being similar,

$$OF : FE :: OA : AH :: BK : BO;$$
$$FE : EO :: AH : HO :: BO : OK;$$
$$EO : OF :: HO : OA :: OK : KB.$$

Hence, observing that $OA=OB=OE=1$, and employing our premised notation, we have

$$\text{Cos.}\,a : \text{sin.}\,a :: 1 : \text{tan.}\,a :: \text{cot.}\,a : 1;$$
$$\text{Sin.}\,a : 1 :: \text{tan.}\,a : \text{sec.}\,a :: 1 : \text{cosec.}\,a;$$
$$1 : \text{cos.}\,a :: \text{sec.}\,a : 1 :: \text{cosec.}\,a : \text{cot.}\,a.$$

From these we obtain the following table of formulæ, exhibiting the relations among trigonometrical quantities, where $\text{cos.}^2\,a$ and $\text{sin.}^2\,a$ denote the squares of the cosine and sine of the arc or angle $a$.

(A)

$$\text{Cos.}^2\,a+\text{sin.}^2\,a=1 \ldots\ldots (1)$$
$$\text{Sec.}^2\,a-\text{tan.}^2\,a=1 \ldots\ldots (2)$$
$$\text{Cosec.}^2\,a-\text{cot.}^2\,a=1 \ldots\ldots (3)$$
$$\text{Cos.}\,a\ \text{sec.}\,a=1 \ldots\ldots (4)$$
$$\text{Sin.}\,a\ \text{cosec.}\,a=1 \ldots\ldots (5)$$
$$\text{Tan.}\,a\ \text{cot.}\,a=1 \ldots\ldots (6)$$
$$\text{Tan.}\,a\ \text{cos.}\,a=\text{sin.}\,a \ldots\ldots (7)$$
$$\text{Cot.}\,a\ \text{sin.}\,a=\text{cos.}\,a \ldots\ldots (8)$$
$$\text{Sin.}\,a\ \text{sec.}\,a=\text{tan.}\,a \ldots\ldots (9)$$
$$\text{Cos.}\,a\ \text{cosec.}\,a=\text{cotan.}\,a \ldots\ldots (10)$$
$$\text{Tan.}\,a\ \text{cosec.}\,a=\text{sec.}\,a \ldots\ldots (11)$$
$$\text{Cotan.}\,a\ \text{sec.}\,a=\text{cosec.}\,a \ldots\ldots (12)$$

It appears from formulæ 7, 8, 4, 5, that

$$\text{tan.}\,a=\frac{\text{sin.}\,a}{\text{cos.}\,a},\qquad \text{cot.}\,a=\frac{\text{cos.}\,a}{\text{sin.}\,a},$$
$$\text{sec.}\,a=\frac{1}{\text{cos.}\,a},\qquad \text{cosec.}\,a=\frac{1}{\text{sin.}\,a}.$$

Hence it follows that the tangent and co-tangent must be regarded as positive quantities when the sine and cosine are both positive, or both negative quantities; but as negative when, of the sine and cosine, one is positive and the other negative; and that the secant and cosine, also the co-secant and sine, must always have the same sign. Therefore the tangent will be positive in the first quadrant, negative in the second, positive in the third, negative in the fourth, and so on; and the secant will be positive in the first, negative in the second and third, positive in the fourth and fifth, and so on to any number of quadrants.



236. We have seen that the sines and cosines, when changing their sign from + to —, or from — to +, in the transition become $=0$. Now, since $\text{tan.}\,a=\frac{\text{sin.}\,a}{\text{cos.}\,a}$, and $\text{sec.}\,a=\frac{1}{\text{cos.}\,a}$; when $a$ is a quadrant, and therefore $\text{cos.}\,a=0$, and $\text{sin.}\,a=1$, then both tan. $a$ and sec. $a$ become infinite: and when $a$ is between a quadrant and a semicircumference, cos. $a$ being then negative, both tan. $a$ and sec. $a$ are negative. Hence it appears that the tangent and secant become both infinite in changing their sign from + to —. In passing from the second to the third quadrant, the tangent, from being negative, becomes positive, because the numerator of the fraction $\frac{\text{sin.}\,a}{\text{cos.}\,a}$ changes from + to —. In this transition the tangent becomes $=0$. The secant, however, continues negative; and when the arc has attained a magnitude between three and four quadrants, both tangent and secant change their signs, after having become infinite, the tangent being now negative, and the secant positive. When the circumference is completed, the tangent is reduced to 0, and the secant to the radius; and the arc being supposed to increase, the same changes will be repeated.

237. Let the sides of any triangle A B C (Fig. 7. Plate XVIII.) be……$a$, $b$, $c$,
and the opposite angles……A, B, C.

From C, any one of the angles, draw C D perpendicular to the opposite side $c$, dividing it into the two segments AD, BD; then, by the definitions (sect. 229),

$$\text{cos. B}=\frac{BD}{BC}=\frac{BD}{a},\ \text{and hence}$$

$$BD=a\ \text{cos. B, and, similarly, } AD=b\ \text{cos. A};$$
$$\text{and } c=AB=BD+AD=a\ \text{cos. B}+b\ \text{cos. A}.$$

Hence we have this property of a triangle:

*If each of any two of its sides be multiplied by the cosine of the angle it makes with the third side, the sum of the products is equal to that third side.* This theorem, combined with these formulæ,

$$\text{Cos.}^2\,A+\text{sin.}^2\,A=1,$$
$$\text{Cos.}\,(\pi-A)=-\text{cos.}\,A,$$
$$\text{Sin.}\,(\pi-A)=\text{sin.}\,A,$$

is to serve as the basis of the whole calculus of sines.

From the preceding theorem, we obtain the following system of formulæ:

I.

$$a=b\ \text{cos. C}+c\ \text{cos. B}, \quad 1.$$
$$b=a\ \text{cos. C}+c\ \text{cos. A}, \quad 2.$$
$$c=a\ \text{cos. B}+b\ \text{cos. A}. \quad 3.$$

From the first of these we get

$$a\ \text{cos. C}=b\ \text{cos.}^2\,C+c\ \text{cos. B cos. C},$$
$$a\ \text{cos. B}=b\ \text{cos. B cos. C}+c\ \text{cos.}^2\,B;$$

and from these again, by transposing,

$$b\ \text{cos.}^2\,C=a\ \text{cos. C}-c\ \text{cos. B cos. C},$$
$$c\ \text{cos.}^2\,B=a\ \text{cos. B}-b\ \text{cos. B cos. C}.$$

Subtract each side of the first of these two from the corresponding side of 2 of system I., and each side of the second from the corresponding side of 3, and write in the results $\sin.^2 C$ for $1-\cos.^2 C$, and $\sin.^2 B$ for $1-\cos.^2 B$; we then get

$$b \sin.^2 C = c(\cos. A + \cos. B \cos. C),$$
$$c \sin.^2 B = b(\cos. A + \cos. B \cos. C).$$

Take now the product of the sides of these equations, and leave out the common factors $b$, $c$, of the result; we thus obtain

$$\text{Sin.}^2 B \sin.^2 C = (\cos. A + \cos. B \cos. C)^2.$$

Hence, taking the square roots,

$$\text{Sin. } B \sin. C = \cos. A + \cos. B \cos. C.$$

Here we have a property of the angles of any triangle, which is independent of its sides; this, by interchanging the angles, gives the following system of formulæ:

II.

$$\text{Cos. } A = -\cos. B \cos. C + \sin. B \sin. C, \quad 1.$$
$$\text{Cos. } B = -\cos. A \cos. C + \sin. A \sin. C, \quad 2.$$
$$\text{Cos. } C = -\cos. A \cos. B + \sin. A \sin. B. \quad 3.$$

Again, from the first of these we have

$$\text{Cos. } A \cos. C = -\cos. B \cos.^2 C + \sin. B \sin. C \cos. C;$$

and hence, by transposition,

$$\text{Cos. } B \cos.^2 C = -\cos. A \cos. C + \sin. B \sin. C \cos. C.$$

Subtract now the sides of this equation from the corresponding sides of 2; the result is

$$\text{Cos. } B(1-\cos.^2 C) = \sin. C(\sin. A - \sin. B \cos. C).$$

Substitute $\sin.^2 C$ for $1-\cos.^2 C$, and divide by $\sin. C$; then,

$$\text{Cos. } B \sin. C = \sin. A - \sin. B \cos. C.$$

This gives us a third system of formulæ, viz.

III.

$$\text{Sin. } A = \sin. B \cos. C + \cos. B \sin. C, \quad 1.$$
$$\text{Sin. } B = \sin. A \cos. C + \cos. A \sin. C, \quad 2.$$
$$\text{Sin. } C = \sin. A \cos. B + \cos. A \sin. B. \quad 3.$$

If it be now considered that $A+B+C=$ two right angles $=\pi$, so that $A+B=\pi-C$, and therefore

$$\text{Sin. }(A+B) = \sin. C, \qquad \cos.(A+B) = -\cos. C,$$

we obtain, from the third formulæ of systems II. and III.,

$$\text{Cos. }(A+B) = \cos. A \cos. B - \sin. A \sin. B,$$
$$\text{Sin. }(A+B) = \sin. A \cos. B + \cos. A \sin. B.$$

238. In this investigation, we have supposed that A and B are two angles of a triangle,—an hypothesis which requires that their sum shall not exceed two right angles, and that the sum of the arcs which measure them do not exceed a semicircumference. The formulæ, however, hold true, whatever be the magnitude of the arcs: for, let A, $\alpha$, and B, $\beta$, denote arcs, such, that $\alpha+A=\pi$, $\beta+B=\pi$; and therefore $(\alpha+\beta)+(A+B)=2\pi$: then,

$$A=\pi-\alpha,\ B=\pi-\beta, \text{ and (sect. 232)}$$
$$\text{Cos. } A = -\cos. \alpha, \qquad \text{Sin. } A = \sin. \alpha,$$
$$\text{Cos. } B = -\cos. \beta, \qquad \text{Sin. } B = \sin. \beta.$$

Hence it follows, that

$$\text{Cos. } A \cos. B - \sin. A \sin. B$$
$$= \cos. \alpha \cos. \beta - \sin. \alpha \sin. \beta,$$
$$\text{Sin. } A \cos. B + \cos. A \sin. B$$
$$= -\sin. \alpha \cos. \beta - \cos. \alpha \sin. \beta.$$

And since (sect. 232)

$$\text{Cos. }(\alpha+\beta) = \cos.(A+B) = \cos. A \cos. B - \sin. A \sin. B,$$
$$\text{Sin. }(\alpha+\beta) = -\sin.(A+B) = -\sin. A \cos. B - \cos. A \sin. B;$$

therefore, $\cos.(\alpha+\beta) = \cos. \alpha \cos. \beta - \sin. \alpha \sin. \beta$;

$$\text{Sin. }(\alpha+\beta) = \sin. \alpha \cos. \beta + \cos. \alpha \sin. \beta.$$

Now, on the hypothesis that $A+B \angle \pi$; then, because $A+B+\alpha+\beta=2\pi$, it follows that $\alpha+\beta \,7\, \pi$. Hence it appears that the formulæ for the cosine and sine of the sum of A, B, arcs less than a semicircle, apply equally to arcs $\alpha$, $\beta$, whose sum is greater than the half, but less than the whole circumference.

Again, if we suppose that $\alpha$, $\alpha'$, and $\beta$, $\beta'$, are such arcs, that

$\alpha'+\alpha=2\pi$, $\beta'+\beta=2\pi$, and therefore $(\alpha'+\beta')+(\alpha+\beta)=4\pi$,

then we shall have $\alpha=2\pi-\alpha'$, $\beta=2\pi-\beta'$,

$$\text{Cos. } \alpha = \cos. \alpha', \qquad \text{Sin. } \alpha = -\sin. \alpha',$$
$$\text{Cos. } \beta = \cos. \beta', \qquad \text{Sin. } \beta = -\sin. \beta',$$
$$\text{Cos. }(\alpha'+\beta') = \cos.(\alpha+\beta),\ \text{Sin. }(\alpha'+\beta') = -\sin.(\alpha+\beta).$$

Here, again, we shall have

$$\text{Cos. }(\alpha'+\beta') = \cos. \alpha' \cos. \beta' - \sin. \alpha' \sin. \beta',$$
$$\text{Sin. }(\alpha'+\beta') = \sin. \alpha' \cos. \beta' + \cos. \alpha' \sin. \beta';$$

and because $\alpha+\beta$ is greater than $\pi$, but less than $2\pi$, therefore $\alpha'+\beta'$ is an arc between two and three semicircumferences.

It is evident we may proceed in this way continually, and thus be assured that the formulæ are true, when A and B are any arcs of a circle, even although they should exceed a circumference, or any number of circumferences.

239. If, in these formulæ, we substitute $a-b$ for A, and $b$ for B, they become

$$\text{Cos. } a = \cos. b \cos.(a-b) - \sin. b \sin.(a-b),$$
$$\text{Sin. } a = \sin. b \cos.(a-b) + \cos. b \sin.(a-b).$$

To abridge, let us put

$$P = \cos.(a-b), \text{ and } Q = \sin.(a-b);$$

we have now, by transposition,

$$P \cos. b - Q \sin. b = \cos. a,$$
$$P \sin. b + Q \cos. b = \sin. a.$$

From these equations, by the ordinary process of elimination, we can determine P and Q: thus, proceeding by sect. 73, we get

$$P \cos.^2 b - Q \sin. b \cos. b = \cos. a \cos. b, \quad 1.$$
$$P \sin.^2 b + Q \sin. b \cos. b = \sin. a \sin. b, \quad 2.$$
$$P \cos. b \sin. b - Q \sin.^2 b = \cos. a \sin. b, \quad 3.$$
$$P \cos. b \sin. b + Q \cos.^2 b = \sin. a \cos. b. \quad 4.$$

By adding equations (1) and (2), and substituting 1 for $\cos.^2 b + \sin.^2 b$, we obtain

$$P = \cos.(a-b) = \cos. a \cos. b + \sin. a \sin. b.$$

And again, by subtracting (3) from (4), we get

$$Q = \sin.(a-b) = \sin. a \cos. b - \cos. a \sin. b.$$

For the sake of reference, and a uniform notation, we shall now bring together the formulæ of this and sect. 237 into one group.

(B)

$$\text{Cos. }(a+b) = \cos. a \cos. b - \sin. a \sin. b, \quad (1)$$
$$\text{Cos. }(a-b) = \cos. a \cos. b + \sin. a \sin. b, \quad (2)$$
$$\text{Sin. }(a+b) = \sin. a \cos. b + \cos. a \sin. b, \quad (3)$$
$$\text{Sin. }(a-b) = \sin. a \cos. b - \cos. a \sin. b. \quad (4)$$

These constitute what we have termed the fundamental theorems of this calculus.

240. By adding and subtracting these formulæ, we obtain others equivalent to them, but under a different form, viz. these:

(C)

$$\text{Cos. } a \cos. b = \tfrac{1}{2}\cos.(a-b) + \tfrac{1}{2}\cos.(a+b), \quad (1)$$
$$\text{Sin. } a \sin. b = \tfrac{1}{2}\cos.(a-b) - \tfrac{1}{2}\cos.(a+b), \quad (2)$$
$$\text{Sin. } a \cos. b = \tfrac{1}{2}\sin.(a+b) + \tfrac{1}{2}\sin.(a-b), \quad (3)$$
$$\text{Cos. } a \sin. b = \tfrac{1}{2}\sin.(a+b) - \tfrac{1}{2}\sin.(a-b). \quad (4)$$

If we now put $a+b=A$, and $a-b=B$, so that $a=\frac{1}{2}(A+B)$, $b=\frac{1}{2}(A-B)$, and substitute these values of $a$, $b$, $a+b$, $a-b$, in the above formulæ, and, for the sake of uniformity, write the letters $a$ and $b$ instead of A and B, we obtain

(D)

$$\text{Cos. } b + \text{cos. } a = 2 \text{ cos. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a-b), \quad (1)$$
$$\text{Cos. } b - \text{cos. } a = 2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ sin. } \tfrac{1}{2}(a-b), \quad (2)$$
$$\text{Sin. } a + \text{sin. } b = 2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a-b), \quad (3)$$
$$\text{Sin. } a - \text{sin. } b = 2 \text{ cos. } \tfrac{1}{2}(a+b) \text{ sin. } \tfrac{1}{2}(a-b). \quad (4)$$

In formulæ (C), let $n$A be written instead of $a$, and A instead of $b$; and consequently $(n-1)$A instead of $a-b$, and $(n+1)$A instead of $a+b$; the result, after putting $a$ and $b$ for A and B, will be

(E)

$$2 \text{ cos. } a \text{ cos. } na = \text{cos. } (n-1)a + \text{cos. } (n+1)a, \quad (1)$$
$$2 \text{ sin. } a \text{ sin. } na = \text{cos. } (n-1)a - \text{cos. } (n+1)a, \quad (2)$$
$$2 \text{ cos. } a \text{ sin. } na = \text{sin. } (n+1)a + \text{sin. } (n-1)a, \quad (3)$$
$$2 \text{ sin. } a \text{ cos. } na = \text{sin. } (n+1)a - \text{sin. } (n-1)a. \quad (4)$$

241. Resuming the first system of formulæ, viz

$$\text{Sin. } (a+b) = \text{sin. } a \text{ cos. } b + \text{cos. } a \text{ sin. } b,$$
$$\text{Cos. } (a+b) = \text{cos. } a \text{ cos. } b - \text{sin. } a \text{ sin. } b,$$

let each side of the first be divided by the corresponding side of the second; then we have

$$\frac{\text{Sin. } (a+b)}{\text{Cos. } (a+b)} = \frac{\text{sin. } a \text{ cos. } b + \text{cos. } a \text{ sin. } b}{\text{cos. } a \text{ cos. } b - \text{sin. } a \text{ sin. } b}$$
$$= \frac{\dfrac{\text{sin. } a}{\text{cos. } a} + \dfrac{\text{sin. } b}{\text{cos. } b}}{1 - \dfrac{\text{sin. } a \text{ sin. } b}{\text{cos. } a \text{ cos. } b}}.$$

Hence, observing that tan. $\text{A} = \dfrac{\text{sin. A}}{\text{cos. A}}$, we obtain

$$\text{Tan. } (a+b) = \frac{\text{tan. } a + \text{tan. } b}{1 - \text{tan. } a \text{ tan. } b}.$$

By a like process we obtain from the formulæ for sin. $(a-b)$, and cos. $(a-b)$, a formula for tan. $(a-b)$. The two, for the sake of reference, may be put together.

(F)

$$\text{Tan. } (a+b) = \frac{\text{tan. } a + \text{tan. } b}{1 - \text{tan. } a \text{ tan. } b}, \quad (1)$$
$$\text{Tan. } (a-b) = \frac{\text{tan. } a - \text{tan. } b}{1 + \text{tan. } a \text{ tan. } b}. \quad (2)$$

242. The expressions which have been found for tan. $(a+b)$, tan. $(a-b)$, give like formulæ for the co-tangent of the sum and difference of two arcs; we have only to substitute in them

$\dfrac{1}{\text{cot.}(a \pm b)}$ for tan. $(a \pm b)$, $\dfrac{1}{\text{cot. } a}$ for tan. $a$, and $\dfrac{1}{\text{cot. } b}$ for tan. $b$. The results are,

(G)

$$\text{Cot. } (a+b) = -\frac{1 - \text{cot. } a \text{ cot. } b}{\text{cot. } a + \text{cot. } b}, \quad (1)$$
$$\text{Cot. } (a-b) = -\frac{1 + \text{cot. } a \text{ cot. } b}{\text{cot. } a - \text{cot. } b}. \quad (2)$$

243. We have found, formulæ (C), that

$$2 \text{ sin. } a \text{ sin. } b = \text{cos. } (a-b) - \text{cos. } (a+b),$$
$$2 \text{ cos. } a \text{ cos. } b = \text{cos. } (a-b) + \text{cos. } (a+b);$$

therefore, $\dfrac{\text{sin. } a \text{ sin. } b}{\text{cos. } a \text{ cos. } b} = \dfrac{\text{cos. } (a-b) - \text{cos. } (a+b)}{\text{cos. } (a-b) + \text{cos. } (a+b)}.$

From these formulæ we also obtain like expressions for

$$\frac{\text{Sin. } a \text{ cos. } b}{\text{Cos. } a \text{ sin. } b}, \quad \frac{\text{cos. } a \text{ sin. } b}{\text{sin. } a \text{ cos. } b}, \quad \frac{\text{cos. } a \text{ cos. } b}{\text{sin. } a \text{ sin. } b};$$

and from these, putting tan. $a$ for $\dfrac{\text{sin. } a}{\text{cos. } a}$, and cot. $a$ for $\dfrac{\text{cos. } a}{\text{sin. } a}$, &c. we deduce this new set of formulæ:

(H)

$$\text{Tan. } a \text{ tan. } b = \frac{\text{cos. } (a-b) - \text{cos. } (a+b)}{\text{cos. } (a-b) + \text{cos. } (a+b)}, \quad (1)$$
$$\text{Tan. } a \text{ cot. } b = \frac{\text{sin. } (a+b) + \text{sin. } (a-b)}{\text{sin. } (a+b) - \text{sin. } (a-b)}, \quad (2)$$
$$\text{Cot. } a \text{ tan. } b = \frac{\text{sin. } (a+b) - \text{sin. } (a-b)}{\text{sin. } (a+b) + \text{sin. } (a-b)}, \quad (3)$$
$$\text{Cot. } a \text{ cot. } b = \frac{\text{cos. } (a-b) + \text{cos. } (a+b)}{\text{cos. } (a-b) - \text{cos. } (a+b)}. \quad (4)$$

244. Because, by formulæ (B),

$$\text{Sin. } a \text{ cos. } b + \text{cos. } a \text{ sin. } b = \text{sin. } (a+b);$$

therefore, $\dfrac{\text{sin. } a}{\text{cos. } a} + \dfrac{\text{sin. } b}{\text{cos. } b} = \dfrac{\text{sin. } (a+b)}{\text{cos. } a \text{ cos. } b}.$

By treating the remaining formulæ in the same way, and substituting the tangent and co-tangent for their values, we obtain

(K)

$$\text{Tan. } a + \text{tan. } b = \frac{\text{sin. } (a+b)}{\text{cos. } a \text{ cos. } b}, \quad (1)$$
$$\text{Tan. } a - \text{tan. } b = \frac{\text{sin. } (a-b)}{\text{cos. } a \text{ cos. } b}, \quad (2)$$
$$\text{Cot. } a + \text{cot. } b = \frac{\text{sin. } (a+b)}{\text{sin. } a \text{ sin. } b}, \quad (3)$$
$$\text{Cot. } a - \text{cot. } b = \frac{\text{sin. } (a-b)}{\text{sin. } a \text{ sin. } b}, \quad (4)$$
$$\text{Tan. } a + \text{cot. } b = \frac{\text{cos. } (a-b)}{\text{cos. } a \text{ sin. } b}, \quad (5)$$
$$\text{Cot. } a - \text{tan. } b = \frac{\text{cos. } (a+b)}{\text{sin. } a \text{ cos. } b}. \quad (6)$$

245. Because, by formulæ (D),

$$\text{Sin. } a + \text{sin. } b = 2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a-b),$$
$$\text{Sin. } a - \text{sin. } b = 2 \text{ cos. } \tfrac{1}{2}(a+b) \text{ sin. } \tfrac{1}{2}(a-b).$$

Hence, multiplying equals by equals, and considering that by formula (3) of (B)

$$2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a+b) = \text{sin. } [\tfrac{1}{2}(a+b) + \tfrac{1}{2}(a+b)] = \text{sin. } (a+b),$$
$$2 \text{ sin. } \tfrac{1}{2}(a-b) \text{ cos. } \tfrac{1}{2}(a-b) = \text{sin. } [\tfrac{1}{2}(a-b) + \tfrac{1}{2}(a-b)] = \text{sin. } (a-b),$$

we find

$$(\text{sin. } a + \text{sin. } b)(\text{sin. } a - \text{sin. } b) = \text{sin. } (a+b) \text{ sin. } (a-b).$$

If we write $90 - a$ for $a$, the formula becomes

$$(\text{cos. } a + \text{sin. } b)(\text{cos. } a - \text{sin. } b) = \text{cos. } (a+b) \text{ cos. } (a-b).$$

The two may be written thus:

(L)

$$\text{Sin.}^2 a - \text{sin.}^2 b = \text{sin. } (a+b) \text{ sin. } (a-b),$$
$$\text{Cos.}^2 a - \text{sin.}^2 b = \text{cos. } (a+b) \text{ cos. } (a-b).$$

246. We have found, formulæ (D),

$$\text{Sin. } a + \text{sin. } b = 2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a-b),$$
$$\text{Sin. } a - \text{sin. } b = 2 \text{ cos. } \tfrac{1}{2}(a+b) \text{ sin. } \tfrac{1}{2}(a-b).$$

Therefore, dividing equals by equals, and putting

Tan. $\tfrac{1}{2}(a \pm b)$ for $\dfrac{\text{sin. } \tfrac{1}{2}(a \pm b)}{\text{cos. } \tfrac{1}{2}(a \pm b)}$, we obtain

$$\frac{\text{Sin. } a + \text{sin. } b}{\text{Sin. } a - \text{sin. } b} = \frac{\text{tan. } \tfrac{1}{2}(a+b)}{\text{tan. } \tfrac{1}{2}(a-b)}.$$

By a similar process we may deduce other five formulæ of the same nature from formulæ (D). The whole are contained in this table.

(M)

$$\frac{\text{Sin. } a + \text{sin. } b}{\text{Sin. } a - \text{sin. } b} = \frac{\text{tan. } \frac{1}{2}(a+b)}{\text{tan. } \frac{1}{2}(a-b)}, \quad (1)$$

$$\frac{\text{Sin. } a + \text{sin. } b}{\text{Cos. } a + \text{cos. } b} = \text{tan. } \tfrac{1}{2}(a+b), \quad (2)$$

$$\frac{\text{Sin. } a + \text{sin. } b}{\text{Cos. } a - \text{cos. } b} = \text{cot. } \tfrac{1}{2}(a-b), \quad (3)$$

$$\frac{\text{Sin. } a - \text{sin. } b}{\text{Cos. } a + \text{cos. } b} = \text{tan. } \tfrac{1}{2}(a-b), \quad (4)$$

$$\frac{\text{Sin. } a - \text{sin. } b}{\text{Cos. } a - \text{cos. } b} = \text{cot. } \tfrac{1}{2}(a+b), \quad (5)$$

$$\frac{\text{Cos. } b + \text{cos. } a}{\text{Cos. } b - \text{cos. } a} = \frac{\text{cot. } \frac{1}{2}(a-b)}{\text{tan. } \frac{1}{2}(a+b)}. \quad (6)$$

247. We have found (formulæ K, No. 4) that

$$\frac{\text{Sin. } (a-b)}{\text{Sin. } a \text{ sin. } b} = \text{cot. } a - \text{cot. } b,$$

$$\frac{\text{Sin. } (b-c)}{\text{Sin. } b \text{ sin. } c} = \text{cot. } b - \text{cot. } c,$$

$$\frac{\text{Sin. } (c-a)}{\text{Sin. } c \text{ sin. } a} = \text{cot. } c - \text{cot. } a.$$

Hence, by adding, we obtain

$$\frac{\text{Sin. } (a-b)}{\text{Sin. } a \text{ sin. } b} + \frac{\text{sin. } (b-c)}{\text{sin. } b \text{ sin. } c} + \frac{\text{sin. } (c-a)}{\text{sin. } c \text{ sin. } a} = 0.$$

In like manner, it appears, from No. 2, that

$$\frac{\text{Sin. } (a-b)}{\text{Cos. } a \text{ cos. } b} + \frac{\text{sin. } (b-c)}{\text{sin. } b \text{ sin. } c} + \frac{\text{sin. } (c-a)}{\text{sin. } c \text{ sin. } a} = 0.$$

Therefore, taking away the denominators, and observing that sin. $(c-a) = -$ sin. $(a-c)$, we have

(N)

$$\text{Sin. } b \text{ sin.} (a-c) = \text{sin. } c \text{ sin.} (a-b) + \text{sin. } a \text{ sin.} (b-c), \quad (1)$$
$$\text{Cos.} b \text{ sin.} (a-c) = \text{cos.} c \text{ sin.} (a-b) + \text{cos.} a \text{ sin.} (b-c). \quad (2)$$

These formulæ are true, $a$, $b$, $c$ being any arcs whatever; and they are sufficient to indicate how innumerable others of the same kind may be obtained.

248. If in the formula for cos. $(a+b)$ we suppose $a=b$, it becomes cos. $2a =$ cos.$^2 a -$ sin.$^2 a$; and, since cos.$^2 a = 1 -$ sin.$^2 a$, and sin.$^2 a = 1 -$ cos.$^2 a$, we have also

$$\text{Cos. } 2a = 1 - 2 \text{ sin.}^2 a = 2 \text{ cos.}^2 a - 1.$$

By assuming $b = a$, we get from the formulæ for sin. $(a+b)$, tan. $(a+b)$, cot. $(a+b)$, other formulæ for the sine, tangent, and co-tangent, of the double of an arc. These, being frequently wanted, may be put together in a table.

(O)

$$\text{Cos. } 2a = \text{cos.}^2 a - \text{sin.}^2 a = 2 \text{ cos.}^2 a - 1 = 1 - 2 \text{sin.}^2 a, \quad (1)$$

$$\text{Sin. } 2a = 2 \text{ sin. } a \text{ cos. } a, \quad (2)$$

$$\text{Tan. } 2a = \frac{2 \text{ tan. } a}{1 - \text{tan.}^2 a} = \frac{2}{\text{cot. } a - \text{tan. } a}, \quad (3)$$

$$\text{Cot. } 2a = \tfrac{1}{2} (\text{cot. } a - \text{tan. } a). \quad (4)$$

249. From the first formula we may get formulæ for the sine and cosine of the half of an arc in terms of the cosine of the whole arc. But we may also express the sine and cosine of the half arc by the sine of the whole arc: thus,

$$\text{Cos.}^2 \tfrac{1}{2}a + \text{sin.}^2 \tfrac{1}{2}a = 1,$$
$$\text{and } 2 \text{ cos. } \tfrac{1}{2}a \text{ sin. } \tfrac{1}{2}a = \text{sin. } a,$$

we have $\text{cos.}^2 \tfrac{1}{2}a + 2 \text{ cos. } \tfrac{1}{2}a \text{ sin. } \tfrac{1}{2}a + \text{sin.}^2 \tfrac{1}{2}a = 1 + \text{sin. } a$,
and $\text{cos.}^2 \tfrac{1}{2}a - 2 \text{cos. } \tfrac{1}{2}a \text{ sin. } \tfrac{1}{2}a + \text{sin.}^2 \tfrac{1}{2}a = 1 - \text{sin. } a$;
whence, taking the square roots,

$$\text{Cos. } \tfrac{1}{2}a + \text{sin. } \tfrac{1}{2}a = \sqrt{1 + \text{sin. } a},$$
$$\text{Cos. } \tfrac{1}{2}a - \text{sin. } \tfrac{1}{2}a = \sqrt{1 - \text{sin. } a};$$

which, by addition and subtraction, give

$$\text{Cos. } \tfrac{1}{2}a = \tfrac{1}{2} \left[\sqrt{1 + \text{sin. } a} + \sqrt{1 - \text{sin. } a}\right],$$
$$\text{Sin. } \tfrac{1}{2}a = \tfrac{1}{2} \left[\sqrt{1 + \text{sin. } a} - \sqrt{1 - \text{sin. } a}\right].$$

Again, because sin. $a = 2$ sin. $\tfrac{1}{2}a$ cos. $\tfrac{1}{2}a$, therefore

$$\text{Sin. } a = \frac{\text{sin. } \frac{1}{2}a}{\text{cos. } \frac{1}{2}a} \times 2 \text{ cos.}^2 \tfrac{1}{2}a:$$

but $\frac{\text{sin. } \frac{1}{2}a}{\text{cos. } \frac{1}{2}a} = \text{tan. } \tfrac{1}{2}a$, and $2 \text{ cos.}^2 \tfrac{1}{2}a = 1 + \text{cos. } a$ (by No. 1 of O),

therefore sin. $a =$ tan. $\tfrac{1}{2}a$ $(1 + \text{cos. } a)$,

$$\text{tan. } \tfrac{1}{2}a = \frac{\text{sin. } a}{1 + \text{cos. } a} = \frac{1 - \text{cos. } a}{\text{sin. } a};$$

$$\text{cotan. } \tfrac{1}{2}a = \frac{1 + \text{cos. } a}{\text{sin. } a} = \frac{\text{sin. } a}{1 - \text{cos. } a};$$

Again, since $\frac{1 - \text{cos. } a}{\text{sin. } a} = \frac{1}{\text{sin. } a} - \frac{\text{cos. } a}{\text{sin. } a} = \text{cosec. } a - \text{cot. } a$,

and $\frac{1 + \text{cos. } a}{\text{sin. } a} = \frac{1}{\text{sin. } a} + \frac{\text{cos. } a}{\text{sin. } a} = \text{cosec. } a + \text{cot. } a$,

therefore tan. $\tfrac{1}{2}a =$ cosec. $a -$ cot. $a$,
and cot. $\tfrac{1}{2}a =$ cosec. $a +$ cot. $a$.

The formulæ investigated in this article may now be brought into one table, viz.

(P)

$$\text{Cos. } \tfrac{1}{2}a = \sqrt{\frac{1 + \text{cos. } a}{2}} = \tfrac{1}{2}\left[\sqrt{1 + \text{sin.} a} + \sqrt{1 - \text{sin.} a}\right], (1)$$

$$\text{Sin. } \tfrac{1}{2}a = \sqrt{\frac{1 - \text{cos. } a}{2}} = \tfrac{1}{2}\left[\sqrt{1 + \text{sin.} a} - \sqrt{1 - \text{sin.} a}\right], (2)$$

$$\text{Tan. } \tfrac{1}{2}a = \frac{\text{sin. } a}{1 + \text{cos. } a} = \text{cosec. } a - \text{cot. } a, \quad (3)$$

$$\text{Cot. } \tfrac{1}{2}a = \frac{\text{sin. } a}{1 - \text{cos. } a} = \text{cosec. } a + \text{cot. } a. \quad (4)$$

250. We shall now investigate formulæ for the cosines and sines of the multiples of any arc.

By the first of formulæ (E) we find that

$$\text{Cos. } (n+1)\, a = 2 \text{ cos. } a \text{ cos. } na - \text{cos. } (n-1)\, a.$$

Let $x$ denote cos. $a$; then,

$$\text{Cos. } a = x,$$
$$\text{Cos. } 2a = 2x \text{ cos. } a - \text{cos. } 0a,$$
$$\text{Cos. } 3a = 2x \text{ cos. } 2a - \text{cos. } a,$$
$$\text{Cos. } 4a = 2x \text{ cos. } 3a - \text{cos. } 2a,$$
&c.

Hence, by substituting successively for cos. $a$, cos. $2a$, &c. their values in the second members of these formulæ,

(Q)

$$\text{Cos. } a = x,$$
$$\text{Cos. } 2a = 2\, x^2 - 1,$$
$$\text{Cos. } 3a = 4\, x^3 - 3x,$$
$$\text{Cos. } 4a = 8\, x^4 - 8x^2 + 1,$$
$$\text{Cos. } 5a = 16x^5 - 20x^3 + 5x,$$
$$\text{Cos. } 6a = 32x^6 - 48x^4 + 18x^2 - 1,$$
$$\text{Cos. } 7a = 64x^7 - 112x^5 + 56x^3 - 7x,$$
&c.

 The law of the series is 2 cos. $na=$

$$(2x)^n-n(2x)^{n-2}+\frac{n(n-3)}{1\cdot 2}(2x)^{n-4}$$
$$-\frac{n(n-4)(n-5)}{1\cdot 2\cdot 3}(2x)^{n-6}+,\ \&c.$$

251. The third formula of (E) gives

$$\text{Sin. }(n+1)\,a=2\cos.\,a\,\sin.\,na-\sin.\,(n-1)a.$$

Let $x$ denote the cosine, and $y$ the sine of $a$; then

Sin. $a=y$,
Sin. $2a=2x$ sin. $a$ — sin. $0a$,
Sin. $3a=2x$ sin. $2a$ — sin. $a$,
Sin. $4a=2x$ sin. $3a$ — sin. $2a$,
&c.

Therefore, proceeding as in last article,

(R)

Sin. $a=y$,
Sin. $2a=2yx$,
Sin. $3a=y(4x^2-1)$,
Sin. $4a=y(8x^3-4x)$,
Sin. $5a=y(16x^4-12x^2+1)$,
Sin. $6a=y(32x^5-32x^3+6x)$,
Sin. $7a=y(64x^6-80x^4+24x^2-1)$,
&c.

Here the law of the series is sin. $na=$

$$y[(2x)^{n-1}-(n-2)(2x)^{n-3}+\frac{(n-3)(n-4)}{1\cdot 2}(2x)^{n-5}$$
$$-\frac{(n-4)(n-5)(n-6)}{1\cdot 2\cdot 3}(2x)^{n-7}+,\ \&c.].$$

252. The series for the cosines and sines of the multiples of an arc are arranged according to the descending powers of the cosine of the arc; but we may find others which proceed according to the ascending powers. It is, however, then necessary to distinguish between the even and odd multiples of the arc.

Let $n$ be odd, and we have, from table (Q),

(S)

Cos. $a=x$,
Cos. $3a=-(3x-4x^3)$,
Cos. $5a=5x-20x^3+16x^5$,
&c.

and in general, cos. $na=$

$$\pm\left[nx-\frac{n(n^2-1)}{2\cdot 3}x^3+\frac{n(n^2-1)(n^2-9)}{2\cdot 3\cdot 4\cdot 5}x^5-,\ \&c.\right].$$

The upper sign is to be taken when $n$ is any number in the series 1, 5, 9, &c. that is, when $n$ has the form $4m+1$; and the lower, when $n$ is one of these, 3, 7, 11, &c. or when it is of the form $4m+3$.

Next, for the even multiples of the arc we find

(2 S)

Cos. $2a=-(1-2x^2)$,
Cos. $4a=+\ 1-8x^2+8x^4$,
Cos. $6a=-(1-18x^2+48x^4-32x^6)$,
&c.

and in general, cos. $na=$

$$\pm\left[1-\frac{n^2}{2}x^2+n^2\frac{(n^2-4)}{2\cdot 3\cdot 4}x^4\right.$$
$$\left.-\frac{n^2(n^2-4)(n^2-16)}{2\cdot 3\cdot 4\cdot 5\cdot 6}x^6+,\&c.\right].$$

Here the upper sign is to be taken when $n$ has the form $4m+2$, and the lower when it has the form $4m$.

253. The corresponding expressions for the sines are obtained from table (R), viz.

(T)

Sin. $a=y$,
Sin. $3a=-y(1-4x^2)$,
Sin. $5a=y(1-12x^2+16x^4)$,
&c.

and in general, sin. $na=$

$$\pm y\left\{1-\frac{n^2-1}{2}x^2+\frac{(n^2-1)(n^2-9)}{2\cdot 3\cdot 4}x^4\right.$$
$$\left.-\frac{(n^2-1)(n^2-9)(n^2-25)}{2\cdot 3\cdot 4\cdot 5\cdot 6}x^6+,\&c.\right\};$$

the upper sign to be taken when $n$ has the form $4n+1$. and the lower when it has the sign $4n+3$.

Also we have

(2 T)

Sin. $2a=2xy$,
Sin. $4a=-y(4x-8x^3)$,
Sin. $6a=y(6x-32x^3+32x^5)$,
&c.

and in general, sin. $na=$

$$\pm\left\{nx-\frac{n(n^2-4)}{2\cdot 3}x^3+\frac{n(n^2-4)(n^2-16)}{2\cdot 3\cdot 4\cdot}x^5-,\&c.\right\};$$

the upper sign to be taken when $n$ has the form $4n+2$, and the lower when it has the form $4n$.

254. Because $x^2=1-y^2$, we have, from table (Q),

(V)

Cos. $a=x$,
Cos. $3a=x(1-4y^2)$,
Cos. $5a=x(1-12y^2+16y^4)$,
&c.

and in general, when $n$ is an odd number, cos. $na=$

$$x\left\{1-\frac{n^2-1}{2}y^2+\frac{(n^2-1)(n^2-9)}{2\cdot 3\cdot 4}y^4\right.$$
$$\left.-\frac{(n^2-1)(n^2-9)(n^2-25)}{2\cdot 3\cdot 4\cdot 5\cdot 6}y^6-,\ \&c.\right\}:$$

and when $n$ is even,

(2 V)

Cos. $2a=1-2y^2$,
Cos. $4a=1-8y^2+8y^4$,
Cos. $6a=1-18y^2+48y^4-32y^6$,
&c.

and in general, cos. $na=$

$$1-\frac{n^2}{2}y^2+\frac{n^2(n^2-4)}{2\cdot 3\cdot 4}y^4-\frac{n^2(n^2-4)(n^2-16)}{2\cdot 3\cdot 4\cdot 5\cdot 6}y^6+,\ \&c.$$

255. In like manner, for the sines, when $n$ is odd, we find

(X)

Sin. $a=y$,
Sin. $3a=3y-4y^3$,
Sin. $5a=5y-20y^3+16y^5$,
&c.

and in general, sin. $na=$

$$ny-\frac{n(n^2-1)}{2\cdot 3}y^3+\frac{n(n^2-1)(n^2-9)}{2\cdot 3\cdot 4\cdot 5}y^5-,\ \&c.$$

Again, when $n$ is even,

(2 X)

Sin. $2a=2xy$,
Sin. $4a=x(4y-8y^3)$,
Sin. $6a=x(6y-32y^3+32y^5)$,
&c.

And in general, sin. $na=$

$$x\left\{ny-\frac{n(n^2-4)}{2\cdot 3}y^3+\frac{n(n^2-4)(n^2-16)}{2\cdot 3\cdot 4\cdot 5}y^5-\text{, \&c.}\right\}.$$

256. We owe to Vieta the formulæ in tables (Q), (R), (2 V), and (X). He, however, enunciated them as properties of the chords of arcs, to which they may be transformed, by considering that chord $a=2$ sin. $\frac{1}{2}a$, and chord $(\pi-a)=$ sup. chord $a=2$ cos. $\frac{1}{2}a$; he did not indicate the general law of the series, but merely showed how the cosines and sines of the multiple arcs might be formed one from another. John Bernoulli gave, in the Leipsic Acts for 1701, a general formula for the chords of multiple arcs, but without demonstration. This is equivalent to table (R). Afterwards, James Bernoulli gave, in the *Memoirs of the Academy of Sciences* for 1702, two formulæ for the chords of multiple arcs: these answer to the general formulæ of tables (2 V) and (X); but the latter had previously been given by Newton in his first letter to Oldenburg, the secretary of the Royal Society. The general formulæ of tables (Q), (R), (X), and (2 X), and these only, are given in the *Introductio in Analysin Infinitorum* of Euler; and the whole are given by Lagrange, in his *Leçons sur le Calcul des Fonctions,* where they are also strictly demonstrated by his calculus, which is equivalent to the differential calculus.

257. If in the formula

$$\tan.(a+b)=\frac{\tan. a+\tan. b}{1-\tan. a\tan. b},$$

we make $b=na$, it becomes

$$\tan.(n+1)a=\frac{\tan. na+\tan. a}{1-\tan. a\tan. na}.$$

Let us make tan. $a=t$, then, making $n$ equal to the numbers 2, 3, 4, &c. successively, and substituting for tan. $na$ its value in tan. $(n+1)\,a$, we get

(Y)

$$\text{Tan. } a=t,$$
$$\text{Tan. } 2a=\frac{2t}{1-t^2},$$
$$\text{Tan. } 3a=\frac{3t-t^3}{1-3t^2},$$
$$\text{Tan. } 4a=\frac{4t-4t^3}{1-6t^2+t^4},$$
$$\text{Tan. } 5a=\frac{5t-10t^3+t^5}{1-10t^2+5t^4},$$

&c.

In general, if we put $\alpha=\frac{n}{1}, \beta=\frac{n(n-1)}{1\cdot 2}, \gamma=\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}$, $\delta=\frac{n(n-1)(n-2)(n-3)}{1\cdot 2\cdot 3\cdot 4}$, &c.; that is, if $\alpha, \beta, \gamma, \delta, \varepsilon$, &c. denote the co-efficients of the second, third, fourth, and following terms of a binomial raised to the $n$th power, we have

$$\text{Tan.} na=\frac{\alpha t-\gamma t^3+\varepsilon t^5-\text{, \&c.}}{1-\beta t^2+\delta t^4-\text{, \&c.}}.$$

This formula was first given by John Bernoulli, in the Leipsic Acts for 1722.

258. We shall next investigate formulæ for the successive integer powers of the cosine and sine of an arc.

By formula (1) of (E) we have, making $n=1$,

$$2\cos.^2 a=\cos. 2a+1.$$

Let both sides be multiplied by 2 cos. $a$, the result is

$$4\cos.^3 a=2\cos. a\cos. 2a+2\cos a;$$

but, by the same formulæ (E),

$$2\cos. a\cos. 2a=\cos. 3a+\cos. a;$$

therefore, $4\cos.^3 a=\cos. 3a+3\cos. a$.

Again, multiplying both sides by 2 cos. $a$, we have

$$8\cos.^4 a=2\cos. a\cos. 3a+6\cos. a\cos. a.$$

Now, $2\cos. a\cos. 3a=\cos. 4a+\cos. 2a$,
and $6\cos. a\cos. a=3\cos. 2a+3$;
therefore, $8\cos.^4 a=\cos. 4a+4\cos. 2a+3$

By proceeding in this way, multiplying both sides of each new formula by 2 cos. $a$, and substituting cos. $(n+1)a$, $+\cos.(n-1)a$ for 2 cos. $a$ cos. $na$, there is obtained a series of formulæ for the successive powers of the cosine of an arc, in terms of the cosines of the multiples of the arc. These are given in the following table:

(Z)

$$\text{Cos. } a=\cos. a,$$
$$2\cos.^2 a=\cos. 2a+1,$$
$$4\cos.^3 a=\cos. 3a+3\cos. a,$$
$$8\cos.^4 a=\cos. 4a+4\cos. 2a+3,$$
$$16\cos.^5 a=\cos. 5a+5\cos. 3a+10\cos. a,$$
$$32\cos.^6 a=\cos. 6a+6\cos. 4a+15\cos. 2a+10,$$
$$64\cos.^7 a=\cos. 7a+7\cos. 5a+21\cos. 3a+35\cos. a,$$

&c.

The general law of the series is $2^{n-1}\cos.^n a=$

$$\cos. na+\frac{n}{1}\cos.(n-2)a+\frac{n(n-1)}{1\cdot 2}\cos.(n-4)a,$$
$$+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\cos.(n-6)\,a+\text{, \&c.}$$

The series is to be continued until we come to a negative arc, and if $n$ be an even number, the half of the coefficient of the last term (viz. that in which the arc $=0a$) is to be taken.

259. Next, for the powers of the sine; from (2) of (E), we have $2\sin.^2 a=-\cos. 2a+1$:
multiply both sides by 2 sin. $a$; then,

$$4\sin.^3 a=-2\sin. a\cos. 2a+2\sin. a.$$

Now, by formula (4) of (E),

$$2\sin. a\cos. 2a=\sin. 3a-\sin. a;$$

therefore $4\sin.^3 a=-\sin. 3a+3\sin. a$.

Again, multiplying both sides by 2 sin. $a$,

$$8\sin.^4 a=-2\sin. a\sin. 3a+6\sin. a\sin. a.$$

But by formula (2) of (E),

$$2\sin. a\sin. 3a=-\cos. 4a+\cos. 2a,$$
and $6\sin. a\sin. a=-3\cos. 2a+3$;

therefore $8\sin.^4 a=\cos. 4a-4\cos. 2a+3$.

In this way we may form the following table:

(A 2)

$$\text{Sin. } a=+\sin. a,$$
$$2\sin.^2 a=-\cos. 2a+1,$$
$$4\sin.^3 a=-\sin. 3a+3\sin. a,$$
$$8\sin.^4 a=+\cos. 4a-4\cos. 2a+3,$$
$$16\sin.^5 a=+\sin. 5a-5\sin. 3a+10\sin. a,$$
$$32\sin.^6 a=-\cos. 6a+6\cos. 4a-15\cos. 2a+10,$$
$$64\sin.^7 a=-\sin. 7a+7\sin. 5a-21\sin. 3a+35\sin. a.$$

In general, when $n$ is an odd number, $\pm 2^{n-1}\sin.^n a$

$$=\sin. na-\frac{n}{1}\sin.(n-2)\,a+\frac{n(n-1)}{1\cdot 2}\sin.(n-4)\,a$$
$$-\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\sin.(n-6)\,a+\text{, \&c.}$$

The upper sign is to be taken when $n$ is a number in the series 1, 5, 9, &c.; that is, when $n$ has the form $4m+1$; and the lower when $n$ is one of the intermediate odd numbers, 3, 7, 11, &c. In either case the series terminates with a multiple of sin. $a$.

When $n$ is an even number, then $\mp 2^{n-1}\sin.^n a =$

$$\cos. na - n\cos.(n-2)a + \frac{n(n-1)}{1\cdot 2}\cos.(n-4)a - \frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\cos.(n-6)a +, \&c.$$

Here the upper sign applies when $n$ is an even number in the series 2, 6, 10, &c.; that is, when $\frac{n}{2}$ is an odd number; and the lower when $n$ has the form $4m$. In either case the series is to be continued until a term contain cos. $(0a)$ (which is $=1$), and then the numeral co-efficient must be divided by 2.

260. The same formulæ (E) serve to resolve any expression of the form $\cos.^m a\ \sin.^n a$ into sines and cosines of multiples of $a$: thus,

$$2\cos. a\sin. a = \sin. 2a;$$
$$4\cos.^2 a\sin. a = 2\cos. a\sin. 2a, \quad = \sin. 3a + \sin. a;$$

$$4\cos. a\sin.^2 a = 2\sin. a\sin. 2a, \quad = -\cos. 3a + \cos. a.$$

In like manner we find

$$8\cos. a\sin.^3 a = -\sin. 4a + 2\sin. 2a,$$
$$8\cos.^2 a\sin.^2 a = -\cos. 4a + 1,$$
$$8\cos.^3 a\sin. a = +\sin. 4a + 2\sin. 2a.$$

$$16\cos. a\sin.^4 a = \cos. 5a - 3\cos. 3a + 2\cos. a,$$
$$16\cos.^2 a\sin.^3 a = -\sin. 5a + \sin. 3a + 2\sin. a,$$
$$16\cos.^3 a\sin.^2 a = -\cos. 5a - \cos. 3a + 2\cos. a,$$
$$16\cos.^4 a\sin. a = \sin. 5a + 3\sin. 3a + 2\sin. a.$$

261. The introduction of the imaginary symbol $\sqrt{-1}$ into analysis, has given great assistance in all investigations connected with the calculus of sines. Let $x$ denote the cosine of any arc $a$, and $y$ its sine; then, by formulæ (B),

$$\text{Cos. } (n+1)a = x\cos. na - y\sin. na, \qquad (1)$$
$$\text{Sin. } (n+1)a = y\cos. na + x\sin. na. \qquad (2)$$

Let $v$ denote a quantity at present indefinite, but to be determined in the course of the investigation; then, from formula (2),

$$v\sin.(n+1)a = vy\cos. na + vx\sin. na. \qquad (3)$$

The sum and difference of formula (1) and (3) give us

$$\text{Cos. } (n+1)a + v\sin.(n+1)a = (x+vy)\cos. na + (x - \tfrac{1}{v}y)\,v\sin. na,$$

$$\text{Cos. } (n+1)a - v\sin.(n+1)a = (x-vy)\cos. na - (x + \tfrac{1}{v}y)\,v\sin. na.$$

Let us now assume that $v^2=-1$, so that $v=\sqrt{-1}$, and $v=-\frac{1}{v}$; the two last formulæ will become

$$\text{Cos. } (n+1)a + v\sin.(n+1)a = (x+vy)(\cos. na + v\sin. na),$$
$$\text{Cos. } (n+1)a - v\sin.(n+1)a = (x-vy)(\cos. na - v\sin. na).$$

By giving to $n$ the values 0, 1, 2, 3, &c. in succession, we obtain from the first of these,

$$\text{Cos. } a + v\sin. a = x+vy,$$
$$\text{Cos. } 2a + v\sin. 2a = (x+vy)^2,$$
$$\text{Cos. } 3a + v\sin. 3a = (x+vy)^3,$$

and, in general, $m$ being any whole number,

$$\text{Cos. } ma + v\sin. ma = (x+vy)^m. \qquad (4)$$

The other equation gives us

$$\text{Cos. } a - v\sin. a = x - vy,$$
$$\text{Cos. } 2a - v\sin. 2a = (x-vy)^2,$$
$$\text{Cos. } 3a - v\sin. 3a = (x-vy)^3;$$

and in general,

$$\text{Cos. } ma - v\sin. ma = (x-vy)^m. \qquad (5)$$

Formulæ (4) and (5), when the quantities denoted by $x$, $y$, and $v$, have been restored, may stand thus:

(B 2)

$$\text{Cos. } na + \sqrt{-1}\sin. na = (\cos. a + \sqrt{-1}\sin. a)^n,$$
$$\text{Cos. } na - \sqrt{-1}\sin. na = (\cos. a - \sqrt{-1}\sin. a)^n.$$

These have been investigated on the hypothesis that $n$ is a whole positive number, but they are also true when $n$ is a fraction, or negative; for we have manifestly

$$\text{Cos. } a + \sqrt{-1}\sin. a \begin{cases} = (\cos. na + \sqrt{-1}\sin. na)^{\frac{1}{n}} \\ = (\cos. ma + \sqrt{-1}\sin. ma)^{\frac{1}{m}}: \end{cases}$$

therefore, raising these equal expressions to the power $m$, we have

$$\text{Cos. } ma + \sqrt{-1}\sin. ma = (\cos. na + \sqrt{-1}\sin. na)^{\frac{m}{n}};$$

and, putting $na=a'$, and therefore $ma=\frac{m}{n}a'$,

$$\text{Cos. } \frac{m}{n}a' + \sqrt{-1}\sin. \frac{m}{n}a' = (\cos. a' + \sqrt{-1}\sin. a')^{\frac{m}{n}}.$$

Exactly in the same way it may be proved that

$$\text{Cos. } \frac{m}{n}a' - \sqrt{-1}\sin. \frac{m}{n}a' = (\cos. a' - \sqrt{-1}\sin. a')^{\frac{m}{n}}.$$

Thus it appears that formulæ (B 2) are true, whether $n$ be whole or fractional.

Again, we have manifestly

$$\frac{1}{\text{Cos. } na + \sqrt{-1}\sin. na} = (\cos. a + \sqrt{-1}\sin. a)^{-n}.$$

Let the numerator and denominator of the first member of this equation be multiplied by $\cos. na - \sqrt{-1}\sin. na$; then, observing that

$$(\cos. na + \sqrt{-1}\sin. na)(\cos. na - \sqrt{-1}\sin. a) = \cos.^2 na + \sin.^2 na = 1,$$

also, that $\cos. na = \cos.(-na)$, and $-\sin. na = \sin.(-na)$, we have

$$\text{Cos.}(-na) - \sqrt{-1}\sin.(-na) = (\cos. a + \sqrt{-1}\sin. a)^{-n}.$$

Exactly in the same way it may be shown, that

$$\text{Cos.}(-na) - \sin.\sqrt{-1}(-na) = (\cos. a - \sqrt{-1}\sin.)^{-n};$$

so that the formulæ are universally true, $n$ being either a positive or negative whole number or fraction. We may even extend the proof to the case of $n$, an irrational quantity; for every such quantity may be expressed to any degree of nearness by numbers.

262. These very remarkable and important expressions (B 2) were first found by Abraham de Moivre, and appeared in his *Miscellanea Analytica*, which was published in 1730. He was led to them by considering the analogy between the circle and hyperbola; but we owe to Euler their introduction into analysis as elementary formulæ. By taking their sum and difference, we obtain them in a different shape, as follows:

(C 2)

$$\text{Cos. } na = \frac{(\cos. a + \sqrt{-1}\sin. a)^n + (\cos. a - \sqrt{-1}\sin. a)^n}{2};$$

$$\text{Sin. } na = \frac{(\cos. a + \sqrt{-1}\sin. a)^n - (\cos. a - \sqrt{-1}\sin. a)^n}{2\sqrt{-1}}.$$

In either case, they are purely symbolical expressions of the kind found by Cardan's rule for the roots of a cubic equation belonging to the irreducible case. (Sect. XI.) Like them, they cannot be immediately applied to calculation; but when treated by the rules of analysis, they reveal some of the most elegant and recondite theorems in geometry.

263. The formulæ (C 2) admit of an immediate application to the determination of the cosine and sine of any multiple of an arc. Let $x=\cos. a$, $y=\sin. a$, so that

$$\text{Cos.}\,na=\frac{(x+\sqrt{-1}\,y)^n+(x-\sqrt{-1}\,y)^n}{2};$$

$$\text{Sin.}\,na=\frac{(x+\sqrt{-1}\,y)^n-(x-\sqrt{-1}\,y)^n}{2\sqrt{-1}}.$$

Now, by the binomial theorem,

$$(x+\sqrt{-1}\,y)^n=x^n+nx^{n-1}y\sqrt{-1}-\frac{n(n-1)}{1\cdot 2}x^{n-2}y^2$$
$$-\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}x^{n-3}y^3\sqrt{-1}+,\ \&c.$$

$$(x-\sqrt{-1}\,y)^n=x^n-nx^{n-1}y\sqrt{-1}-\frac{n(n-1)}{1\cdot 2}x^{n-2}y^2$$
$$+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}x^{n-3}y^3\sqrt{-1}+,\ \&c.$$

Hence, taking half the sum and difference of these series, and in the latter case dividing by $\sqrt{-1}$, we obtain

(D 2)

$$\text{Cos.}\,na=x^n-\frac{n(n-1)}{1\cdot 2}x^{n-2}y^2$$
$$+\frac{n(n-1)(n-2)(n-3)}{1\cdot 2\cdot 3\cdot 4}x^{n-4}y^4-,\ \&c.$$

$$\text{Sin.}\,na=\frac{n}{1}x^{n-1}y-\frac{n(n-1)(n-2)}{1\cdot 2}x^{n-3}y^3$$
$$+\frac{n(n-1)(n-2)(n-3)(n-4)}{1\cdot 2\cdot 3\cdot 4\cdot 5}x^{n-5}y^5-,\ \&c.$$

These series terminate as often as $n$ is a whole positive number. They were first given in 1701, by John Bernoulli, in the Leipsic Acts, but without demonstration. They also appear in letter 129 of the *Commercium Epistolicum* of Leibnitz and Bernoulli, and in the *Sections Coniques* of M. de l'Hôpital. It is remarkable that John Bernoulli should have fallen on these beautiful theorems, and yet missed the formulæ of De Moivre, which are easily deducible from them, but which were not discovered until twenty years later.

If it be observed that $\sin. a = \tan. a \cos. a$, and $\sin. na = \tan. na \cos. na$; and if, after substitution, the second formula be divided by the first, the result, after due reduction, will be the expression for the tangent which was given in sect. 257.

264. The same powerful instrument of analysis might enable us to investigate all the general expressions for the cosines and sines of multiple arcs from (R) to (2 X); but we shall rather reserve them to show the application of the differential calculus, or method of fluxions. We shall, however, now exemplify their use in the investigation of general series for the powers of the cosine and sine of an arc, in terms of the cosines and sines of its multiples.

Let us put $p=\cos. a+\sqrt{-1}\sin. a$, $q=\cos. a-\sqrt{-1}\sin. a$;

then $pq=\cos.^2 a+\sin.^2 a=1$, and $q=\frac{1}{p}$.

De Moivre's formulæ may now be expressed thus:

(E 2)

$$2\cos. na=p^n+q^n=p^n+\frac{1}{p^n},$$

$$2\sqrt{-1}\sin. na=p^n-q^n=p^n-\frac{1}{p^n};$$

and since $2\cos. a=p+q$, therefore, putting $c'$, $c''$, $c'''$, &c. for the numeral co-efficients of the second, third, fourth, &c. terms of a binomial, we have

$$(2\cos. a)^n=p^n+c'p^{n-1}q+c''p^{n-2}q^2+c'''p^{n-3}q^3+,\ \&c.$$

Because $2\cos. a=q+p$, we have also

$$(2\cos. a)^n=q^n+c'q^{n-1}p+c''q^{n-2}p^2+c'''q^{n-3}p^3+,\ \&c.$$

Taking now the sum of both series, and observing that $pq=1$, we obtain

$$2(2\cos. a)^n=p^n+q^n+c'(p^{n-2}+q^{n-2})+c''(p^{n-4}+q^{n-4})$$
$$+c'''(p^{n-6}+q^{n-6})+,\ \&c.$$

Now,
$$p^n+q^n=2\cos. na,$$
$$p^{n-2}+q^{n-2}=2\cos.(n-2)a,$$
$$p^{n-4}+q^{n-4}=2\cos.(n-4a),$$
$$p^{n-6}+q^{n-6}=2\cos.(n-6)a,$$
&c.

Therefore, substituting and dividing by 2,

$$(2\cos. n)^n=\cos. na+c'\cos.(n-2)a+c''\cos.(n-4)a$$
$$+c'''\cos.(n-6)a+,\ \&c.$$

By continuing the series, we come to the cosines of negative arcs, which are exactly the same as the cosines of positive arcs having the same co-efficient: Thus, $\cos.(m-n)a=\cos.(n-m)a$, for each is equal to $\cos. ma\cos. na+\sin. ma\sin. a$. Now, in the series which is the expansion of $(p+q)^n$, the terms at equal distances from the first and last have the same co-efficient; therefore the series for $(2\cos. a)^n$ must have the same property; and further, the cosines of the arcs at equal distances from the extremes are, as has been just proved, equal; we may therefore omit the terms which are the cosines of negative arcs, and in their stead take the doubles of these, which are the cosines of positive arcs. The above formula will then be abbreviated to

$$(2\cos. a)^n=2\,[\cos. na+c'\cos.(n-2)a+c''\cos.(n-4)a$$
$$+,\ \&c.].$$

When $n$ is an even number, the series has a term at equal distances from both extremes, which, being single in the expansion, must not be doubled; but when $n$ is an odd number, the cosines of the negative arcs are equal in number to those of the positive arcs. Lastly, by considering that the cosine of $(n-n)a=1$, the truth of the general formulæ of table (Z) will be sufficiently obvious.

265. The general formulæ of table (A 2) may be established by a process quite similar to the above, by the expression $2\sqrt{-1}\sin. a=p^n-q^n$; but more easily by substituting $\frac{1}{2}\pi-a'$ instead of $a$, and remarking that $\cos.(\frac{1}{2}\pi-a')=\sin. a$: we have thus

$$(2\sin. a')^n=2\cos. n(\tfrac{1}{2}\pi-a')+2c'\cos.(n-2)(\tfrac{1}{2}\pi-a')$$
$$+2c''\cos.(n-4)(\tfrac{1}{2}\pi-a')+,\ \&c.$$

The terms of this series being all of the form

$$\cos. m\,[\tfrac{1}{2}\pi-a']=\cos. m\frac{\pi}{2}\cos. ma'+\sin. m\frac{\pi}{2}\sin. ma'$$

will have the form $\pm\sin. ma'$, when $m$ is an odd number; and the form $\pm\cos. ma'$, when $m$ is an even number.

266. Before we proceed to other applications of De Moivre's formulæ, it will be convenient to establish some analytic principles of frequent application, regarding the limits between which certain expressions involving arcs and their sines, tangents, &c. are always contained.

It is an axiom in geometry, that any arc is less than its tangent (as defined sect. 224), but greater than its sine, therefore, $\frac{a}{n}$ being any arc,

$$\tan.\frac{a}{n} > \frac{a}{n}, \qquad \sin.\frac{a}{n} < \frac{a}{n}.$$

Multiplying the first of these by $n$, and the second by sec. $\frac{a}{n}$, and observing that sec. $\frac{a}{n}$ sin. $\frac{a}{n} = \tan.\frac{a}{n}$, we have

$$n\tan.\frac{a}{n} > a, \qquad n\tan.\frac{a}{n} < a\sec.\frac{a}{n}.$$

Suppose now $n$ to increase continually, while the arc $a$ is invariable, it is manifest, that since $\frac{a}{n}$ will decrease, and may become less than any assignable arc, sec. $\frac{a}{n}$ will continually approach to the radius $= 1$, and may differ from it by less than any assignable quantity. Hence it follows that $n$ being supposed to increase continually, the expression $n$ tan. $\frac{a}{n}$ approaches continually to $a$, which is its limit.

In like manner, because

$$n\sin.\frac{a}{n} < a, \qquad n\sin.\frac{a}{n} > a\cos.\frac{a}{n};$$

and because, while $n$ increases, cos. $\frac{a}{n}$ approaches to radius $= 1$, which is its limit; therefore the limit of $n$ sin. $\frac{a}{n}$ is the arc $a$.

Hence, it appears that the arc $a$ being supposed to decrease continually,

$$\text{limit of } \frac{a}{\sin. a} = 1, \text{ and limit of } \frac{a}{\tan. a} = 1.$$

267. It is sufficiently evident that the limit of cos. $\frac{a}{n}$ is 1; but, in what is to follow, it will be necessary to find the limit of cos.$^n \frac{a}{n}$ when $n$ increases indefinitely.

By a known formula, cos. $\frac{a}{n} = \sqrt{1-\sin.^2\frac{a}{n}}$. Let us put $\omega = n\sin.\frac{a}{n}$; then $\omega$ will be less than $a$, and

$$\text{Cos.}^n\frac{a}{n} = \left(1-\frac{\omega^2}{n^2}\right)^{\frac{n}{2}}.$$

By the binomial theorem, the second member of this equation is

$$1-\frac{\omega^2}{2n}+\left(1-\frac{2}{n}\right)\frac{\omega^4}{2\cdot 4n^2}-\left(1-\frac{2}{n}\right)\left(1-\frac{4}{n}\right)\frac{\omega^6}{2\cdot 4\cdot 6n^3}+,\&c.$$

But since, by hypothesis, $n$ may be greater than any assignable number, and $\omega$ is not greater than $a$, every term of this series, except the first, will evidently be $= 0$, when $n$ is indefinitely great; therefore, in that case, cos.$^n \frac{a}{n}$ is accurately $= 1$.

268. Resuming now De Moivre's formulæ (261), we have

$$\text{Cos.}\,a+\sqrt{-1}\sin.\,a = \left(\cos.\frac{a}{n}+\sqrt{-1}\sin.\frac{a}{n}\right)^n,$$

$$\text{Cos.}\,a-\sqrt{-1}\sin.\,a = \left(\cos.\frac{a}{n}-\sqrt{-1}\sin.\frac{a}{n}\right)^n.$$

Let $t$ denote the tangent of the arc $\frac{a}{n}$, then observing that sin. $\frac{a}{n} = \cos.\frac{a}{n}\tan.\frac{a}{n}$, we have

$$\text{Cos.}\,a+\sqrt{-1}\sin.\,a = \cos.^n\frac{a}{n}\left(1+\sqrt{-1}\,t\right)^n,$$

$$\text{Cos.}\,a-\sqrt{-1}\sin.\,a = \cos.^n\frac{a}{n}\left(1-\sqrt{-1}\,t\right)^n.$$

By the binomial theorem $(1+\sqrt{-1}\,t)^n =$

$$1-\left(1-\frac{1}{n}\right)\frac{n^2t^2}{1\cdot 2}+\left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\left(1-\frac{3}{n}\right)\frac{n^4t^4}{1\cdot 2\cdot 3\cdot 4}-,\&c.$$

$$+\sqrt{-1}\left\{nt-\left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\frac{n^3t^3}{1\cdot 2\cdot 3}+,\&c.\right\}.$$

(Here we have resolved the whole expansion into two parts; one entirely free from the imaginary sign, and the other having that sign as a common factor of all its terms.) Let us denote the first of these series by P, and the second, setting aside its imaginary factor $\sqrt{-1}$, by Q; then

$$(1+\sqrt{-1}\,t)^n = \text{P}+\sqrt{-1}\,\text{Q}.$$

By a like process we find

$$(1-\sqrt{-1}\,t)^n = \text{P}-\sqrt{-1}\,\text{Q};$$

and hence again

$$\text{Cos.}\,a+\sqrt{-1}\sin.\,a = \cos.^n\frac{a}{n}(\text{P}+\sqrt{-1}\,\text{Q});$$

$$\text{Cos.}\,a-\sqrt{-1}\sin.\,a = \cos.^n\frac{a}{n}(\text{P}-\sqrt{-1}\,\text{Q}).$$

and from these, by adding and subtracting,

$$\text{Cos.}\,a = \cos.^n\frac{a}{n}\text{P}, \qquad \sin.\,a = \cos.^n\frac{a}{n}\text{Q};$$

or, substituting for P, Q, and $t$, their values,

$$\text{Cos.}\,a = \cos.^n\frac{a}{n}\left\{1-\left(1-\frac{1}{n}\right)\frac{n^2t^2}{1\cdot 2} + \left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\left(1-\frac{3}{n}\right)\frac{n^4t^4}{1\cdot 2\cdot 3\cdot 4}-,\&c.\right\}$$

$$\text{Sin.}\,a = \cos.^n\frac{a}{n}\left\{nt-\left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\frac{n^3t^3}{1\cdot 2\cdot 3} + \left(1-\frac{1}{n}\right)\left(1-\frac{2}{n}\right)\left(1-\frac{3}{n}\right)\left(1-\frac{4}{n}\right)\frac{n^5t^5}{1\cdot 2\cdot 3\cdot 4\cdot 5}-,\&c.\right\}$$

These formulæ must hold true, whatever value we give to $n$. But let us now suppose $n$ indefinitely great; then, from what was proved in last section,

$$\text{Cos.}^n\frac{a}{n}=1, \quad nt = n\tan.\frac{a}{n} = a, \quad \frac{1}{n}=0, \quad \frac{2}{n}=0, \ \&c.$$

We have therefore, by substitution,

$$\text{(F 2)} \quad \text{Cos.}\,a = 1-\frac{a^2}{1\cdot 2}+\frac{a^4}{1\cdot 2\cdot 3\cdot 4}-,\&c.$$

$$\text{Sin.}\,a = a-\frac{a^3}{1\cdot 2\cdot 3}+\frac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5}-,\&c.$$

These elegant theorems, discovered by Newton, were among the first fruits of his analytical methods.

269. It has been shown (sect. 177) that if $e$ denote the number 2·7182818, viz. that whose Napierian logarithm is 1, then

$$e^x = 1+\frac{x}{1}+\frac{x^2}{1\cdot 2}+\frac{x^3}{1\cdot 2\cdot 3}+\frac{x^4}{1\cdot 2\cdot 3\cdot 4}+\frac{x^5}{1\cdot 2\cdot 3\cdot 4\cdot 5}+,\&c.$$

Now, $a$ being any arc, let $x = a\sqrt{-1}$; then, by substituting and separating the real and imaginary terms, so as to form two series, we have

$$e^{a\sqrt{-1}} = \begin{cases} 1-\dfrac{a^2}{2}+\dfrac{a^4}{1\cdot 2\cdot 3\cdot 4}-,\&c. \\ +\sqrt{-1}\left(a-\dfrac{a^3}{1\cdot 2\cdot 3}+\dfrac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5}-,\&c.\right).\end{cases}$$

Again, putting $x = -a\sqrt{-1}$, we obtain, in like manner,

$$e^{-a\sqrt{-1}} = \begin{cases} 1 - \dfrac{a^2}{1\cdot 2} + \dfrac{a^4}{1\cdot 2\cdot 3\cdot 4} -, \text{\&c.} \\ -\sqrt{-1}\left(a - \dfrac{a^3}{1\cdot 2\cdot 3} + \dfrac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5} -, \text{\&c.}\right). \end{cases}$$

But it was found that

$$\text{Cos.}\, a = 1 - \frac{a^2}{1\cdot 2} + \frac{a^4}{1\cdot 2\cdot 3\cdot 4} -, \text{\&c.}$$

$$\text{Sin.}\, a = a - \frac{a^3}{1\cdot 2\cdot 3} + \frac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5} -, \text{\&c.}$$

Hence it follows that

(G 2)

$$e^{a\sqrt{-1}} = \cos.\, a + \sqrt{-1}\,\sin.\, a,$$

$$e^{-a\sqrt{-1}} = \cos.\, a - \sqrt{-1}\,\sin.\, a;$$

and consequently that

$$\text{Cos.}\, a = \frac{e^{a\sqrt{-1}} + e^{-a\sqrt{-1}}}{2}, \quad \text{Sin.}\, a = \frac{e^{a\sqrt{-1}} - e^{-a\sqrt{-1}}}{2\sqrt{-1}}.$$

Here the cosine and sine are expressed by imaginary exponentials. Lagrange considered these formulæ to be the happiest analytical inventions of the age. The series for the cosine and sine from which they have been here deduced had been given by Newton before the end of the 17th century. They might therefore then have been found, and a perfection given to this subject which it did not attain until fifty years later, by the labours of Euler.

270. From formulæ (G 2) we find

$$\frac{\cos.\, a + \sqrt{-1}\,\sin.\, a}{\cos.\, a - \sqrt{-1}\,\sin.\, a} = \frac{e^{a\sqrt{-1}}}{e^{-a\sqrt{-1}}} = e^{2a\sqrt{-1}};$$

or, putting, instead of sin. $a$, its equivalent tan. $a$ cos. $a$, and leaving out the common factor cos. $a$,

$$\frac{1+\sqrt{-1}\,\tan.\, a}{1-\sqrt{-1}\,\tan.\, a} = e^{2a\sqrt{-1}}.$$

Now, observing that $e$ is the base or radical number of Napier's logarithms, it follows, from the theory of logarithms (Sect. XIX.), that

$$2a\sqrt{-1} = \text{Nap. log.}\,\frac{1+\sqrt{-1}\,\tan.\, a}{1-\sqrt{-1}\,\tan.\, a}.$$

But it was shown, sect. 167, that $v$ being any number,

$$\log.\,\frac{1+v}{1-v} = 2\left(v + \frac{v^3}{3} + \frac{v^5}{5} + \frac{v^7}{7} +, \text{\&c.}\right).$$

Put now $\sqrt{-1}$ tan. $a$ instead of $v$, and the result equal to $2a\sqrt{-1}$, and divide both sides by $2\sqrt{-1}$, and we have

(H 2)

$$a = \tan.\, a - \tfrac{1}{3}\tan.^3 a + \tfrac{1}{5}\tan.^5 a - \tfrac{1}{7}\tan.^7 a +, \text{\&c.}$$

This elegant expression for an arc of a circle was first found by James Gregory, from whom it was received by Collins, an eminent mathematician of that period, in the beginning of 1671. It was sent to Leibnitz in 1675 (see *Commercium Epistolicum*, p. 98 and 120), and it appears that this celebrated person had communicated the same series to his friends on the Continent as his own discovery, and even sent it to England in 1676. (*Com. Ep.* 133.) He was accused by the English mathematicians of appropriating to himself the discovery of Gregory: but this, of course, he denied. (*Com. Ep. Leibnitii et Bernoullii*, tom. ii. p. 313.) We have been thus particular, because Lagrange has given it to Leibnitz. (*Calcul des Fonctions*, p. 68.) John Bernoulli, however, in expressing his belief that Leibnitz had found the series himself, admits that it was first discovered by Gregory.

271. If we suppose $a$ to be an arc of 45°, the Gregorian series gives

$$1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} + \tfrac{1}{9} - \tfrac{1}{11} +, \text{\&c.}$$

for one eighth of the circumference. This, however, converges too slowly to be of any practical use. Newton found a different series, viz.

$$1 + \tfrac{1}{3} - \tfrac{1}{5} - \tfrac{1}{7} + \tfrac{1}{9} + \tfrac{1}{11} - \tfrac{1}{13} - \tfrac{1}{15} +, \text{\&c.}$$

for the length of the quadrantal arc of a circle of which the chord $= 1$. This converges somewhat faster than Gregory's series; but Newton says that the addition of no fewer than 5000,000,000 of the terms would be required to give the length of the quadrant true to twenty decimal places of figures; a labour which would require about one thousand years.

272. The simplicity of Gregory's series is a great recommendation; and as the determination of the ratio of the diameter of a circle to the circumference is a problem of primary importance, we shall investigate an auxiliary formula, which will make it the fittest of any for the solution.

Let $n$, $x$, $y$, be three whole numbers, such, that the arc whose tangent is $\frac{1}{n}$ is equal to the sum of the arcs whose tangents are $\frac{1}{x}$ and $\frac{1}{y}$; then, by formulæ (F),

$$\frac{1}{n} = \frac{\frac{1}{x}+\frac{1}{y}}{1-\frac{1}{xy}} = \frac{x+y}{xy-1};$$

hence we find $y = \dfrac{nx+1}{x-n} = n + \dfrac{n^2+1}{x-n}$.

Now as $y$ is a whole number, $n^2+1$ must be divisible by $x-n$. Let $p$ be any divisor of $n^2+1$, and $q$ the quotient, so that $pq = n^2+1$; then $x-n$ may be assumed $= p$, and $x = n+p$, and therefore

$$y = n + \frac{n^2+1}{x-n} = n + p.$$

Hence we have the following *theorem;*

Let $n$ be any whole number, and let $n^2+1$ be resolved into any two factors $p$ and $q$, one of which may be unity. The arc whose tangent is $\frac{1}{n}$ is equal to the sum of the arcs whose tangents are $\dfrac{1}{n+p}$ and $\dfrac{1}{n+q}$.

As a convenient notation, let $\mathrm{A}\frac{1}{n}$ denote the arc whose tangent is $\frac{1}{n}$, and similarly, $\mathrm{A}\,\dfrac{1}{n+p}$ and $\mathrm{A}\,\dfrac{1}{n+q}$, the arcs whose tangents are $\dfrac{1}{n+p}$, and $\dfrac{1}{n+q}$; our theorem will then stand thus:

(K 2)

$$\mathrm{A}\,\frac{1}{n} = \mathrm{A}\,\frac{1}{n+p} + \mathrm{A}\,\frac{1}{n+q}.$$

By giving to $n$ different values, we form the following table:

(L 2)

$$\begin{array}{lll l}
n=1,\ n^2+1 & =1\times 2, & \mathrm{A}\frac{1}{1}=\mathrm{A}\frac{1}{2}+\mathrm{A}\frac{1}{3}, & (1) \\
n=2,\ n^2+1 & =1\times 5, & \mathrm{A}\frac{1}{2}=\mathrm{A}\frac{1}{3}+\mathrm{A}\frac{1}{7}, & (2) \\
n=3,\ n^2+1 & \begin{cases}=1\times 10, \\ =2\times 5,\end{cases} & \begin{array}{l}\mathrm{A}\frac{1}{3}=\mathrm{A}\frac{1}{4}+\mathrm{A}\frac{1}{13}, \\ \mathrm{A}\frac{1}{3}=\mathrm{A}\frac{1}{5}+\mathrm{A}\frac{1}{8},\end{array} & \begin{array}{l}(3) \\ (4)\end{array} \\
n=4,\ n^2+1 & =1\times 17, & \mathrm{A}\frac{1}{4}=\mathrm{A}\frac{1}{5}+\mathrm{A}\frac{1}{21}, & (5) \\
n=5,\ n^2+1 & =2\times 13, & \mathrm{A}\frac{1}{5}=\mathrm{A}\frac{1}{7}+\mathrm{A}\frac{1}{18}, & (6) \\
n=6,\ n^2+1 & =1\times 37, & \mathrm{A}\frac{1}{6}=\mathrm{A}\frac{1}{7}+\mathrm{A}\frac{1}{43}, & (7) \\
n=7,\ n^2+1 & =2\times 25, & \mathrm{A}\frac{1}{7}=\mathrm{A}\frac{1}{9}+\mathrm{A}\frac{1}{32}, & (8) \\
\quad\text{\&c.} & & \quad\text{\&c.} &
\end{array}$$

We may proceed with this series to any extent; and from these formulæ, by elimination, we obtain the following:

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(M 2)

$$A\tfrac{1}{1} = A\tfrac{1}{2} + A\tfrac{1}{3}$$

From 1 and 2, $A\tfrac{1}{1} = 2A\tfrac{1}{3} + A\tfrac{1}{7}$, (9)

4 and 9, $A\tfrac{1}{1} = 2A\tfrac{1}{5} + A\tfrac{1}{7} + 2A\tfrac{1}{8}$, (10)

6 and 10, $A\tfrac{1}{1} = 3A\tfrac{1}{7} + 2A\tfrac{1}{8} + 2A\tfrac{1}{18}$, (11)

8 and 11, $A\tfrac{1}{1} = 2A\tfrac{1}{8} + 3A\tfrac{1}{9} + 2A\tfrac{1}{18} + 3A\tfrac{1}{32}$, (12)

&c.

By any one of these the circumference of a circle may be found with great facility, particularly by the two last. The first and simplest, but not the best, is Euler's formula; and it shows that $\tfrac{1}{4}$ of the semi-circumference is the sum of the arcs whose tangents are $\tfrac{1}{2}$ and $\tfrac{1}{3}$.

By putting $\tfrac{1}{2}$ and $\tfrac{1}{3}$ in the general series instead of tan. $a$, we get two series whose sum multiplied by 4 gives for half the circumference,

$$4\left\{\begin{array}{l} \dfrac{1}{2} - \dfrac{1}{3\cdot 2^3} + \dfrac{1}{5\cdot 2^5} - \dfrac{1}{7\cdot 2^7} + \dfrac{1}{9\cdot 2^9} -, \\ +\dfrac{1}{3} - \dfrac{1}{3\cdot 3^3} + \dfrac{1}{5\cdot 3^5} - \dfrac{1}{7\cdot 3^7} + \dfrac{1}{9\cdot 3^9} -, \&c. \end{array}\right\}.$$

The arithmetical calculation being performed, the result gives half the circumference to the radius 1, which we have expressed by $\pi$, or the whole circumference to the diameter 1 equal to

3·14159,26535,89793,23846,26433,83279,50288.

We have put down this important *datum* true to 35 places of decimals, not because such accuracy can ever be wanted, but as a memorial of the almost incredible patience of Ludolph Van Ceulen, a Flemish mathematician, who obtained this result by the most laborious but most obvious of all methods, namely, the inscription and circumscription of polygons in and about a circle. He so highly estimated this effort, that he directed the number to be inscribed on his sepulchre, in imitation of the tomb of Archimedes, which was inscribed with a sphere and cylinder; but, by methods which have been here explained, it might have been accomplished with no great labour. De Lagny, a Frenchman, carried the calculation, by an easier method, to 128 figures; and Euler ascertained that his result could be verified with 80 hours' labour. It is said that the same important number has even been carried as far as 150 figures, and that this labour may be seen in manuscript in the Radcliffe Library at Oxford.

273. The importance of the problem to determine the ratio of the diameter to the circumference, which is called the rectification of the circle, makes it desirable to have an elementary solution; we shall therefore give another, which is entirely independent of the binomial theorem, or the doctrine of imaginary quantities.

Supposing A to be any arc of a circle, we found, sect. 257, that

$$\text{tan. } 2A = \frac{2 \text{ tan. } A}{1 - \text{tan.}^2 A}, \text{ and therefore } \frac{1}{\text{tan. } 2A} = \frac{1}{2 \text{ tan. } A} - \tfrac{1}{2} \text{ tan. } A.$$

From this formula we deduce the following equations:

$$\frac{1}{\text{tan. } a} = \frac{1}{2 \text{ tan. } \frac{1}{2}a} - \tfrac{1}{2} \text{ tan. } \tfrac{1}{2}a,$$

$$\frac{1}{2 \text{ tan. } \frac{1}{2}a} = \frac{1}{4 \text{ tan. } \frac{1}{4}a} - \tfrac{1}{4} \text{ tan. } \tfrac{1}{4}a,$$

$$\frac{1}{4 \text{ tan. } \frac{1}{4}a} = \frac{1}{8 \text{ tan. } \frac{1}{8}a} - \tfrac{1}{8} \text{ tan. } \tfrac{1}{8}a.$$

By adding both sides, and rejecting what is common to the results, we find

$$\frac{1}{\text{tan. } a} = \frac{1}{8 \text{ tan. } \frac{1}{8}a} - \tfrac{1}{2} \text{ tan. } \tfrac{1}{2}a - \tfrac{1}{4} \text{ tan. } \tfrac{1}{4}a - \tfrac{1}{8} \text{ tan. } \tfrac{1}{8}a;$$

and hence, by transposing,

$$\frac{1}{8 \text{ tan. } \frac{1}{8}a} = \frac{1}{\text{tan. } a} + \tfrac{1}{2} \text{ tan. } \tfrac{1}{2}a + \tfrac{1}{4} \text{ tan. } \tfrac{1}{4}a + \tfrac{1}{8} \text{ tan. } \tfrac{1}{8}a.$$

In general, $n$ being any integer power of 2, we have

$$\frac{1}{n \text{ tan. } \frac{1}{n}a} = \frac{1}{\text{tan. } a} + \tfrac{1}{2} \text{ tan. } \tfrac{1}{2}a + \tfrac{1}{4} \text{ tan. } \tfrac{1}{4}a + \tfrac{1}{8} \text{ tan. } \tfrac{1}{8}a + \tfrac{1}{16} \text{ tan. } \tfrac{1}{16}a \ldots\ldots + \frac{1}{n} \text{ tan. } \frac{a}{n}.$$

Suppose now $n$ to be increased indefinitely, the series will then consist of an infinite number of terms; and since it was proved in sect. 266 that $n \text{ tan. } \frac{1}{n}a = a$, we have

(N 2)

$$\frac{1}{a} = \frac{1}{\text{tan. } a} + \tfrac{1}{2} \text{ tan. } \tfrac{1}{2}a + \tfrac{1}{4} \text{ tan. } \tfrac{1}{4}a + \tfrac{1}{8} \text{ tan. } \tfrac{1}{8}a +, \&c.$$

This very simple and neat expression for the reciprocal of an arc was found by Professor Wallace, and given along with various others in the sixth volume of the *Transactions of the Royal Society of Edinburgh*, about the year 1812. He believed it to be new, and indeed it was not then known in this country; but it had been given before by Euler, in his *Opuscula Analytica*, tom. i. p. 350. This series converges pretty fast; for the tangent of the half of an arc being less than half the tangent of the whole arc, as is easily proved, each term is less than one fourth of the term before it. As, however, the series proceeds, the ratio of any two consecutive terms approaches continually to that of 4 to 1; and hence any term somewhat advanced in the series will be nearly three times the sum of all that follow it; and, by this property, as soon as a term is found to be nearly one fourth of that before it, one third of that term will give the sum of all that follow it, very near.

From the formula $\text{tan. } \frac{1}{2}a = \text{cosec. } a - \text{cot. } a$ (sect. 249), we get

$$\text{tan. } \tfrac{1}{2}a = \sqrt{1 + \text{cot.}^2 a} - \text{cot. } a = \text{cot. } a(\sqrt{1 + \text{tan.}^2 a} - 1).$$

But by the binomial theorem

$$\sqrt{1 + \text{tan.}^2 a} = 1 + \tfrac{1}{2} \text{ tan.}^2 a - \tfrac{1}{8} \text{ tan.}^4 a + \tfrac{1}{16} \text{ tan.}^6 a -, \&c.$$

therefore, $\text{tan. } \frac{1}{2}a = \frac{1}{2} \text{ tan. } a - \frac{1}{8} \text{ tan.}^3 a + \frac{1}{16} \text{ tan.}^5 a$, &c.

By the first of these expressions we may compute the terms of the series until the seventh or fifth power may be neglected, and then the remaining terms may be more readily computed by the second.

Let $a$ be a quadrant $= \frac{1}{2}\pi$. In this case, $\dfrac{1}{\text{tan.} a} = 0$.

The calculation of the length of the arc will stand thus:

$$\begin{aligned}
\text{Tan.} \tfrac{1}{2}a &= \cdot 50000000000 \\
\text{Tan.} \tfrac{1}{4}a &= \cdot 41421356237 \\
\text{Tan.} \tfrac{1}{8}a &= \cdot 19891236738 \\
\text{Tan.} \tfrac{1}{16}a &= \cdot 09849140336 \\
\text{Tan.} \tfrac{1}{32}a &= \cdot 04912684977 \\
\text{Tan.} \tfrac{1}{64}a &= \cdot 02454862211 \\
\text{Tan.} \tfrac{1}{128}a &= \cdot 01227246238 \\
\text{Tan.} \tfrac{1}{256}a &= \cdot 00613600016 \\
\text{Tan.} \tfrac{1}{512}a &= \cdot 00306797120
\end{aligned}$$

$$\begin{aligned}
\tfrac{1}{2} \text{ tan.} \tfrac{1}{2}a &= \cdot 50000000000 \\
\tfrac{1}{4} \text{ tan.} \tfrac{1}{4}a &= \cdot 10355339059 \\
\tfrac{1}{8} \text{ tan.} \tfrac{1}{8}a &= \cdot 02486404592 \\
\tfrac{1}{16} \text{ tan.} \tfrac{1}{16}a &= \cdot 00615571271 \\
\tfrac{1}{32} \text{ tan.} \tfrac{1}{32}a &= \cdot 00153521406 \\
\tfrac{1}{64} \text{ tan.} \tfrac{1}{64}a &= \cdot 00038357222 \\
\tfrac{1}{128} \text{ tan.} \tfrac{1}{128}a &= \cdot 00009587861 \\
\tfrac{1}{256} \text{ tan.} \tfrac{1}{256}a &= \cdot 00002396875 \\
T = \tfrac{1}{512} \text{ tan.} \tfrac{1}{512}a &= \cdot 00000599213 \\
\tfrac{1}{3}T &= \cdot 00000199737
\end{aligned}$$

$$\frac{2}{\pi} = \cdot 63661977236$$

$$\pi = 3\cdot 1415926536.$$

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274. It appears from Sect. X. that the resolution of any equation depends on our being able to resolve it into its factors, whether of the first or second degree. In one class of equations this can be effected by the calculus of sines, as will appear from the following analysis:

Since $\cos.(m+1)x=2\cos.x\cos.mx-\cos.(m-1)x$,

let $2\cos.x=v+\frac{1}{v}$;

then $2\cos.2x=4\cos.x\cos.x-2\cos.0x=v^2+\frac{1}{v^2}$,

$$2\cos.3x=4\cos.x\cos.2x-2\cos.x=v^3+\frac{1}{v^3},$$

$$2\cos.4x=4\cos.x\cos.3x-2\cos.2x=v^4+\frac{1}{v^4},$$

&c.

and in general, $2\cos.mx=v^m+\frac{1}{v^m}$;

hence we get

$$v^{2m}-2v^m\cos.mx+1=0.$$

The equation $v+\frac{1}{v}=2\cos.x$ gives

$$v^2-2v\cos.x+1=0.$$

Now, since the two equations

$$v^{2m}-2v^m\cos.mx+1=0,$$
$$v^2-2v\cos.x+1=0,$$

require to be both satisfied at the same time, they must have at least one common root. Let $a$ be that root, then $\frac{1}{a}$ will also be a root of both; for putting them under the form

$$v^m+\frac{1}{v^m}-2\cos.mx=0,$$

$$v+\frac{1}{v}-2\cos.x=0,$$

the results will be the very same whether we substitute $a$ or $\frac{1}{a}$ for $v$.

Now the quadratic equation

$$v^2-2v\cos.x+1=0$$

can only have two roots, therefore these must also be roots of the equation

$$v^{2m}-2v^m\cos.mx+1=0;$$

hence it follows that the trinomial

$$v^{2m}-2v^m\cos.mx+1$$

must be divisible by this other expression,

$$v^2-2v\cos.x+1;$$

or, putting $mx=\varphi$, and therefore $x=\frac{\varphi}{m}$, that

$$v^{2m}-2v^m\cos.\varphi+1$$

must have for a divisor

$$v^2-2v^m\cos.\frac{\varphi}{m}+1.$$

Now we found, sect. 232, that $\pi$ being put for half the circumference,

$$\text{Cos.}\,\varphi=\cos.(2n\pi+\varphi);$$

hence it follows, that instead of $\frac{\varphi}{m}$, we may take any one of this series of arcs,

$$\frac{2\pi}{m}+\frac{\varphi}{m},\ \frac{4\pi}{m}+\frac{\varphi}{m},\ \frac{6\pi}{m}+\frac{\varphi}{m}\ldots\ldots\text{to}\left\{\frac{2(m-1)\pi}{m}+\frac{\varphi}{m}\right\},$$

for the cosine of $m$ times any one of these is the very same quantity; we may therefore infer that the trinomial

$$v^{2m}-2v^m\cos.\varphi+1$$

is divisible by each of these trinomial expressions of the second degree, viz.

$$v^2-2v\cos.\frac{\varphi}{m}+1,$$

$$v^2-2v\cos.\left(\frac{2\pi}{m}+\frac{\varphi}{m}\right)+1,$$

$$v^2-2v\cos.\left(\frac{4\pi}{m}+\frac{\varphi}{m}\right)+1,$$

$$\ldots\ldots$$

$$v^2-2v\cos.\left\{\frac{2(m-1)}{m}\pi+\frac{\varphi}{m}\right\}+1.$$

It is needless to carry the series farther, because the next divisor would involve $\cos.\left(\frac{2m}{m}\pi+\frac{\varphi}{m}\right)$, which is the same as $\cos.\left(2\pi+\frac{\varphi}{m}\right)=\cos.\frac{\varphi}{m}$, a repetition of the first, and so on. As the number of divisors which differ from one another is $m$, and the trinomial is of the $2m^{\text{th}}$ degree, it follows from the theory of equations, that the trinomial is the continual product of all the divisors.

This elegant theorem is due to De Moivre, as appears from his *Miscellanea Analytica*.

275. If we suppose $\varphi=0$, then $\cos.\varphi=1$, and the trinomial $v^{2m}-2v^m\cos.\varphi+1$ becomes in this case $v^{2m}-2v^m+1=(v^m-1)^2$, and the factors are

$$v^2-2v+1=(v-1)^2,$$

$$v^2-2v\cos.\frac{2\pi}{m}+1,$$

$$v^2-2v\cos.\frac{4\pi}{m}+1,$$

$$\ldots\ldots$$

$$v^2-2v\cos.\frac{2(m-1)}{m}\pi+1.$$

If, again, $\varphi=\pi$, then $\cos.\varphi=-1$, and the trinomial $v^{2m}-2v^m\cos.\varphi+1=v^{2m}+2v^m+1=(v^m+1)^2$; therefore the factors of this quantity are

$$v^2-2v\cos.\frac{\pi}{m}+1,$$

$$v^2-2v\cos.\frac{3\pi}{m}+1,$$

$$v^2-2v\cos.\frac{5\pi}{m}+1,$$

$$\ldots\ldots$$

$$v^2-2v\cos.\frac{(2m-1)\pi}{m}+1.$$

276. The two last formulæ are the analytic expressions of a very remarkable property of the circle discovered by Cotes, the friend and contemporary of Newton, and called the *Cotesian Theorem*. It consists of two parts, and may be thus enunciated (see Plate XVIII. fig. 25 and 26): Let the circumference of any circle be divided into $2m$ equal parts (for example ten), at the points $A_0$, $A_1$, $A_2$, $A_3$, $A_4$, ... $A_9$; and let $A_0C$ be a diameter drawn through $A_0$, one of the points of division; and from any point P in the diameter (fig. 25), or the diameter produced (fig. 26), let straight lines $PA_1$, $PA_3$, $PA_5$, $PA_7$, $PA_9$, be drawn to the points in the circumference which are the first, third, fifth, &c. from $A_0$; and also straight lines $PA_2$, $PA_4$, $PA_6$, $PA_8$, to the points which are the second, fourth,

sixth, &c.: then, putting $v = CP$, the distance of P from the centre, and $r = CA_0$, the radius.

I. The continual product of the lines drawn from P to $A_1$, $A_3$, $A_5$, $A_7$, &c. (the points marked with the odd numbers), is equal to $r^m + v^m$.

II. The continual product of the lines drawn from P to $A_0$, $A_2$, $A_4$, $A_6$, &c. (the points marked with even numbers), is equal to $r^m - v^m$, when the point is within the circle (fig. 25), or to $v^m - r^m$, when it is without (fig. 26).

Join $CA_1$, and, to simplify, let $r = 1$; because the whole circumference is divided into $2m$ parts, the arcs $A_0 A_1 = \frac{\pi}{m}$, $A_0 A_2 = \frac{2\pi}{m}$, $A_0 A_3 = \frac{3\pi}{m}$, and so on. Now by the elements of Geometry,

$$PA_1^2 = PC^2 - 2PC \times CA_1 \cos.\frac{\pi}{m} + CA^2 = v^2 - 2v \cos. \frac{\pi}{m} + 1.$$

In like manner, it will appear that

$$PA_2^2 = v^2 - 2v \cos. \frac{2\pi}{m} + 1,$$

$$PA_3^2 = v^2 - 2v \cos. \frac{3\pi}{m} + 1,$$

and so on, with respect to the lines drawn to the remaining points $PA_4$, $PA_5$.

Now, remarking that $PA_0 = v - 1$, from what has been proved, it appears that the product

$$PA_1^2 \times PA_3^2 \times PA_5^2 \ldots \text{to } PA_{2m-1}^2$$

is equal to the product of the trinomials

$$v^2 - 2v \cos. \frac{\pi}{m} + 1,$$

$$v^2 - 2v \cos. \frac{3\pi}{m} + 1,$$

$$v^2 - 2v \cos. \frac{5\pi}{m} + 1,$$

$$\cdot \; \cdot \; \cdot \; \cdot \; \cdot$$

$$v^2 - 2v \cos. \frac{(2m-1)}{m}\pi + 1;$$

and that the product

$$PA_0^2 \times PA_2^2 \times PA_4^2 \ldots \text{to } PA_{2m-2}^2$$

is equal to the product of the trinomials,

$$(v-1)^2 \text{ or } (1-v)^2,$$

$$v^2 - 2v \cos. \frac{2\pi}{m} + 1,$$

$$v^2 - 2v \cos. \frac{4\pi}{m} + 1,$$

$$\cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot$$

$$v^2 - 2v \cos. \frac{2(m-1)}{m}\pi + 1.$$

But we have proved that the first of these products is equal to $(v^m+1)^2$, and the second to $(1-v^m)^2 = (v^m-1)^2$; therefore, taking the square roots, we have

$$PA_1 \times PA_3 \times PA_5 \times PA_7, \text{ \&c.} = v^m + 1,$$
$$PA_0 \times PA_2 \times PA_4 \times PA_6, \text{ \&c.} = 1 - v^m \text{ or} = v^m - 1.$$

Thus both parts of the theorem are demonstrated.

This elegant geometrical theorem was found among the papers of Mr Cotes after his death. It had no demonstration, but that was soon supplied by his contemporaries, particularly De Moivre, who gave it the more general form which is expressed analytically in last article. At the time of its discovery, it was greatly esteemed; but now, analytical formulæ are found by experience more convenient than geometrical diagrams, and therefore are employed instead of them.



277. If we consider that

$$\text{Cos.}\frac{2(m-n)}{m}\pi = \cos.(2\pi - \frac{2n}{m}\pi) = \cos.\frac{2n}{m}\pi,$$

it will readily appear that the factors of the quantity $(v^m-1)^2$, which have been given in sect. 275, may be written thus:

$$v^2 - 2v + 1 = (v-1)^2,$$

$$v^2 - 2v \cos. \frac{2\pi}{m} + 1,$$

$$v^2 - 2v \cos. \frac{4\pi}{m} + 1,$$

$$\cdot \; \cdot \; \cdot \; \cdot$$

$$\cdot \; \cdot \; \cdot \; \cdot \; \cdot$$

$$v^2 - 2v \cos. \frac{4\pi}{m} + 1,$$

$$v^2 - 2v \cos. \frac{2\pi}{m} + 1,$$

where the second and last are identical; and the same is true of the third and last but two, the fourth and last but three, and so on, until, in the case of $m$ an even number, we come to two equal factors, one on each side of the $(\frac{1}{2}m+1)$th factor, which being $v^2 - 2v \cos. \frac{m\pi}{m} + 1$, will be $v^2 + 2v + 1 = (v+1)^2$; but in the case of $m$ an odd number, we come to two adjoining equal factors, the first of which is $v^2 - 2v \cos.\frac{m-1}{m}\pi + 1$; therefore, taking the square root of $(v^m-1)^2$, and at the same time rejecting one of each pair of equal factors, we find that when $m$ is an even number, $v^m - 1$ is equal to the product of these quantities,

$$v - 1,$$

$$v + 1,$$

$$v^2 - 2v \cos.\frac{2\pi}{m} + 1,$$

$$v^2 - 2v \cos.\frac{4\pi}{m} + 1,$$

$$\cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot$$

$$v^2 - 2v \cos.\frac{m-2}{m}\pi + 1.$$

But when $m$ is an odd number, the factors are

$$v - 1,$$

$$v^2 - 2v \cos.\frac{2\pi}{m} + 1,$$

$$v^2 - 2v \cos.\frac{4\pi}{m} + 1,$$

$$\cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot$$

$$v^2 - 2v \cos.\frac{m-1}{m}\pi + 1.$$

278. Next let us consider the expression $(v^m+1)^2$ and its factors, as given sect. 275. We have for this case

$$\text{Cos. } \frac{2m-n}{m}\pi = \cos. (2\pi - \frac{n}{m}\pi) = \cos.\frac{n}{m}\pi.$$

The factors are therefore

$$v^2 - 2v \cos. \frac{\pi}{m} + 1,$$

$$v^2 - 2v\cos.\frac{3\pi}{m} + 1,$$

. . . . . .

. . . . . .

$$v^2 - 2v\cos.\frac{3\pi}{m} + 1,$$

$$v^2 - 2v\cos.\frac{\pi}{m} + 1.$$

Here it appears that the first and last factors are identical, also the second and last but one, and so on, until in the case of $m$ an even number, we come to two adjoining equal factors, the first of which is $v^2 - 2v\cos.\frac{m-1}{m}\pi + 1$. But if $m$ be an odd number, there are two equal factors, and a single one between them, viz. $v^2 - 2v\cos.\frac{m}{m}\pi + 1 = v^2 + 2v + 1 = (v+1)^2$; therefore, taking the square roots of $(v^m + 1)^2$ and $(v+1)^2$, and rejecting one of each pair of equal factors, we obtain, in the case of $m$ an even number, $v^m + 1$, equal to the product of these factors:

$$v^2 - 2v\cos.\frac{\pi}{m} + 1,$$

$$v^2 - 2v\cos.\frac{3\pi}{m} + 1,$$

$$v^2 - 2v\cos.\frac{5\pi}{m} + 1,$$

. . . . . .

$$v^2 - 2v\cos.\frac{m-1}{m}\pi + 1.$$

But when $m$ is an odd number, the factors are,

$$v + 1,$$

$$v^2 - 2v\cos.\frac{\pi}{m} + 1,$$

$$v^2 - 2v\cos.\frac{3\pi}{m} + 1,$$

. . . . . .

$$v^2 - 2v\cos.\frac{m-2}{m}\pi + 1.$$

These formulæ, exhibiting the decomposition of the expressions $v^{2m} - 2v^m\cos.\varphi + 1$ and $v^m \pm 1$, are of great importance in the Differential Calculus or doctrine of Fluxions, and in the more recondite theories of Analysis.

279. In concluding the calculus of sines, we shall yet give three other examples of its application: the first shall be to the resolution of quadratic equations.

(1.) Let the equation be

$$x^2 + px = q,$$

where $p$ and $q$ are both positive numbers. This equation has two roots, a positive and a negative, of which $-p$ is the sum, and $-q$ the product. (Sect. 93.) Let $\tan.\frac{1}{2}v\sqrt{q}$ be the positive root, where $v$ is an angle to be determined; then $-\text{cotan}.\frac{1}{2}v\sqrt{q}$ will be the negative root, because $\tan.\frac{1}{2}v\sqrt{q} \times -\cot.\frac{1}{2}v\sqrt{q} = -q$. To determine $v$, we have this equation,

$$\sqrt{q}\,(\cot.\tfrac{1}{2}v - \tan.\tfrac{1}{2}v) = p:$$

but by (3) and (4) of (Q),

$$\cot.\tfrac{1}{2}v - \tan.\tfrac{1}{2}v = 2\cot.v = \frac{2}{\tan.v};$$

therefore, $\tan.v = \frac{\sqrt{q}}{\frac{1}{2}p}$. Hence we have this rule:

To resolve the equation $x^2 + px = q$, find an angle $v$, such, that $\tan.v = \frac{\sqrt{q}}{\frac{1}{2}p} \times$ *radius;* then the roots of the equation are,

$$x = +\tan.\tfrac{1}{2}v\sqrt{q}, \text{ and } x = -\frac{\sqrt{q}}{\tan.\frac{1}{2}v}.$$

(2.) In like manner we find that in the equation

$$x^2 - px = q,$$

the angle $v$ being found as before, the roots of the equation are,

$$x = +\frac{\sqrt{q}}{\tan.\frac{1}{2}v}; \text{ and } x = -\sqrt{q}\tan.\tfrac{1}{2}v.$$

(3.) When the equation is

$$x^2 - px = -q,$$

which has two positive roots whose sum is $p$, and product $q$ (sect. 93), these may be expressed by $\tan.\frac{1}{2}v\sqrt{q}$, and $\cot.\frac{1}{2}v\sqrt{q}$. In this case,

$$\sqrt{q}\,(\cot.\tfrac{1}{2}v + \tan.\tfrac{1}{2}v) = p:$$

but by (3) and (4) of formulæ (Q),

$$\cot.\tfrac{1}{2}v + \tan.\tfrac{1}{2}v = 2\,\text{cosec}.v = \frac{2}{\sin.v};$$

therefore, $\sin.v = \frac{\sqrt{q}}{\frac{1}{2}p}$. Hence, to resolve this case, find an angle $v$, such, that

$$\text{Sin}.v = \frac{\sqrt{q}}{\frac{1}{2}p} \times \textit{radius};$$

$$\text{then } x = +\sqrt{q}\tan.\tfrac{1}{2}v, \quad x = +\frac{\sqrt{q}}{\tan.\frac{1}{2}v}.$$

280. The second example is the resolution of a problem in pure algebra, said to have been proposed by the late Professor Porson.

Find $u, x, y, z$, from these equations,

$$uxyz = a, \quad . \quad . \quad . \quad (A)$$
$$uz + xy = b, \quad . \quad . \quad . \quad (B)$$
$$uy + xz = c, \quad . \quad . \quad . \quad (C)$$
$$ux + yz = d \quad . \quad . \quad . \quad (D)$$

*Solution.*

Let $p, q, r$, be such angles that

$$uz = \sqrt{a}\tan.p, \quad . \quad . \quad . \quad 1$$
$$uy = \sqrt{a}\tan.q, \quad . \quad . \quad . \quad 2$$
$$ux = \sqrt{a}\tan.r; \quad . \quad . \quad . \quad 3$$

then from the equation (A),

$$xy = \sqrt{a}\cot.p, \quad . \quad . \quad 4$$
$$xz = \sqrt{a}\cot.q, \quad . \quad . \quad . \quad 5$$
$$yz = \sqrt{a}\cot.r; \quad . \quad . \quad 6$$

and hence by substitution in the other equations

$$\sqrt{a}(\tan.p + \cot.p) = b,$$
$$\sqrt{a}(\tan.q + \cot.q) = c,$$
$$\sqrt{a}(\tan.r + \cot.r) = d;$$

and from these again (because A being any arc,

$$\tan.A + \cot.A = 2\,\text{cosec}.A = \frac{2}{\sin.2A}, \text{ sect. } 250);$$

$$\frac{2\sqrt{a}}{\sin.2p} = b, \quad \frac{2\sqrt{a}}{\sin.2q} = c, \quad \frac{2\sqrt{a}}{\sin.2r} = d,$$

$$\text{and } \sin.2p = \frac{2\sqrt{a}}{b}, \quad . \quad . \quad 7$$

$$\sin.2q = \frac{2\sqrt{a}}{c}, \quad . \quad . \quad 8$$

$$\sin.2r = \frac{2\sqrt{a}}{d}. \quad . \quad . \quad 9$$

By these equations the angles $p, q, r$ are determined.

By multiplying the corresponding sides of (1) (2) (3) we get

$$u^3xyz = (\sqrt{a})^3 \tan. p \tan. q \tan. r : \qquad 10$$

and, dividing this by Eq. (A),

$$u^2 = \sqrt{a} \tan. p \tan. q \tan. r. \quad . \quad . \quad 11$$

From this and equations 3, 2, and 1,

$$x^2 = \sqrt{a}\frac{\tan. r}{\tan. p \tan. q} = \sqrt{a} \cot. p \cot. q \tan. r,$$

$$y^2 = \sqrt{a}\frac{\tan. q}{\tan. p \tan. r} = \sqrt{a} \cot. p \tan. q \cot. r,$$

$$z^2 = \sqrt{a}\frac{\tan. p}{\tan. q \tan. r} = \sqrt{a} \tan. p \cot. q \cot. r :$$

so that, on the whole, to determine $u, x, y, z$, we first find the angles $p, q, r$, from these formulæ,

$$\sin. 2p = \frac{2\sqrt{a}}{b},$$

$$\sin. 2q = \frac{2\sqrt{a}}{c},$$

$$\sin. 2r = \frac{2\sqrt{a}}{d};$$

and then

$$u = \sqrt[4]{a}\sqrt{\tan. p \tan. q \tan. r},$$

$$x = \sqrt[4]{a}\sqrt{\cot. p \cot. q \tan. r},$$

$$y = \sqrt[4]{a}\sqrt{\cot. p \tan. q \cot. r},$$

$$z = \sqrt[4]{a}\sqrt{\tan. p \cot. q \cot. r}.$$

281. The last example shall be the manner of inscribing a regular polygon of 17 sides in a circle,—a discovery due to Mr Gauss of Brunswick, and one of the most remarkable that has been made in geometry. We take it as given in the excellent *Treatise on Geometry* by Legendre.

Let the arc $\frac{\pi}{17} = \varphi$; in the first place we have this equation,

$$\left.\begin{array}{l}\text{Cos. } \varphi + \cos. 3\varphi + \cos. 5\varphi + \cos. 7\varphi \\ + \cos. 9\varphi + \cos. 11\varphi + \cos. 13\varphi + \cos. 15\varphi\end{array}\right\} = \tfrac{1}{2}.$$

For, putting P for the first member, and multiplying all the terms by 2 cos. $\varphi$, and transforming the results by the formula 2 cos. $a$ cos. $b$ = cos. $(a-b)$ + cos. $(a+b)$ (sect. 238), we shall have 2 P cos. $\varphi$

$$= \left\{\begin{array}{l}1 + 2\cos. 2\varphi + 2\cos. 4\varphi + 2\cos. 6\varphi + 2\cos. 8\varphi \\ + 2\cos. 10\varphi + 2\cos. 12\varphi + 2\cos. 14\varphi + \cos. 16\varphi.\end{array}\right.$$

But since $17\varphi = \pi$, therefore cos. $2\varphi$ = cos. $(\pi - 15\varphi)$ = — cos. $15\varphi$; cos. $4\varphi$ = cos. $(\pi - 13\varphi)$ = — cos. $13\varphi$, and so on, to cos. $16\varphi$ = — cos. $\varphi$; therefore

$$2 \text{P} \cos. \varphi = 1 - 2\cos. 15\varphi - 2\cos. 13\varphi \ldots - 2\cos. 3\varphi - \cos. \varphi;$$

$$\text{or } 2 \text{P} \cos. \varphi = 1 + \cos. \varphi - 2 \text{P},$$

$$\text{or } 2 \text{P} (1 + \cos. \varphi) = 1 + \cos. \varphi, \text{ hence } \text{P} = \tfrac{1}{2}.$$

This being proved, we now divide the terms which compose P into two parts,

$$x = \cos. 3\varphi + \cos. 5\varphi + \cos. 7\varphi + \cos. 11\varphi,$$

$$y = \cos. \varphi + \cos. 9\varphi + \cos. 13\varphi + \cos. 15\varphi.$$

We have therefore $x + y = \frac{1}{2}$. We next multiply the four terms of $x$ by the four terms of $y$, and changing the products of cosines into the cosines of simple arcs, we obtain, all reductions being made,

$$xy = \phantom{-}2 (\cos. 2\varphi + \cos. 4\varphi + \cos. 6\varphi \ldots + \cos. 16\varphi),$$

$$\text{or } xy = -2 (\cos. 15\varphi + \cos. 13\varphi + \cos. 11\varphi \ldots + \cos. \varphi),$$

or at last $xy = -1$.

By these equations we obtain

$$x = \tfrac{1}{4} + \tfrac{1}{4}\sqrt{17}, \qquad y = \tfrac{1}{4} - \tfrac{1}{4}\sqrt{17}.$$

Now, if we divide anew the sums $x$ and $y$ into two parts, viz.

$$x = s + t, \qquad y = u + z,$$

$$s = \cos. 3\varphi + \cos. 5\varphi, \quad u = \cos. \varphi + \cos. 13\varphi,$$

$$t = \cos. 7\varphi + \cos. 11\varphi, \quad z = \cos. 9\varphi + \cos. 15\varphi.$$

We obtain in like manner,

$$st = -\tfrac{1}{4}, \qquad uz = -\tfrac{1}{4}:$$

so that we may now determine the four numbers $s, t, u, z$, by means of two new equations of the second degree.

Lastly, knowing cos. $\varphi$ + cos. $13\varphi = u$, and cos. $\varphi$ cos. $13\varphi$ $= \frac{1}{2}(\cos. 12\varphi + \cos. 14\varphi) = -\frac{1}{2}(\cos. 3\varphi + \cos. 5\varphi) = -\frac{1}{2}s$, we may obtain by a fourth equation of the second degree the value of cos. $\varphi$, and thence the side of the polygon, which is 2 sin. $\varphi = 2\sqrt{1 - \cos.^2 \varphi}$.

As to the method which has guided us in forming these equations, it depends on a very delicate theory, founded on the Indeterminate Analysis. For this we must refer to the work of Gauss, *Disquisitiones Arithmeticæ;* or the French translation, *Recherches Arithmétiques.* (W. W.)

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ALGEMESI, a town of Spain, in the province of Valencia, on the river Jucar, 21 miles S.S.W. of Valencia. Its chief products are rice and silk. Pop. 4492.

ALGENIB, or $\gamma$ *Pegasi*, a star of 2·3 magnitude, in the wing of Pegasus: R.A. January 1. 1853, 0 h. 5 m. 40·25 sec.; N. Decl. 75° 38′ 1·85″.

ALGER, a learned French priest, who lived between the eleventh and twelfth centuries. He was first a deacon of the church of St Bartholomew at Liége, his native town; he was afterwards translated to the cathedral church of St Lambert, and finally retired to the monastery of Cluny, where he died in 1131. His History of the Church of Liége, and many others of his works, are lost, but there still exist of his: 1. *De Misericordia et Justitia*, a collection of extracts from Fathers, with reflections. It is to be found in the *Anecdota* of Martene, vol. v. 2. *De Sacramento Corporis et Sanguinis Domini;* a treatise in three books, against the Berengerian heresy, highly commended by Peter of Cluny and Erasmus. 3. *De libero arbitrio;* given in Pezius' *Anecdota*, vol. iv. 4. *De Sacrificio Missae;* given in the *Collectio Scriptor. Vet.* of Angelo Mai, vol. ix.



ALGEZIRAS, a city of Andalucia in Spain, on the western side of the bay of Gibraltar, and opposite to that fortress. It is situated at the foot of a high mountain called the Trocha, over which there is only one line of road, which is excessively bad. Algeziras derives its name from the Arabic *al-ghezeirah* (the island), on account of Isla Verde, a small islet that forms one side of its harbour. It was founded by Tarik, the moorish general who invaded Spain in 713; and was a place of note in the wars of the Moors and Christians of Spain. It was taken from the Moors in 1344 by Alphonso XI. of Castile, surnamed *The Avenger*, after an obstinate siege, in which Mariana says gunpowder was first used by the Moors in the wars of Europe. "The Earls of Derby and Salisbury were there from England:" this Earl of Derby was John of Gaunt, son of Edward III.

Alghalib-Billah || Alghisi.

During the famous siege of Gibraltar, in 1780–81–82, Algeziras was the station of the Spanish fleet and floating batteries. It is now a place of far less importance, and its fortifications have entirely gone to decay. It has a few manufactures of coarse linen, cotton, paper, leather, and culinary utensils, and exports charcoal made in the mountains around. The chief occupations of its inhabitants are fishing and smuggling. An aqueduct supplies the place with water. Pop. 11,000. Long. 5. 26. 4. W. Lat. 36. 8. N.

ALGHALIB-BILLAH, or THE CONQUEROR FOR THE CAUSE OF GOD, also called ALAHMAR, or *the Red Man*, the surname of Mohammed-ben-Yusuf-ben-Nasr, the first Moorish sovereign of Granada. He was born in the province of Jaen in Spain, A.D. 1195, and died in 1273, after a reign of forty-two years. On the decline of the empire of the Almohades in Spain, the governors of the several provinces declared themselves independent. Mohammed, following the general example, caused himself to be proclaimed sultan of Mahometan Spain; and after subduing various towns, established himself at Granada as the capital of his dominions. He was long the ally, and afterwards the vassal of the king of Castile. He encouraged learning, arts, and manufactures among his subjects; Granada was by him adorned as became the capital of a powerful sovereign; and in his reign the famous palace of the Alhambra was begun. The dynasty of which he was the founder reigned in Granada for two centuries, and ended with Boabdil, who was dethroned by Ferdinand and Isabella in 1492.

ALGHAZZALI, ABU HAMED MOHAMMED EBN MOHAMMED, commonly called ALGAZEL, a celebrated Arabian divine and philosopher, born at Tús in Khorassan, A.D. 1058. After studying at Nisapur and elsewhere, he settled at Baghdad, as a teacher of theology in the college of that city. After four years he embraced the monastic life, and retired to Mecca, where he spent many years in the study of philosophy and theology. Thence he travelled through Syria, Palestine, and Egypt, visiting Damascus, Jerusalem, Cairo, and Alexandria. He finally returned to Tús, and after some years retired to Baghdad, where he died, A.D. 1111.

Algazel was one of the most eminent and voluminous of Arabian writers. In his attempt to establish Mahometan theology on a philosophical foundation, he made himself obnoxious on the one hand to the orthodox Mahometans, and on the other to the followers of Aristotle. To the one he appeared as a heretic; to the other as a philosophical sceptic in the garb of a divine. In his celebrated treatise, entitled the *Destruction of the Philosophers*, he attacks the doctrines of Aristotle and the other Greek philosophers, attempting to show from their mutual want of agreement the uncertainty of philosophical principles, and the necessity of a refuge in religious faith. This was replied to by Averroes in his *Destruction of the Destruction*. A list of Algazel's numerous works on metaphysics, morals, and religion, is given in Casiri's *Bibl. Arab. Hisp. Escur*.

ALGHERI, or AGHUER, a strongly-fortified city on the island of Sardinia, in the district called Capo di Sassari. It is the see of a bishop, has a cathedral, seven monasteries, and 8000 inhabitants, who speak the Catalan language. Their chief occupation is cultivating vineyards. About a league from the city is the fine roadstead or open bay, Porto Conte, where a fleet can anchor securely and be defended by a strong fort.

ALGHISI, or ALGISI, FRANCESCO, an Italian musical composer, was born at Brescia in 1666, and died there in 1733. He was organist of the cathedral in his native city, and composed, during a residence at Venice, two operas, which had great success. In his latter years, his severe abstinence procured him the reputation of a saint.

ALGHISI, *Galeazzo*, an eminent Italian architect, of the latter end of the sixteenth century. He was a native of Carpi, in Modena, and held the office of architect to the Duke of Ferrara, for whom he designed a magnificent palace. His work, *Della Fortificazione*, on military architecture, published at Venice in 1570, was the best architectural production that had then appeared.—*Tiraboschi, Storia.*

Alghisi || Algiers.

ALGHISI, *Tomasso*, an eminent Italian surgeon, especially celebrated as a lithotomist. He was born at Florence in 1669, and died in 1713. He studied anatomy under Lorenzo Bellini, and surgery under his father, who was surgeon to the hospital of Sta Maria Nuova, at Florence. In 1703, he received his degree of Doctor at Padua, from the celebrated Vallisnieri. He afterwards became professor of surgery in his native town. His work, entitled *Litotomia, ovvero del cavar la Pietra*, published at Florence in 1707, and at Venice in 1708, with plates by himself, describes his treatment of lithotomy.—*Mazzuchelli Scritt. d'Italia.*

ALGIABARII, a Mahometan sect of predestinarians, who attribute all the actions of men, good or evil, to the agency of God. They stand opposed to the ALKADARII.

ALGIDUS, a mountain range of Latium in Italy, between Præneste and the Mons Albanus. On the top of one of these mountains was erected a temple of Diana, to which Horace refers, lib. i. ode 21, "*Quæcunque aut gelido prominet Algido;*" and lib. iii. ode 23, "*Quæ nivali pascitur Algido,*" &c.

ALGIERS, or ALGERIA, an extensive country of northern Africa bordering on the Mediterranean, formerly an independent kingdom, but now a dependency of France. It extends from Long. 2. 20. W. to 8. 45. E., and is bounded on the north by the Mediterranean, on the west by Marocco, on the south by the great desert of the Sahara, and on the east by Tunis; but, indeed, except along the coast, the exact boundaries of the country are very undefined. Boundaries

Algiers is traversed by lofty ranges of the Atlas mountains, running nearly parallel to the coast, and rising in some places to the height of upwards of 7000 feet, with deep valleys and extensive plains. Some of the mountains rise abruptly from the sea, and the coast generally is steep and rocky, abounding in capes and gulfs: but it is very deficient in good harbours, and even in secure roadsteads, in consequence of its exposure to the north winds. Mountains.

The rivers of Algiers are numerous, and generally assume the character of mountain torrents, rushing with great impetuosity from the elevations through deep and rocky channels. During the rainy season they are much swollen, which, from the present deficiency of sufficient bridges, renders communication with the different parts of the country extremely difficult. The most important river, both from the length of its course, and the volume of its waters, is the Chelif. It rises in the Djebel Amûr, takes first a northern, and afterwards a western direction, flows through Lake Titterie, and finally empties itself into the Mediterranean, near Mostagan, after a course of nearly 300 miles; during which it receives numerous tributary streams. The Seibouse is formed by the union of several small brooks in the interior of the province of Constantine, south of the town of that name, and after a course of about 120 miles reaches the Mediterranean at Bona. The Oued-el-Kebir or Rummel rises west of Constantine, passes that town, and then pursues a north-westerly course to the sea. Among the less important rivers which empty themselves into the Mediterranean are the Harrach, Isser, Mazafran, Tafna, and Macta. Besides these there are a number of streams in the interior; but they are less known, and are generally dry except in the rainy season. Rivers.

Algiers abounds in extensive lakes and marshes. Of the lakes in the northern part of the country, near the coast, are the Fezara, fourteen miles south-west of Bona; the two Lakes.

Algiers. lakes Sebgha and El-Melah, south of Oran; three small lakes in the immediate vicinity of the Calle, and several others. In the southern parts of the country are the extensive lakes of Chott-el-Harbi or Western Chott; the Chott-el-Chergui or Eastern Chott; the Zarhez Gherbi; and the Zarhez Chergui; the Grand Sebkha-el-Chott, and a number of others. They are mostly dried up in summer, leaving a thick stratum of salt. Many of the marshes, especially in the neighbourhood of the larger towns, have been drained by the French, thus improving considerably the salubrity of the climate. There are also a number of warm mineral springs, principally containing salts of lime, which are used with success by the Arabs in several kinds of diseases. Some of these are in the vicinity of the Calle, Bougie, Miliana, &c.

Plains. It has several fertile and well-watered plains; the principal, that of Metidja, immediately south of Algiers, is about 50 miles long by 20 broad.

Minerals. The mineral wealth of the country is considerable. Iron is very plentiful, and mines of copper, lead, silver, antimony, and coal, are wrought. Salt is obtained in great abundance from many of the lakes and marshes.

Climate. The nature of the climate varies considerably with the elevation. In the northern parts of the country it very much resembles that of the south of Spain, while in the Sahara the heat is frequently excessive. In the more elevated parts the winter is frequently severe; but along the coast it is mild, though often attended with heavy rain, and sometimes in such torrents as in a few hours to exceed the quantity falling at Paris in a whole year. The hottest month is August. In general, with the exception of places in the vicinity of the marshes, it is not unhealthy for Europeans. At Algiers the mean temperature is from 70° to 75° Fahr.; in summer averaging 86°, and in winter from 55° to 65°.

Productions. The vegetation generally resembles that of southern Europe. It has extensive forests of various species of oak, pine, cedar, elm, olive, &c. The trees are frequently of gigantic size, especially the cedars and oaks; but great injury is often done to the forests, by the inhabitants annually burning up the grass of their fields; and thus sometimes the most beautiful forests are consumed. The want of roads and navigable rivers, has, as yet, prevented the French from deriving much benefit from the forests. Among the fruits are oranges, lemons, pomegranates, dates, peaches, melons, &c.: wheat, barley, cotton, sugar-cane, and tobacco, are also extensively cultivated. In the animal kingdom, there is little particularly deserving of notice. Lions were formerly very plentiful, but they are now nearly extirpated; leopards are still common, and in the south are many jackals and hyænas. The chief wealth of most of the Arab tribes consists in their sheep, of which they frequently possess immense flocks; horses, mules, and camels, are also abundant, and of superior quality. Coral and sponge fishing is extensively prosecuted along the coast.

Divisions. Algiers was formerly divided into four provinces, viz., Constantine, Algiers, Oran, and Tittcrie: at present it is divided into three, Algiers, Oran, and Constantine. These provinces are divided into districts, and each district is subdivided into one or more circles. By the natives it is divided into the *Tell* or green country, in the north, and the *Date country*, in the south.

Population The population of Algiers is estimated at about 3,000,000. At the close of 1850, the European population was 125,963; and in the preceding year 112,607; of whom 58,005 were French, 6943 Anglo-Maltese, 33,659 Spaniards, 6986 Italians, 2515 Germans, 1253 Swiss, and 3246 of other nations. The increase of the European population is caused by immigration, as for several years the deaths have exceeded the births. In 1847, 1848, 1849, the deaths were 5163, 4835, 10,493; the births in the same years were 4283, 4347, 5206. The great mortality of 1849 was occasioned by cholera. The indigenous population residing in the towns in 1849, amounted to 84,133, being 60,928 Turks, 4177 Negroes, and 19,028 Jews.

Races. Besides the Europeans there are eight distinct races inhabiting Algiers. *1st*, The Arabs, the most numerous race in Algiers, inhabit the southern part of the country, and lead a pastoral life. They are the most unsettled and turbulent of the Algerine population, but are at the same time sprightly and intelligent. *2d*, The Kabyles or Berbers are next to the Arabs in point of numbers, and are descendants of the aboriginal inhabitants of the country. They occupy chiefly the more elevated and mountainous parts, but numbers of them also inhabit the plains and valleys: they are an active, industrious race, and principally engaged in husbandry. *3d*, The Moors, a mixed race, inhabiting principally the towns. *4th*, The Jews, also inhabiting the towns, and engaged in mercantile pursuits. They are supposed to amount to about 80,000. *5th*, Negroes, originally brought from the interior, and sold as slaves. They were declared free in 1848, and are estimated at 80,000. *6th*, The Turks, the former dominant race, are now decreasing rapidly. A great number of them left the country when it came into the hands of the French. *7th*, The Kolouglis, who are the descendants of Turks by native women, are also decreasing, and at present are about 20,000. *8th*, The Mozabites, an African race now principally inhabiting the coast towns. They are a peaceable, honest, and industrious race, chiefly engaged in manual labour.

History. The Algerine kingdom made formerly a considerable part of the Mauritania Tingitana, which was reduced to a Roman province by Julius Cæsar, and from him also called *Mauritania Cæsariensis*. The Romans were driven out of that continent by the Vandals; these by Belisarius, the Greek emperor Justinian's general; and the Greeks in their turn by the Saracens. This last revolution happened about the middle of the seventh century; and the Arabs continued masters of the country, divided into a great number of petty kingdoms or states, under chiefs of their own choosing, till the year 1051. In this year Abubeker-ben-Omar, or, as the Spanish authors call him, Abu-Texefien, an Arab of the Zinhagian tribe, gathered, by the help of his marabouts or saints, a most powerful army of malcontents, in the southern provinces of Numidia and Libya. His followers were named Marabites or Morabites, by the Spaniards Almoravides, probably from their being assembled principally by the saints, who were also called Morabites. The caliph's forces were at this time employed in quelling other revolts in Syria, Mesopotamia, &c.; and the Arabs in Spain were engaged in the most bloody wars; so that Texefien having nothing to fear from them had all the success he could wish against the Arabian sheiks or petty tyrants, whom he defeated in many battles, and at last drove not only out of Numidia and Libya, but out of all the western districts, reducing the whole province of Tingitania under his dominion. Texefien was succeeded by his son Yusef or Joseph, a brave and warlike prince. He founded the city of Marocco; and engaging in war with the Zeneti, a powerful tribe who inhabited Tremecen, defeated them in repeated engagements, and finally almost exterminated them. He then extended his conquests over almost all Barbary. Thus was founded the empire of the Morabites, which, however, was of no long duration, that race being in the twelfth century driven out by Mohavedin, a marabout. This race of priests was expelled by Abdulac, governor of Fez; and he in the thirteenth century was stripped of his new conquests by the Scherifs of Hascen, the descendants of those Arabian princes whom Abu-Texefien had formerly expelled.

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The better to secure their new dominions, the Scherifs divided them into several little kingdoms or provinces; and among the rest, the present kingdom of Algiers was divided into four, namely, Tremecen, Tenez, Algiers Proper, and Bujeiah. The first four princes laid so good a foundation for a lasting balance of power between their little kingdoms, that they continued for some centuries in mutual peace and amity; but at length the king of Tremecen having ventured to violate some of their articles, Abul-Farez, king of Tenez, declared war against him, and obliged him to become his tributary. This king dying soon after, and having divided his kingdom among his three sons, new discords arose, which Spain taking advantage of, sent a powerful fleet and army against Barbary, under the count of Navarre, in 1505. This commander soon made himself master of the important cities of Oran, Bujeiah, and some others. Finally, he landed a number of forces near Algiers, and obliged that metropolis to become tributary to Spain.

Barbarossa.

To this galling yoke the Algerines were obliged to submit till the year 1516, when, hearing of the death of Ferdinand, king of Spain, they sent an embassy to Aruch Barbarossa, who was at that time on a cruise with a squadron of galleys and barks, spreading terror wherever he appeared by his valour and success. The purport of the embassy was, that he should come and free them from the Spanish yoke; for which they agreed to pay him a gratuity answerable to so great a service. Upon this Barbarossa immediately despatched 18 galleys and 30 barks to the assistance of the Algerines, while he himself advanced towards the city with 800 Turks, 3000 Jegelites, and 2000 Moorish volunteers. Instead of taking the nearest road to Algiers, he directed his course towards Shershel, where Hassan, another famed corsair, had established himself. Him he surprised, and obliged to surrender, not without a previous promise of friendship; but no sooner had Barbarossa got him in his power, than he beheaded him, and obliged all Hassan's Turkish adherents to follow him in his new expedition.

On Barbarossa's approach to Algiers, he was welcomed by all the people of that metropolis, who looked for deliverance from this daring bandit, whom they accounted invincible. Elated beyond measure with this kind reception, Barbarossa formed a design of becoming king of Algiers; and fearing some opposition from the inhabitants, on account of the excesses he suffered his soldiers to commit, he murdered their prince Eutemi, and caused himself to be proclaimed king; his Turks and Moors crying out as he rode along the streets, "Long live King Aruch Barbarossa, the invincible king of Algiers, the *chosen of God* to deliver the people from the oppression of the Christians; and destruction to all that shall oppose or refuse to own him as their lawful sovereign." These threatening words so intimidated the inhabitants, already apprehensive of a general massacre, that he was immediately acknowledged as king.

Barbarossa was no sooner seated on the throne, than he treated his subjects with such cruelty, that they used to shut up their houses and hide themselves when he appeared in public. In consequence of this, a plot was soon formed against him; but having discovered it, he caused twenty of the principal conspirators to be beheaded, and their bodies to be buried in a dunghill, and laid a heavy fine on those who survived. This so terrified the Algerines, that they never afterwards dared to attempt anything against either Barbarossa or his successors.

In the mean time the son of Prince Eutemi, having fled to Oran, and put himself under the protection of the marquis of Gomarez, laid before that nobleman a plan for putting the city of Algiers into the hands of the king of Spain. Cardinal Ximenes, having approved of it, sent a fleet with 10,000 land forces, under the command of Don Francisco, or, as others call him, Don Diego de Vera, to drive out the Turks, and restore the young prince; but the fleet no sooner came within sight of land than it was dispersed by a storm, and the greater part of the ships dashed against the rocks. Most of the Spaniards were drowned, and the few who escaped to the shore were either killed by the Turks or made slaves.

Though Barbarossa had nothing to boast on this occasion, his pride and insolence had now risen to such a pitch, that he imagined himself invincible. He found little difficulty in conquering the kingdoms of Tenez and Tremecen. Abuchen Men, however, the exiled sovereign of Tremecen, had recourse to Charles V. then lately arrived in Spain with a powerful fleet and army. That monarch immediately ordered the young king a succour of 10,000 men, under the command of the governor of Oran, who, under the guidance of Abuchen Men, began his march towards Tremecen; and in their way they were joined by Prince Selim, with a great number of Arabs and Moors. The tyrant kept close in his capital, being embarrassed by his fears of a revolt, and the politic delays of the king of Fez, who had not sent the auxiliaries he promised. Being now informed that Abuchen Men and his Arabs, accompanied by the Spaniards, were in full march to lay siege to Tremecen, he thought proper to come out at the head of 1500 Turks and 5000 Moorish horse, in order to break his way through the enemy; but he had not proceeded far from the city before his council advised him to return and fortify himself in it. This advice was now too late, the inhabitants being resolved to shut him out, and open their gates to their own lawful prince as soon as he appeared. In this distress Barbarossa saw no resource but to retire to the citadel. Here he defended himself vigorously; but his provisions failing, he took advantage of a subterraneous path, which he had caused to be dug, and, taking his immense treasure with him, stole away as secretly as possible. His flight, however, was soon discovered; and he was so closely pursued, that to amuse, as he hoped, the enemy, he caused a great part of his money, plate, jewels, &c. to be scattered on the way, thinking they would delay their pursuit in gathering it up. This stratagem, however, failed through the vigilance of the Spanish commander, who being himself at the head of the pursuers, obliged them to march on, till he came up close to him on the banks of the Huexda, about eight leagues from Tremecen. Barbarossa had just crossed the river with his vanguard, when the Spaniards came up with his rear on the other side, and cut them all off; and then crossing the water, overtook him at a small distance from it. Here a bloody engagement ensued, in which the Turks fought like lions; but being at length overpowered by numbers, they were all cut in pieces, and Barbarossa among the rest, in the 44th year of his age, and four years after he had raised himself to the royal title of *Jigel*.

Succeeded by Hayradin.

The news of Barbarossa's death spread the utmost consternation among the Turks at Algiers; however, they caused his brother Hayradin to be immediately proclaimed king. The Spanish commander now sent back the emperor's forces, without making any attempt upon Algiers, by which he lost the opportunity of driving the Turks out of that country; while Hayradin, justly dreading the consequences of the tyranny of his officers, sought the protection of the grand signior. This was readily granted, and he himself appointed bashaw or viceroy of Algiers; by which means he received such considerable re-

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inforcements, that the unhappy Algerines could attempt no resistance; and such numbers of Turks resorted to him, that he was able not only to keep the Moors and Arabs in subjection at home, but to annoy the Christians at sea.

Hayradin next undertook to build a strong mole for the protection of his ships. In this he employed 30,000 Christian slaves, whom he obliged to labour without intermission for three years, in which time the work was completed. Hayradin soon became dreaded, not only by the Arabs and Moors, but also by the maritime Christian powers, especially the Spaniards. The viceroy failed not to acquaint the grand signior with his success, and obtained from him a fresh supply of money, by which he was enabled to build a strong fort, and to erect batteries on all places that might favour the landing of an enemy. All these have since received greater improvements from time to time.

Succeeded by Hassan Aga.

In the mean time the sultan, either out of a sense of the great services Hayradin had rendered, or perhaps out of jealousy lest he should make himself independent, raised him to the dignity of bashaw of the empire, and appointed Hassan Aga, a Sardinian renegado, an intrepid warrior, and an experienced officer, to succeed him as bashaw of Algiers. Hassan had no sooner taken possession of his new government, than he began to pursue his ravages on the Spanish coast with greater fury than ever, extending them to the Ecclesiastical State, and other parts of Italy. Pope Paul III. exhorted the emperor Charles V. to send a powerful fleet to suppress these frequent and cruel piracies; and, that nothing might be wanting to render the enterprise successful, a bull was published by his holiness, in which a plenary absolution of sins, and the crown of martyrdom, were promised to all those who either fell in battle or were made slaves. The emperor accordingly set sail at the head of a powerful fleet, consisting of 120 ships and 20 gallcys, having on board 26,000 chosen troops, and an immense quantity of money, arms, ammunition, &c. In this expedition many young noblemen and gentlemen attended as volunteers, and among these many knights of Malta, so remarkable for their valour against the enemies of Christianity. Even ladies of birth and character attended Charles in his expedition; and the wives and daughters of the officers and soldiers followed them with a design to settle in Barbary after the conquest should be completed. The expedition meeting with a favourable wind, soon appeared before Algiers; every ship displaying the Spanish colours on the stern, and another at the head, with a crucifix to serve for a pilot.

Charles V.'s expedition against Algiers.

By this prodigious armament the Algerines were thrown into the utmost consternation. The city was surrounded only by a wall, with scarcely any outworks. The whole garrison consisted of 800 Turks and 5000 Moors, without firearms, and poorly disciplined and accoutred; the rest of their forces being dispersed in the other provinces of the kingdom, to levy the usual tribute on the Arabs and Moors. The Spaniards landed without opposition, and immediately built a fort, under the cannon of which they encamped, and diverted the course of a spring which supplied the city with water. Being now reduced to the utmost distress, Hassan received a summons to surrender at discretion, on pain of being put to the sword with all the garrison. He was on the point of surrendering the city, when advice was brought to him that the forces belonging to the western government were in full march towards the place; upon which it was resolved to defend it to the utmost. Charles, in the mean time, resolving upon a general assault, kept up a constant firing upon the town; which, from the weak defence made by the garrison, he looked upon as already in his hands. But while the douwan, or Algerine senate, were deliberating on the most proper means of obtaining an honourable capitulation, a mad prophet, attended by a multitude of people, entered the assembly, and foretold the speedy destruction of the Spaniards before the end of the moon, exhorting the inhabitants to hold out till that time. This prediction was soon accomplished in a very surprising and unexpected manner; for on the 28th of October 1541 a dreadful storm of wind, rain, and hail, arose from the north, accompanied with violent shocks of earthquake, and a dismal and universal darkness both by sea and land; so that the sun, moon, and elements seemed to combine together for the destruction of the Spaniards. In that one night, some say in less than half an hour, 86 ships and 15 galleys were destroyed, with all their crews and military stores, by which the army on shore was deprived of all means of subsistence. Their camp also, which spread itself along the plain under the fort, was laid quite under water by the torrents which descended from the neighbouring hills. Many of the troops, in endeavouring to remove into some better situation, were cut in pieces by the Moors and Arabs; while several galleys and other vessels, seeking to gain some neighbouring creeks along the coasts, were immediately plundered, and their crews massacred, by the inhabitants.

The next morning Charles beheld the sea covered with the fragments of his numerous ships, and the bodies of men and horses floating on the waves. Seeing his affairs desperate, he abandoned his tents, artillery, and all his heavy baggage, and marched in great disorder towards Cape Metafuz, in order to re-embark his troops in the few vessels which had survived the tempest. But Hassan, who had caused his motions to be watched, allowed him just time to get to the shore, when he sallied out and attacked the Spaniards in the midst of their confused and hasty embarkation, killing great numbers, and bringing away a still greater number of captives; after which he returned in triumph to Algiers, where he celebrated with great rejoicings his happy deliverance.

Its failure.

Charles having reached the port of Bujeiah on the 2d of December, was detained there by contrary winds for several weeks, whence he set sail for Carthagena, which he reached without further disasters. In this unfortunate expedition upwards of 120 ships and galleys were lost, with above 300 colonels and other land and sea officers, 8000 soldiers and marines, besides those destroyed by the enemy on the re-embarkation, or drowned in the last storm. The number of prisoners was so great that the Algerines sold some of them, by way of contempt, for an onion per head.

Hassan, elated with this victory, in which he had very little share, undertook an expedition against the king of Tremecen, who, being now deprived of the assistance of the Spaniards, was forced to procure a peace by paying a large sum of money, and becoming tributary to him. The bashaw returned to Algiers laden with riches, and soon after died of a fever, in the 66th year of his age.

From this time the Spaniards were never able to annoy the Algerines in any considerable degree. In 1555 they lost the city of Bujeiah, which was taken by Salha Rais, Hassan's successor, who next year set out on a new expedition, which was suspected to be intended against Oran; but he had scarcely got four leagues from Algiers, when the plague, which at that time raged violently in the city, carried him off in 24 hours.

Bashaws.

The dignity of bashaw passed through several hands, when it was occupied by Hassan, the son of Hayradin. Immediately on his arrival, he engaged in a war with the Arabs, by whom he was defeated with great loss. Next year the Spaniards undertook an expedition against

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Mostagan, under the command of the count d'Alcandela; but were utterly defeated, the commander himself killed, and 12,000 men taken prisoners.

Hassan engaged in the siege of Marsalquiver, situated near the city Oran, which he designed to invest immediately after. The army employed in this siege consisted of 26,000 foot and 10,000 horse, besides which he had a fleet consisting of 32 galleys and galliots, together with three French vessels laden with biscuit, oil, and other provisions. The city was defended by Don Martin de Cordova, brother of the count d'Alcandela, who had been taken prisoner in the battle where that nobleman was killed, but had obtained his liberty from the Algerines with immense sums, and now made a most gallant defence against the Turks. The city was attacked with the utmost fury by sea and land, so that several breaches were made in the walls. The Turkish standards were several times planted on the walls, and as often dislodged; but the place must have in the end submitted, had not Hassan been obliged to raise the siege in haste, on the news that the famed Genoese admiral Doria was approaching with considerable succours from Italy.

In 1567 Hassan was recalled to Constantinople, where he died three years after. He was succeeded by Mahomet, who gained the love of the Algerines by several public-spirited actions. He incorporated the janizaries and Levantine Turks together, and by that means put an end to their dissensions, which paved the way for making Algiers independent of the Porte. He likewise added some considerable fortifications to the city and castle, which he designed to render impregnable. At this time one John Gascon, a bold Spanish adventurer, formed a design of surprising the whole piratical navy in the bay, and setting them on fire in the night-time. For this he not only had the permission of King Philip II., but was furnished by him with proper vessels, mariners, and fire-works, for the execution of his plot. He came accordingly, unperceived by any, to the very mole-gate, and dispersed his men with their fire-works; but, to their great surprise, they found these so ill mixed, that all their art could not make them take fire. In the mean time Gascon took it into his head, by way of bravado, to go to the mole-gate, and give three loud knocks with the pommel of his dagger. This he had the good fortune to do without meeting with any disturbance or opposition; but it was not so with his men; for on finding their endeavours unsuccessful, they made such a noise as quickly alarmed the guard posted on the adjacent bastion, from which the alarm quickly spread through the whole garrison. Gascon now finding himself in the utmost danger, sailed off with all possible haste; but he was pursued, overtaken, and brought back a prisoner to Mahomet, who no sooner got him into his power than he immediately caused a gibbet of considerable height to be erected on the spot where Gascon had landed, ordering him to be hoisted up, and hung by the feet to a hook, so that he died in exquisite torture.

Mahomet, being soon after recalled, was succeeded by the renegado Ochali, who reduced the kingdom of Tunis, which, however, remained subject to the viceroy of Algiers only till the year 1586, when a bashaw of Tunis was appointed by the Porte.

The kingdom of Algiers continued to be governed, till the beginning of the 17th century, by viceroys or bashaws appointed by the Porte, whose avarice and tyranny were intolerable both to the Algerines and the Turks themselves. At last the Turkish janizaries and militia became powerful enough to depose these petty tyrants, and set up officers of their own. They sent a deputation of some of their chief members to the Porte, to complain of the avarice and oppression of these bashaws, and represent how much more honourable, as well as more economical, it would be for the grand signior to permit them to choose from among themselves their own dey or governor, whose interest it would be to see that the revenue of the kingdom was duly employed in keeping up its forces complete, and in supplying all other exigencies of the state, without any further charge or trouble to the Porte than that of allowing them its protection. On their part, they engaged always to acknowledge the grand signior as their sovereign, to pay him their usual allegiance and tribute, to respect his bashaws, and to lodge and maintain them and their retinue. All concerns which related to the government of Algiers were to be left under the direction of the dey and his douwan.

Algerines choose their own dey.

These proposals having been accepted by the Porte, the deputies returned highly satisfied; and having notified their new privileges, the great douwan immediately proceeded to the election of a dey from among themselves. Altercations, however, frequently happened between the bashaws and deys, the one endeavouring to recover their former power, and the other to reduce it.

In the year 1601 the Spaniards, under the command of Doria, the Genoese admiral, made another attempt upon Algiers, in which they were more fortunate than usual, their fleet being only driven back by contrary winds, so that they came off without loss. In 1609 the Moors, being expelled from Spain, flocked in great numbers to Algiers; and as many of them were very able sailors, they undoubtedly contributed to raise the Algerine fleet to that formidable condition which it soon after reached; though it is probable the frequent attempts made on their city would also induce them to increase their fleet. In 1616 it consisted of 40 sail of ships between 200 and 400 tons, their flag-ship having 500 tons. It was divided into two squadrons, one of 18 sail, stationed before the port of Malaga, and the other at the cape of Santa Maria, between Lisbon and Seville, both of which attacked all Christian ships, both English and French, with whom they pretended to be in friendship, as well as Spaniards and Portuguese, with whom they were at war.

The Algerines were now become very formidable to the European powers. The Spaniards, who were most in danger, and least able to cope with them, solicited the assistance of England and other states, and of the pope. The French, however, were the first who dared to show their resentment of these outrages; and in 1617 M. Beaulieu was sent against the Algerines with a fleet of 50 men of war, who defeated their fleet and took two of their vessels, while their admiral sunk his own ship and crew rather than fall into his enemies' hands.

In 1620 a squadron of English men of war was sent against Algiers, under the conduct of Sir Robert Mansel; but of this expedition we have no other account than that it returned without effecting any thing; and the Algerines, becoming more and more insolent, openly defied all the European powers, the Dutch only excepted, to whom, in 1625, they sent a proposal directed to the prince of Orange, that in case they would fit out 20 sail of ships the following year, upon any good service against the Spaniards, they would join them with 60 sail of their own.

The next year the *Coulolies* or *Cologlies* (the children of such Turks as had been permitted to marry at Algiers), who were enrolled in the militia, having seized on the citadel, had nearly made themselves masters of the city, but were attacked by the Turks and renegadoes, who defeated them with terrible slaughter. Many of them were put to death, and their heads thrown in heaps

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upon the city-walls, without the eastern gate. Part of the citadel was blown up; and the remaining Coulolies were dismissed from the militia, to which they were not again admitted till long after.

Throw off their dependence on the Porte.

In the year 1623 Algiers and the other states of Barbary threw off altogether their dependence on the Porte. No sooner was this resolution taken, than the Algerines began to make prizes of several merchant ships belonging to powers at peace with the Porte. Having seizéd a Dutch ship and polacre at Scanderoon, they ventured on shore; and finding the town abandoned by the Turkish aga and inhabitants, they plundered all the magazines and warehouses, and set them on fire. About this time Louis XIII. undertook to build a fort on their coasts, in the room of one formerly built by the Marsilians, which they had demolished. This, after some difficulty, he accomplished, and it was called the *Bastion of France;* but the situation being afterwards found inconvenient, the French purchased the port of La Calle, and obtained liberty to trade with the Arabians and Moors. The Ottoman court, in the mean time, was so much embarrassed with the Persian war, that there was no leisure to check the Algerine piracies. This gave an opportunity to the vizier and other courtiers to compound with the Algerines, and to share their prizes, which were very considerable. However, for form's sake, a severe reprimand, accompanied with threats, was sent them; to which they replied, that "these depredations deserved to be indulged to them, seeing they were the only bulwark against the Christian powers, especially against the Spaniards, the sworn enemies of the Moslem name;" adding, that "if they should pay a punctilious regard to all that could purchase peace, or liberty to trade with the Ottoman empire, they would have nothing to do but set fire to all their shipping, and turn camel-drivers for a livelihood."

In the year 1635 four younger brothers of a good family in France entered into an undertaking so desperate, that perhaps the annals of knight-errantry can scarcely furnish its equal. This was no less than to retort the piracies of the Algerines upon themselves, and this with a small frigate of ten guns! In this ridiculous undertaking 100 volunteers embarked: a Maltese commission was procured, together with an able master and 36 mariners. They had the good fortune, on their first setting out, to take a ship laden with wine on the Spanish coast, with which they were so much elated, that three days after they madly encountered two large Algerine corsairs, one of 20 and the other of 24 guns, both well manned, and commanded by able officers. These vessels attacked the frigate so furiously that she soon lost her main-mast; notwithstanding which, the French made so desperate a resistance, that the pirates were not able to take them, till the noise of their fire brought up five more Algerines, when the French vessel, being almost torn in pieces, was boarded and taken. The young knights-errant were punished for their temerity by a dreadful captivity, from which they redeemed themselves in 1642 at the price of 6000 dollars.

Various expeditions.

The Algerines prosecuted their piracies with impunity, to the terror and disgrace of the Europeans, till the year 1652, when a French fleet being accidentally driven to Algiers, the admiral took it into his head to demand a release of all the captives of his nation, without exception. This being refused, the Frenchman without ceremony carried off the Turkish viceroy, and his cadi or judge, who had just arrived from the Porte, with all their equipage and retinue. The Algerines, by way of reprisal, surprised the Bastion of France already mentioned, and carried off the inhabitants to the number of 600, with all their effects; which so provoked the admiral, that he sent them word that he would pay them another visit the next year with his whole fleet.

The Algerines, undismayed by the threats of the French admiral, fitted out a fleet of 16 galleys and galliots, well manned and equipped, under the command of Admiral Hali Pinchinin. The chief design of this armament was to capture the treasure of Loretto, which, however, they were prevented by contrary winds from reaching. They then made a descent on Puglia, in the kingdom of Naples, where they ravaged the whole territory of Necotra, carrying off a vast number of captives. Thence steering towards Dalmatia, they scoured the Adriatic; and, having collected immense plunder, left these coasts in the utmost consternation and resentment.

At last the Venetians, alarmed at such terrible depredations, equipped a fleet of 28 sail, under the command of Admiral Capello, with express orders to burn, sink, or take, all the Barbary corsairs he should meet. An engagement ensued, in which the Algerines were defeated, and five of their vessels disabled, with the loss of 1500 men, Turks and Christian slaves, besides 1600 galley-slaves who regained their liberty. Pinchinin, after this defeat, returned to Valona, where he was again watched by Capello; but the latter had not lain long at his old anchorage before he received a letter from the senate, desiring him to make no further attempt on the pirates at that time, for fear of a rupture with the Porte. The brave Venetian was forced to comply; but resolving to take such a leave of the Algerines as he thought they deserved, attacked them with such bravery, that, without any great loss, his men towed out their 16 galleys, with all their cannon, stores, &c. To conceal this, Capello was ordered to sink all the Algerine ships he had taken, except the admiral's, which was to be conducted to Venice, and laid up as a trophy. Capello came off with a severe reprimand; but the Venetians were obliged to purchase, with 500,000 ducats, a peace from the Porte.

The news of this defeat and loss filled Algiers with the utmost grief and confusion. The whole city was on the point of a general insurrection, when the bashaw and douwan issued a proclamation, forbidding complaints and outcries, under the severest penalties. In the mean time they applied to the Porte for an order that the Venetians settled in the Levant should make up their loss. But with this the grand signior refused to comply, and left them to repair their losses, as well as build new ships, in the best manner they could.

Our pirates did not long continue in their weak and defenceless state; being able, at the end of two years, to appear at sea with a fleet of 65 sail. Admiral Pinchinin equipped four galliots at his own expense, with which, in conjunction with the chiayah, or secretary of the bashaw of Tripoli, he made a second excursion. This small squadron, consisting of five galleys and two brigantines, fell in with an English ship of 40 guns, which, however, Pinchinin's captains refused to engage; but being afterwards reproached by him for their cowardice, they swore to attack the next Christian ship that should come in their way. This happened to be a Dutch merchantman of 28 guns, which, however, beat them off with great loss. But though Pinchinin thus returned in disgrace, the rest of the fleet quickly returned with vast numbers of slaves, and an immense quantity of rich spoils; insomuch that the English, French, and Dutch, were obliged to court the mighty Algerines, who sometimes vouchsafed to be at peace with them, but swore eternal war against Spain, Portugal, and Italy, whom they looked upon as the greatest enemies to the Mahometan name. At last

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Louis XIV., provoked by the grievous outrages committed by the Algerines on the coasts of Provence and Languedoc, ordered, in 1681, a considerable fleet to be fitted out against them, under the marquis du Quesne, vice-admiral of France. His first expedition was against a number of Tripolitan corsairs, who had the good fortune to escape him, and shelter themselves in the island of Scio, belonging to the Turks. This did not, however, prevent him from pursuing them thither, and making such a terrible fire upon them as quickly destroyed fourteen of their vessels, besides battering the walls of the castle.

Algiers bombarded and set on fire by the French.

This severity seemed only to be designed as a check to the piracies of the Algerines; but, finding they still continued their outrages on the French coast, he sailed to Algiers in August 1682, cannonading and bombarding it so furiously, that the whole town was in flames in a very short time. The great mosque was battered down, and most of the houses laid in ruins, insomuch that the inhabitants were on the point of abandoning the place; when on a sudden the wind changed, and obliged Du Quesne to return to Toulon. The Algerines immediately made reprisals, by sending a number of galleys and galliots to the coast of Provence, where they committed the most dreadful ravages, and brought away a vast number of captives; upon which a new armament was ordered to be prepared at Toulon and Marseilles against the next year; and the Algerines, having received timely notice, put themselves in as good a state of defence as the time would allow.

In May 1683, Du Quesne, with his squadron, cast anchor before Algiers; where, being joined by the marquis d'Affranville at the head of five stout vessels, he resolved to bombard the town next day. Accordingly, 100 bombs were thrown into it the first day, which did terrible execution; while the besieged made some hundred discharges of their cannon without doing any considerable damage. The following nights the bombs were again thrown into the city in such numbers, that the dey's palace and other great edifices were almost destroyed; some of their batteries were dismounted, and several vessels sunk in the port. The dey and Turkish bashaw, as well as the whole soldiery, alarmed at this dreadful devastation, sued for peace. As a preliminary, the immediate surrender of all Christian captives who had been taken fighting under the French flag was demanded; which being granted, 142 of them were immediately delivered up, with a promise of sending the remainder as soon as they could be got from the different quarters of the country. Accordingly Du Quesne sent his commissary-general, and one of his engineers, into the town; but with express orders to insist upon the delivery of all the French captives without exception, together with the effects taken from the French; and that Mezomorto, the admiral, and Hali Rais, one of their captains, should be given as hostages.

This last demand having embarrassed the dey, he assembled the douwan, and acquainted them with it; upon which Mezomorto broke out into a violent passion, and told the assembly that the cowardice of those who sat at the helm had occasioned the ruin of Algiers; but that, for his part, he would never consent to deliver up any thing that had been taken from the French. He immediately acquainted the soldiery with what had passed; which so exasperated them, that they murdered the dey that very night, and next day chose Mezomorto in his place. The new dey immediately cancelled all the articles of peace, and hostilities were renewed with greater fury than ever.

The French admiral now kept pouring in such volleys of bombs, that in less than three days the greater part of the city was reduced to ashes; and the fire burnt with such vehemence, that the sea was illumined by it for more than two leagues around. Mezomorto, unmoved at all these disasters, and the vast number of the slain, whose blood ran in rivulets along the streets, or rather growing furious and desperate, sought only revenge; and, not content with causing all the French in the city to be cruelly murdered, ordered their consul to be tied hand and foot, and fastened alive to the mouth of a mortar, whence he was shot away. By this piece of inhumanity Du Quesne was so exasperated, that he did not leave Algiers till he had utterly destroyed their fortifications, shipping, almost all the lower, and above two-thirds of the upper part of the city, by which means it became little else than a heap of ruins.

Treaty with England.

The haughty Algerines were now thoroughly convinced that they were not invincible; they therefore immediately sent an embassy into France, begging in the most abject terms for peace, which Louis immediately granted, to their inexpressible joy. They now began to pay some regard to other nations, and to be a little cautious how they wantonly incurred their displeasure. The first bombardment by the French had so far humbled the Algerines, that they condescended to enter into a treaty with England, which was renewed upon terms very advantageous to the latter in 1686. It is not to be supposed, however, that the rooted perfidy of the Algerines would at once disappear. Notwithstanding this treaty, they lost no opportunity of making prizes of the English ships which they could conveniently reach. Upon some outrage of this kind, Captain Beach drove ashore and burnt seven of their frigates in 1695, which produced a renewal of the treaty five years after; but it was not till the taking of Gibraltar and Port Mahon that Britain could have a sufficient check upon them to enforce the observation of treaties, and they have since paid a greater deference to the English than to any other European power.

The eighteenth century furnishes no very remarkable events with regard to Algiers, except the taking of the city of Oran from the Spaniards in 1708 (which, however, they regained in 1737), and the expulsion of the Turkish bashaw, and uniting his office to that of dey, in 1710.

The increasing naval power of the great European states, in this century, made the Barbary corsairs more cautious in their attacks, which were now chiefly confined to the weaker states in the vicinity of the Mediterranean, particularly those of Naples and Sardinia;—not only attacking their vessels, but making descents upon their shores, and carrying off not only property but also persons of every age, sex, and rank, and disposing of them as slaves. Europe, engrossed by the mightier evils in which it was involved during thirty years of war, bestowed comparatively little attention on this partial distress. At the Congress of Vienna, however, when the peace of the Continent appeared to be established on a permanent basis, the attention of the sovereigns was laudably drawn to every quarter from which it could suffer disturbance. The evil in question, by which numerous individuals, often of a respectable place in society, were torn from their homes, immured in dungeons, and exposed to every outrage, could not fail to appear of the first magnitude. The Congress, having been unexpectedly broken up, did not come to any final decision. The subject, however, continued to be agitated in the councils of Britain, and her gallant officers who had been employed in the Mediterranean strongly represented the propriety of interference. The Dutch, at the same time, her now friendly neighbours, cordially concurred in promoting this common interest of humanity.

The first step taken was to send squadrons under Lord Exmouth to Algiers, and Sir Thomas Maitland to Tunis,

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with a demand for the general liberation of the slaves actually in bondage, and the entire discontinuance, for the future, of this detestable trade. Overawed by the immense power with which they knew these demands to be supported, they returned a conciliatory answer. They dismissed a number of slaves actually in their hands, and engaged that only the final sanction of the Porte should be wanting to abolish for ever the system of Christian slavery. The British commanders then returned to England with their fleets, which were immediately laid up.

Tunis, which had imbibed some portion of European humanity and civilisation, and was better aware of its real interests and position, adhered very tolerably to the terms stipulated. But Algiers, bred in rapine, furiously repelled a system which opened to its rovers the fearful prospect of being obliged to earn a subsistence by honest industry. So dreadful was the ferment, that a plan, it is said, had been formed to assassinate Lord Exmouth on his way to the ship. The dey, raised from the dregs of the soldiery, and sharing all their barbarism, allowed full scope to their violence, and sought only to secure himself against its effects. He formed alliances with the Porte, the emperor of Marocco, and other leading Mussulman potentates; he strengthened Algiers with new works, and prepared to brave the utmost fury of the Christian powers. Under these precautions, the system of Christian piracy was commenced with redoubled activity, to compensate for the late suspension, and to repair the loss of the slaves who had been given up. The Algerine soldiery, in their blind fury, had recourse to an outrage still more terrible. A number of vessels, belonging to Naples and other Mediterranean states, had been in the practice of assembling at Bona to carry on the pearl fishery, in which, upon payment of an annual tribute, they were protected by the Algerine state. Suddenly these peaceful and industrious fishermen were surrounded by a band of Moors, who commenced an indiscriminate massacre, which could not be justified on any ground or pretence, and seems to have had no object but to show their implacable hatred to the Christian name.

Lord Exmouth's expedition.

As soon as the tidings of this dreadful outrage arrived in England, they kindled at once a just indignation, and a determination to follow up to the utmost the measures projected against this common pest of the civilized world. Lord Exmouth's fleet was re-equipped with almost incredible dispatch. Early in July 1816 he sailed with five ships of the line and eight smaller vessels, and arrived at Gibraltar in the beginning of August, when he was joined by a Dutch fleet of six frigates under Admiral Capellen. Having remained at Gibraltar a short time, to make some necessary preparations, Lord Exmouth sent forward Captain Dashwood, of the Prometheus, to bring away, if possible, the consul and his family. Captain Dashwood was strictly interrogated as to Lord Exmouth's armament, of which the dey had received information from a French vessel, and from other quarters. He contrived to evade the questions; and, though he found it impossible to obtain the consul's release, managed to bring off his wife and daughter, disguised in the uniform of naval officers. An attempt was also made to carry off his infant child in a basket, but it betrayed itself by its cries; however, the dey, with unusual humanity, allowed the child to follow its mother. The consul himself was thrown into close confinement. The dey, meantime, was exerting himself in the most extraordinary manner to put the place in a posture of defence. The batteries on the mole, and all other points commanding the harbour, were strengthened and enlarged; and armed men, to the number of forty thousand, were brought in from the surrounding country.

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Lord Exmouth, being detained by calms and contrary winds, did not anchor in front of Algiers till the 26th, when he sent in a flag of truce under cover of the Severn gun-brig, with a peremptory demand of certain conditions, which, however, were extremely moderate. They consisted in the final abolition of Christian slavery—the immediate liberation of all slaves now within the territory of Algiers—the repayment of all ransoms obtained since the commencement of the year—the liberation of the consul and all British subjects now in confinement. On the Severn arriving in front of the mole, the captain of the port came out to meet the English, and invited them to enter the city. Salame, the interpreter, declined, but presented the conditions, demanding that an answer should be sent within an hour. The captain, not without some reason, replied that this was a period wholly inadequate to decide on so important a demand. Hereupon two or three hours were allowed; and two were declared by the captain to be sufficient. Meantime, a favourable breeze having sprung up, Lord Exmouth moved forward his ships to within a mile of the harbour, where he held himself ready for action. Salame waited three hours and a half, when no boat appearing from the land, he steered for the fleet, making signals of the failure of his mission; after which, steps were immediately taken for commencing operations.

Algiers was fortified in the strongest manner, and by all the resources of nature and art. The mole, considered a masterpiece of defensive architecture, was encircled by four batteries, respectively of 44, 48, 66, and 60 guns. All the range of steeps facing the sea, on which the city was built, were covered with batteries, which could keep up a united fire on an assailing fleet. Lord Exmouth, undismayed, bore up into the centre of this mighty line of defence, and placed the Queen Charlotte within fifty yards of the mole,—a bold and happy position, where her own fire was more effective than elsewhere, and many of the principal Turkish guns could not bear upon her. The other ships took their stations in line; while the Dutch squadron, which could not find room in front of the mole, was detached to the flanks, to occupy the fire of batteries which might otherwise have borne on the English. The fleets were placed in this formidable array, yet all was still silent, and the surrounding heights were crowded with spectators, who came as to a show. Lord Exmouth began to hope that the dey was yet to yield, when three shots were fired from the batteries. They were instantly returned, and a fire commenced, as animated and well supported as was ever witnessed. The British navy, pitched against these iron walls, underwent as hard and doubtful a struggle as it had ever maintained against the strongest array of hostile fleets. The atmosphere was filled with so thick a smoke, as to render it impossible for one ship to discern the position of another. About sunset Admiral Milne communicated that his vessel, the Impregnable, had lost 150 killed and wounded, and that he stood in urgent need of a frigate to divert some part of the fire now directed against them. Soon, however, the enemy's efforts began to slacken; the principal batteries were successively silenced; ship after ship caught fire, till the flame spread over the whole fleet, and reached the arsenal; the harbour and bay were illumined by one mighty and united blaze. At ten o'clock, seven hours after the commencement of this hard combat, the destruction of the Algerine naval force was complete; but as some distant batteries still kept up a harassing fire, Lord Exmouth gave the signal to steer out into the bay, which was speedily accomplished.

Next morning Lord Exmouth, confident that the dey was now sufficiently humbled, sent a letter, in which, after enumerating the heavy wrongs which had called forth this signal chastisement, he repeated the moderate terms already offered, adding, that in the event of their being now accepted, three guns should be fired as a signal. This letter was sent in the same boat as the day before, with instructions to wait three hours. As soon as the English boat was seen, another came out having on board the captain of a frigate, who received the letter, and intimated that there was no doubt of its terms being complied with; pretending even that, had a little longer time been allowed the day before, the conflict would have been unnecessary. Accordingly, in an hour and a half three shots were fired, and a boat immediately came out, on board of which were the captain of the port and the Swedish consul. All the demands were granted; and the dey in vain attempted, on various pretexts, to evade or delay their execution. The captives, to the number of 1083, were set at liberty; ransoms amounting to 382,500 dollars were repaid to Sicily and Sardinia; the consul was liberated, and received a compensation for the insults he had endured: in fine, a treaty was signed, by which the dey bound himself to discontinue the practice of Christian slavery, and hereafter to treat prisoners of war according to the established practice of civilized nations.

In this desperate contest the English lost 128 killed and 690 wounded, the Dutch 13 killed and 52 wounded. Lord Exmouth received two slight hurts, and his clothes were cut with several balls. The enemy lost four frigates, five large corvettes, and 30 gun-boats. All their arsenals were consumed, and their principal batteries reduced to a state of ruin. The city also was greatly injured, Salame having counted no less than thirty shots which had passed through the walls of the consul's house.

The Algerines, notwithstanding this severe and merited chastisement, did not long adhere to sentiments of moderation. No time was lost, and no effort spared to place the city in a more formidable state of defence than ever; and they considered themselves again in a condition to set even the great powers at defiance. Annoyances were begun against the French trade; and the consul having made remonstrances on the subject, was grossly insulted. France then declared war, and sent a fleet against Algiers; but the fortifications on the sea-side were so strong, that for more than a year her ships could only prolong an ineffective blockade. At length war on a great scale was resolved on. A large fleet under Admiral Duperre, and a land force of upwards of 30,000 men under General Bourmont, then minister at war, sailed from Toulon in the end of May 1830. After some delay in the bay of Palma in Majorca, this armament reached the coast of Africa, and the troops began to land on the morning of the 14th June, upon the western side of the peninsula of Sidi Ferruch, in the bay of Torre Chica. The disembarkation began at a quarter past four, and continued till twelve. The Algerines at first showed only flying parties of horse, which retreated before the fire of two steam-vessels. Afterwards they opened a somewhat brisk fire from several batteries, which having kept up for several hours, not without some loss on the part of the French, they retreated.

The army continued for some days landing their provisions and stores, with only slight annoyance from flying troops of cavalry. On the 19th, however, the Turkish troops in Algiers being reinforced by the contingents of the beys of Constantine, Oran, and Titterie, a general attack was made with a force of 40,000 or 50,000 men. They advanced, outflanking the French army, and charged with such impetuosity as to penetrate the line at several points. After a very obstinate conflict they were compelled to retreat, and their camp was taken and plundered. The French admit a loss of 60 killed and 450 wounded; and the son of the commander-in-chief died of his wounds.

The Algerine troops renewed their attacks on the 24th and 25th, when, after hard combats, they were again repulsed. The French then advanced upon Algiers; on the 29th the trenches were opened, and at four in the morning of the 4th July the batteries began their fire, which was returned with much vigour. At ten the fort called Emperor, being no longer defensible, was blown up by the enemy, with a tremendous explosion. The French commander took possession of its ruins, where he received a flag of truce: before the close of the day a treaty was concluded for the entire surrender of Algiers; and next day, 5th July, the French flag waved on its forts. Twelve ships of war, 1500 brass cannon, and L.2,028,500 sterling, came into the hands of the conquerors. The Turkish troops were permitted to go wherever they pleased, provided they left Algiers; and the dey chose Naples for his place of retirement, while most of the soldiers desired to be landed in Asia Minor.

The capture of Algiers was celebrated in France with great demonstrations of joy. This was the first military exploit of any brilliancy of which France could boast since the downfall of Napoleon. General Bourmont was raised to the rank of marshal, and Admiral Duperre was promoted to the peerage. The ministry had hoped by this war to render themselves popular with a people so enthusiastically fond of military glory, and to divert the public attention from their mal-administration. But three weeks after the capture of Algiers, the revolution of 1830 dethroned the elder branch of the house of Bourbon, and placed the crown on the head of the Duke of Orleans. On receiving intelligence of this event, the army in Algiers declared in favour of the revolutionists. General Clausel was appointed to succeed Marshal Bourmont, with instructions to reduce to obedience all the provinces dependent on Algiers, and to promote commerce and agriculture by encouraging the settlement of European emigrants. The new governor found himself placed in circumstances requiring the greatest prudence, both in his intercourse with the natives, and in his military operations. The French army, which had not been there three months, was already reduced, by the loss of 15,000 men, killed, wounded, or sick; and from the unsettled state of the country at home, the French government was unable to render him any efficient assistance. The conquerors, instead of attempting to gain the good will of the natives, had destroyed a number of their mosques, seized upon lands set apart for religious purposes, and attempted to introduce their own forms and usages in the place of those of the country,—the consequence of which was that the natives imbibed the greatest abhorrence of their oppressors, whom they looked upon as the enemies of God and their prophet. General Clausel incensed them still more by seizing upon the possessions of the dey, the beys, and the expelled Turks, in direct violation of the conditions on which the capital had been surrendered. Colonists, however, now began to arrive from Europe, particularly from France and Germany, and a model farm was laid out in the vicinity of Algiers for the purpose of instructing the inhabitants in the arts of cultivation. Bona was taken possession of, and an incursion made into the southern province of Titterie, when the troops of the bey were defeated, and Mediah taken. The beys of Titterie and Oran were deposed; the former being sent to France, and a pension of 12,000 francs granted him; and the latter to Alexandria. Clausel established tributary rulers in the provinces, and actively assisted them when attacked by the hostile Arabs, while he severely punished those who were faithless in their engagements to him. Still the war continued. Mediah was evacuated, and Oran abandoned. The French were incessantly harassed by irruptions of hordes of the

Arabs, so that no Frenchman was safe even in the vicinity of the town, and little reliance could be placed on the fidelity of the beys who governed the provinces. In these circumstances a corps of irregular Arab troops was organised; and Clausel entered into an agreement with the bey of Tunis, by which the provinces of Constantine and Oran were transferred to two brothers of the latter, on condition of their paying an annual tribute of a million of francs, and of their doing all in their power to promote the settlement of the French in the country. The French government, however, refused to sanction this treaty, on the ground that the governor had exceeded his powers. General Berthezene was now appointed commander-in-chief of the troops, although Clausel was still allowed to retain the title of governor of the colony. The warlike operations were continued during the ensuing spring and summer (1831), and several expeditions were made into the interior, to chastise the hostile tribes; but on the approach of the French troops, these wild hordes deserted their villages, dispersed themselves over the country, and again collecting, hung upon the rear of the army on its return.

In one of these expeditions (in June 1836) the French having gone to assist the new bey of Mediah whom the inhabitants refused to acknowledge, were attacked in their retreat by a numerous army of nomad tribes, which engaged them in incessant skirmishes, in which a great number of the French were slain. It was no longer possible to keep Belida and Mediah in subjection, and the newly-installed bey was obliged to take refuge in Algiers. In October Bona was surrounded and taken by the Kabyles. There was now no safety but in the town of Algiers; and the government found itself compelled, at the same time, to support the emigrants who had settled there. Agriculture was consequently neglected; and it was necessary to send to France for a supply of provisions, and for fresh troops.

The French government now determined to try the effect of a change in the administration of the colony, and entrusted the civil and military jurisdictions to distinct officers. Accordingly, in the end of the year 1831, Savary, Duke of Rovigo, was sent out as governor with an additional force of 16,000 men, and Baron Pichon was placed at the head of the civil administration of the colony; but in consequence of the conflicts between the two powers, they were both afterwards united in the hands of the governor. The determination of the French government to retain permanent possession of Algiers was now no longer doubtful.[1] The new governor, the Duke of Rovigo, did not disdain to have recourse to fraud and cruelty for the accomplishment of his purpose. Among his exploits was the extirpation of an Arab tribe, on account of a robbery committed by them, when not only the men, but the women and children were massacred in the night time; as were also two Arab chiefs, whom he had enticed into his power by a written assurance of safety. These proceedings still farther exasperated the natives, and those tribes which had hitherto remained quiet now embraced the cause of their countrymen.

About this time Abd-el-Kader first appears as an opponent to the French. For fourteen years, this chief, with a few nomadic Arab tribes, kept in check the forces of one of the most powerful nations of the world. His father, a marabout of the tribe of Hachem, had collected a few of the hostile tribes, and attacked and taken possession of Oran. On this the tribes wished to acknowledge him as their chief: but this, on account of his great age, he declined in favour of his son Abd-el-Kader, who, he said, united in himself all the qualities of intelligence, activity, valour, and piety, necessary to ensure success; farther adding, that in his journey to Mecca, an old *fakir* had predicted that his son would one day become sultan of the Arabs. Abd-el-Kader was born about the beginning of 1807, at the *ghetna* of his father, in the vicinity of Mascara. The *Ghetna* is a seminary where the marabouts instruct the young Arabs in literature, theology, and jurisprudence. Abd-el-Kader early distinguished himself in these branches, and soon acquired great reputation among his countrymen for his learning. Nor did he neglect those manly exercises for which the Arabs are distinguished, but was remarkable for his skill in horsemanship, and in throwing the lance and wielding the yatagan. He made two pilgrimages to Mecca in company with his father, once when only a child, and again in 1828, by which he obtained the title of *Hadji*. On his return he married a female whom he tenderly loved, and by whom he has two sons. He also visited Egypt, for the purpose of observing the civilisation which had been introduced there under Mahomet Ali. At the time that his father was proclaimed emir, he was living in obscurity, distinguished by the austerity of his manners, his piety, and his zeal in observing all the precepts of the Koran. Having resolved to devote himself to the defence of his country, he, by great exertions, collected an army of 10,000 horsemen, with whom, accompanied by his father, he marched to attack the town of Oran, which had been taken possession of by the French. They arrived before the town about the middle of May 1832; but after continuing their attack for three days with great bravery, they were repulsed with considerable loss.

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In this first essay of Abd-el-Kader as a soldier, he is said to have conducted himself with extraordinary bravery. He several times threw himself into the thickest of the fight, to teach the Arabs not to dread the fire of the artillery. This enterprise was followed by a series of contests more or less severe between the parties, without any permanent or decided advantage being gained by either. In March 1833, the Duke of Rovigo was obliged, on account of his declining health, to return to France, and General Avizard was appointed interim governor; but the latter dying shortly afterwards, General Voirol was nominated his successor. Abd-el-Kader was still extending his influence more and more widely among the Arab tribes, and now resolved to subdue the whole province of Mascara. He accordingly marched to Tlemecen, which at that time was in the possession of two separate factions; the Turks occupying the citadel and the Moors the rest of the town. Abd-el-Kader began by attacking the Moors, whose chief soon took to flight, and the inhabitants surrendered the town. He treated them with great kindness, and set a new chief over them; but he was not equally successful with the Turks, who refused to surrender; and not having been able to force the citadel, he returned to Mascara, where he heard with great grief of the death of his father. The French now considered it their interest to offer the emir conditions of peace. A treaty was accordingly concluded with him by General Desmichels, governor of Oran; one of the conditions of

[1] When the French undertook the Algerine expedition, the Duke of Wellington's Ministry insisted upon and obtained from the French court pledges that France did not aim at the permanent possession of Algiers, but only to obtain satisfaction for the injuries and insults she had received, and to put down that system of piracy with which Europe had been so long outraged. The French Ministry engaged that these objects being accomplished, the final settlement and government of the country should be arranged in concert with the other European powers for the general advantage; and the Wellington Cabinet obtained a repetition of these assurances from Louis Philippe and his ministry immediately after their accession. Nevertheless, in the session of 1833, the French Ministry declared that it was the intention of their government to retain possession of Algiers and to colonise it.

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which was, that the emir was to have a monopoly of the trade with the French in corn. This part of the treaty General Desmichels at first endeavoured to keep secret from the government; but they soon heard of it, from the disputes which arose, and the general was consequently removed from his post. Towards the end of 1834, Drouet Count d'Erlon was appointed governor-general of the colony; and under him were appointed a commander of the troops, a commander of the naval forces, and several other officers. Tribunals of justice were also established, by which both French and natives were allowed to enjoy their respective laws. From the tranquil state of the country at this time, the new governor was enabled to devote his attention to its improvement. The French soon became jealous of the power of the emir; and on the pretence that he had been encroaching on their territory, General Trezel, who had succeeded Desmichels in the governorship of Oran, was sent out against him with a considerable force. The two armies met at the River Macta, where the French army was routed with great slaughter on the 28th of June 1835. On the news of this defeat the government resolved effectually to humble Abd-el-Kader, and sent Marshal Clausel to Algiers for that purpose, where he arrived in August 1835. On the 26th November following, he set out, at the head of 11,000 men, for Mascara, which he reached on the 6th of the following month. On his arrival, finding the town totally deserted, he destroyed it, and afterwards returned to Algiers, persuading himself, if we may judge from his bulletins, that he had extirpated the Arab power. Some time after this the emir attacked General d'Arlanges and a company of 3000 men, on the Tafna. The contest was continued for some time with great vigour, but the French troops were at length put to flight. On this General Bugeaud was commissioned to put down the emir either by hostile or pacific measures. Conciliatory means having failed, he attacked the Arabs at the pass of Sikak, on the 6th of July 1836, and gained a complete victory over them; but not having sufficiently followed up this advantage, the emir in a few months had so far recovered himself that the French were fain to conclude a treaty with him, even on terms very advantageous to the Arabs. By the terms of this treaty, Abd-el-Kader was allowed to retain possession of those parts of the country that were already in subjection to him, with liberty to purchase from the French such military stores as he required; while on his side he was bound to acknowledge the sovereignty of France, and to deliver for the use of the French army a stipulated quantity of provisions. This treaty was concluded on the 30th of May 1837. Previous to this, however, Marshal Clausel made an unsuccessful attack upon Constantine. He arrived before the town after a very fatiguing march on the 21st of November 1836, with a force of about 9000 men. After several unsuccessful attacks upon the town, he was obliged to retreat. In this expedition he lost a great number of his soldiers through exhaustion and disease; and this failure occasioned his recal from his government. His successor, general Damremont, arrived on the 3d of April 1837; and after subjecting some tribes of the Kabyles who had revolted, he directed his attention to the capture of Constantine;—for which purpose he collected a force of 12,000 men, partly Europeans and partly natives. With this army he arrived before the town on the 6th of October without encountering any opposition on his march. The town was defended by 6000 or 7000 men, chiefly Kabyles, under the command of Ben Aissa, the deputy of the bey. After a very gallant defence, the town was taken by storm on the 13th of that month by General Vallée, General Damremont having been killed by a cannon ball on the preceding day. On the capture of the city, the neighbouring tribes hastened to make their submission to the conquerors; and a strong garrison being left to defend the town, the army retraced its steps to Bona, where it arrived on the 3d of November. As a reward for his services, General Vallée was made a marshal, and appointed governor-general of the colony. Disputes with the emir as to the boundaries of his territory were very frequent, until at length war was again declared between the parties. The French have endeavoured to fix upon the emir the infringement of both these treaties; but the truth seems to be, that it was occasioned by their jealousy of his growing power; and even some of themselves admit, that he can be accused of no breach of faith, and that, in both instances, the formal violation of the treaties was by the French. The emir, like a good general, had employed those intervals of peace in extending his influence among his subjects, chastising those tribes that refused to acknowledge him, and treating those who submitted to his authority with the greatest kindness. He set rulers and chiefs on whom he could depend over the divisions and subdivisions of his territory, and bestowed the greatest attention on the military training of his subjects.

The immediate cause of the war on this occasion was the marching of an armed force of French troops through the emir's territory. This the latter looked upon as an infringement of the treaty, and consequently declared war. On the 14th of December 1839, he fell upon the French troops in the plain of Metidja, and routing them with great slaughter, took and destroyed their settlements. He even advanced as far as the very walls of Algiers, and soon reduced their possessions to the fortified places which they occupied. On this the French army in Africa was augmented, and numerous skirmishes took place, without any decisive results to either party; the only thing worthy of notice being the gallant and successful defence, for four days, of Fort Mazagran, near Mostagan, by a garrison of 123 men, against from 12,000 to 13,000 of the enemy. The campaign was opened on the part of the French on the 25th of April 1840, when they set out with a considerable force to take possession of the towns of Mediah and Milianah. Although successful, the permanent results of this expedition were comparatively trifling. The garrisons left behind found themselves so surrounded by enemies that they could not trust themselves without their walls; and even when the French arms were successful at a distance, no one could consider himself secure immediately without the walls of Algiers. The French government being dissatisfied with Marshal Vallée's want of success, appointed General Bugeaud as his successor. The new governor-general arrived at Algiers on the 22d of February 1841. On opening the campaign, his first object was to provision Mediah and Milianah. Having accomplished this, he next marched at the head of 11,000 men to Jekedemt, the principal stronghold of Abd-el-Kader. When he arrived there on the 25th of May, he found it abandoned by its inhabitants; on which he ordered it to be destroyed, and the citadel, which had been built by the emir, to be blown up. From hence the general went to Mascara, which he entered on the 30th of the month. In October following, he set out for Laida, the only remaining stronghold in the possession of the emir, which he took, and entirely demolished. These misfortunes of the emir caused numerous defections among his subjects;—none of them now offered any opposition to the French, and several of them became their allies. The region towards the borders of Marocco being still unsubdued, an expedition was sent into that territory in January 1842. On the 30th of that month, they took the town of Tlemecen; and ten days afterwards the fort of Tafrua, which they demolished. The troops of Abd-el-Kader having been almost entirely destroyed by so many misfortunes, he was

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obliged to take refuge in Marocco, and most of his subject tribes now submitted to the French. But Abd-el-Kader was not yet overcome: he appeared again with a small force, and going from tribe to tribe exhorted them, by all they held dear and sacred, to bestir themselves, and by one vigorous effort, to drive the invaders out of their country. By these means he was able to raise a considerable force; and he made up for the want of troops by the rapidity of his movements. He suddenly made an attack upon one part of the French territories, when he was supposed to be in quite a contrary direction, and even advanced to within a short distance of Mascara. An army was accordingly sent out against him, which advanced south as far as the sources of the Taguin, but without coming up to the enemy. On their retreat, however, a conflict took place at Isna, in which the Arabs were defeated, and the emir himself narrowly escaped being taken prisoner. On this the French troops returned to Mascara, in the end of November 1842. The emir now stirred up the Kabyles of Bougie to make an attack upon Cherchell. In this however they were baffled by the energetic proceedings of General Bugeaud, who did not hesitate to go in the middle of winter to the mountainous regions of the Jurjura to quell this insurrection. Though the colony was now in a comparatively quiet and secure state, this had only been accomplished at a vast expenditure of money, amounting to not less than L.60,000,000 sterling, and at a great sacrifice of human life, of which we may in some measure judge from the fact that, in the month of September, independently of the lives lost, out of 80,000 men, as many as 24,000 were lying in the hospitals. It is unnecessary to follow out the remaining struggles of the emir in Algiers. His forces were now so reduced, that he could not cope with the French in the open field, though he did not cease to harass them by incursions into their territories.

The emir was at length reduced to such straits, that he agreed to deliver himself up to the French, on receiving a promise of safety, and of being allowed to retire to Alexandria or to St Jean d'Acre. Notwithstanding this promise, which was given by General Lamoriciere, and ratified by the governor of the colony, the Duke d'Aumale, son of Louis Philippe, he and his suite were embarked at Oran for Toulon, where he arrived on the 29th of January 1848. From Toulon the emir was removed first to the chateau of Paris, and afterwards (in November) to the chateau of Amboise near Boise, where, till very recently, he was detained a prisoner. The emir, in December 1852, left France for Broussa, where he now lives in retirement, and is said to be devoting his time chiefly to reading the Koran, and religious exercises.

Since the removal of Abd-el-Kader from Algiers, the French power may be said to be established in the country; but even now skirmishes are not unfrequent with some of the more unsettled tribes. This possession has as yet turned out to be anything but a profitable speculation for France; and although it has been lately much improved, it is doubtful if, for many years to come, it will compensate for the immense sums of money and the loss of life that it has occasioned to that country.

Government.

Before giving an account of the present government of Algiers, it may be interesting to take some notice of it under the Turks. The bey or pasha, although nominally under the Porte, to whom he annually transmitted some presents, was in reality an absolute monarch. The first Beys were elected by the militia, who were then called the *douwan* or "common council." This body was at first composed of 800 militia officers, but was afterwards reduced to thirty *chiah-bashaws* or colonels, with the *mufti* or high priest, and *cadi*, or chief judge, upon some emergencies; and on the election of a dey the whole militia was allowed to vote. Latterly the power of this court was merely nominal, and it had only to sanction the measures of the dey. The dey rose from the army, and indeed any bold and aspiring soldier might attain that honour, if he succeeded in getting rid of the existing ruler. Thus the dey was continually exposed to attacks, and few of them had the good fortune to die in office. The new dey frequently established his power by causing to be strangled all the officers of the douwan who had opposed his election. Each of the three provinces, exclusive of Algiers, was governed by a bey nominated by the dey. The corsairs or pirates formed a number of small republics, of each of which the *rais* or captain was the supreme bashaw; who, with the officers under him, composed a kind of douwan, in which every question relating to the vessel was decided. These corsairs carried on likewise the commerce of Algiers, importing whatever commodities were brought into the kingdom either as merchandise or as prizes.

At present the country is under a governor-general, who is invested with the chief power in all the civil and military affairs. Each of the provinces has a prefect, under whom are sub-prefects for each of the districts, and under these, a number of native rulers over smaller divisions. Various courts of justice have been established, with a court of appeal in the capital, composed of two chambers—the one for civil, and the other for criminal cases. The natives are also still allowed their own courts and laws; and among the Jews, justice is administered by the rabbis.

Religion.

The Roman Catholic religion was established here in 1838. There is a cathedral in Algiers, and the Catholic worship is performed in almost every town, either in edifices built for the purpose, or in mosques which have been appropriated to that end. The Bishop of Algiers is assisted by four vicars-general, and eight canons, with a number of curates and vicars, amounting in 1849 to 114. There are four Protestant pastors in the country, established at the towns of Algiers, Douera, Blidah, and Oran. The Jews and Turks are also allowed the free exercise of their religious worship.

Education

Considerable attention is paid to education by the establishment of schools and other means. In 1850 there were 68 public, 39 private, and eight infant schools, attended by 9679 scholars, besides Mussulman and Jewish schools. There is also a college at Algiers, the capital; and in 1848 an academy was established there, at the head of which is a rector, who, assisted by an inspector, has the general superintendence of the public instruction.

Medical board.

The medical knowledge of the Arabs is in a very rude state, but latterly the French surgeons have been in great request among them. A medical board has been established near each Arab bureau; and the inhabitants come in great numbers to consult the physicians. Some tribes less subject to national prejudice even bring their wives, and consent that they should be visited by the French practitioners. The patients most seriously affected are received into the military hospitals, when they can surmount the repugnance to enter them. The officers of health likewise make frequent tours to visit the sick in their tents. Vaccination has spread with unexpected success. At first the Arabs refused to present their infants, because they believed that the object of the French was to fix a mark upon them by which they might afterwards recognise them and carry them into France as slaves or as soldiers. This distrust has now been overcome.

The Arab markets were always objects of vigilant surveillance, for it was there that all the reports hostile to the French originated and were propagated. To meet these fomenters of disorder, and to circulate intelligence of the administrative measures of the government, a journal is printed in the Arabic character, and distributed gratis among

Algiers. the chiefs. It is published every fortnight, and is sought after with great avidity; and has already produced the most beneficial effects.

Commerce. From the unsettled state of the country, the restrictions and heavy duties of the French tariff, and the poverty of the people, Algiers has as yet attained little commercial importance. The principal exports of the country are horses and cattle, skins of animals, leeches, wool, wax, coral, tobacco, and minerals. The exports of 1848 amounted in value to L.281,863, of which L.138,484 was the produce of the country, and L.143,379, was the re-exportation of French and foreign merchandise. The following were the proportions of the principal of its exports:—to France, 48·5 per cent.; Spain, 22·8; the Two Sicilies, 7·6; Sardinia, 6·8; England, 5·8; Tuscany, 5·5. The imports of the same year amounted to L.3,419,858, of which nearly a third consisted of cotton and woollen goods, and a fifth of grain. The following countries contributed to its imports as follows, viz.—France, 77·5 per cent.; Tuscany, 5·7; Turkey, 5·7; Spain, 4·9; England, 4·1. Army. The French troops in Algiers in 1850 amounted to 70,771 infantry, and 13,189 cavalry, 6437 native infantry, and 3422 cavalry, with a militia force of 16,407 men.—See *Tableaux de la situation des etablissements Français dans l'Algerie*, 1851.

ALGIERS, the capital of the above territory, is probably the ancient *Icosium;* by the Arabians called *Algezair*, or rather *Al-Jezier* or *Al-Jezerah*, i.e. *the island*, because there was an island before the city, to which it has since been joined by a mole. It is built of white stone, on the declivity of a hill fronting the sea, in the form of an amphitheatre; and from the sea resembles a ship under sail. The houses rise above each other in such a manner that each from its flat roof commands a view of the sea. The streets are so narrow as scarcely to admit two persons to walk abreast. But since the French conquest, about a fourth part of the old town has been superseded by new streets, lined with fine houses, shops, and hotels; and in the centre of the city is the *Place du Gouvernement*, a large and handsome square in the European style. The streets have all received French names; and in a population amounting in 1849 to 97,389, including the garrison, 72,393 were French or other Europeans, the rest Moors, Kabyles, Jews, &c. The town is the seat of a court of appeal and two courts of primary jurisdiction, has a public hospital, a chamber of commerce, library, and museum, a cathedral, and a Protestant church. Many shops have been opened by Europeans, but business is still mostly transacted in the bazaars; which, with barbers' shops and cafés, are the chief places of resort for the natives. Algiers is the residence of the governor-general of the French possessions in Africa, and of the principal functionaries, and courts of justice. It has been newly fortified, and is strongly garrisoned. It is well supplied with water: provisions are generally cheap, except bread, which is dear. Long. 3. 30. E. Lat. 36. 49. N. The harbour of Algiers, at the time of the capture, was rather small, and incapable of accommodating any vessel larger than a middle-sized frigate; but a plan was definitively adopted in 1848, which, when carried out, will render the harbour very capacious. It will be surrounded on the northern side by a breakwater 700 yards long, on the south by one 1200 yards long, and the entrance will be 350 yards wide. Each side of the entrance is to be defended by a strong battery. These improvements are now being effected, and experiments were recently made (1852) to ascertain how far they were satisfactory. Five men-of-war towed by steamers severally entered the port, and cast anchor at a cable's length from each other: a sixth man-of-war and several steamers also entered and anchored; and all these vessels did not encroach upon the space set apart for merchant vessels. It is said that three men-of-war and three steam frigates in addition might have anchored there without inconvenience. It is calculated that the removal of a rock called "Roche sans nom," situated about the middle of the port, will allow a fleet of at least twelve men-of-war and as many frigates to anchor, in addition to the merchant vessels. Orders have been given to have this rock removed forthwith.

Algoa ‖ Alhambra.

ALGOA BAY, or ZWART-KOPS, in Southern Africa, is situated in Long. 26. 53. E. Lat. 33. 56. S. and 425 miles east from the Cape of Good Hope. It lies between Capes Woody and Recife, which are 33½ miles apart; but it is only in the west and north-east parts of the bay that ships may anchor and find shelter. The anchorage of Port Elizabeth on the west side is perfectly secure for six months in the year, during the prevalence of the north-east winds. The bay is much frequented by black whales and seals. There is a lighthouse on Cape Recife.

ALGOL, or $\beta$ *Persei*, a variable fixed star of the second or third magnitude, called *Medusa's Head.* Its position, according to the catalogue of the London Astronomical Society, was, on January 1. 1853, 2 h. 58 m. 37·16 sec.; N. Decl. 49° 36′ 51·76″.

ALGOR is used to signify an unusual coldness in any part of the body.

ALGORITHM, an Arabic word expressive of numerical computation.

ALGUAZIL, in the Spanish polity, an officer whose business it is to see the decrees of a judge executed.

ALHAMA, a city of Spain, in the province of Granada, in Andalucia. It is in a fine valley, enjoys a most salubrious climate, and is surrounded by fields most abundantly productive of wheat and barley. Near it are some medicinal baths of ancient celebrity, to which invalids still resort. Dr Traill found their temperature equal to 118° F. It was a most important fortress when the Moors ruled Granada, and its capture by the Christians was the most decisive step in the reduction of their power. It contains 6500 inhabitants, and is situated in Lat. 37. N. Long. 4. 10. W.

ALHAMBRA, the ancient fortress and residence of the Moorish monarchs of Granada. It derives its name from the red colour of the materials with which it was originally built, Alhambra signifying a red house. It appears to a traveller a huge heap of as ugly buildings as can well be seen, all huddled together, seemingly without the least intention of forming *one* habitation out of them. The walls are entirely unornamented, all of *tapia* or *pisé*, a mixture of fine gravel and clay, formed into huge sun-dried bricks; yet this is the palace of the Moorish kings of Granada, indisputably the most curious place within that exists in Spain, perhaps in the world. In many countries may be seen excellent modern as well as ancient architecture, both entire and in ruins; but nothing to be met with anywhere else can convey an idea of this edifice, except the decorations of an opera, or the tales of the genii.

Passing round the corner of the emperor's palace, one is admitted at a plain unornamented door in a corner. "On my first visit," says Mr Swinburne (*Travels in Spain*), "I confess I was struck with amazement, as I stept over the threshold, to find myself on a sudden transported into a species of fairy land. The first place you come to is the court called the *communa* or *del mesucar*, that is, the *common baths;* an oblong of 165 by 25 feet, with a deep basin of clear water in the middle; two flights of marble steps leading down to the bottom; on each side a parterre of flowers, and a row of orange trees. Round the court runs a peristyle paved with marble: the arches bear upon very slight pillars, in proportions and style different from all the regular orders of architecture. The ceilings and walls are incrustated with fretwork in stucco, so minute and intricate that the most patient draughtsman would find it difficult to follow it, unless he made himself master of the general plan. This would facilitate the operation exceedingly; for all this work is frequently and regularly repeated at certain distances, and has been executed by means of square moulds applied successively, and the parts joined together with the utmost nicety. In every division are Arabic sentences of different lengths, most of them expressive of the following meanings: 'There is no conqueror but God;' or, 'Obedience and honour to our lord Abouabdoulah.' The ceilings are gilt or painted, and time has caused no diminution in the freshness of their colours, though constantly exposed to the air. The lower part of the walls is mosaic, disposed in fantastic knots and festoons. A work so novel, so exquisitely finished, and so different from all that he has ever seen, must afford a stranger the most agreeable sensations while he treads this magic ground. The porches at the ends are more like grotto-work than any thing else to which they can be compared. That on the right hand opens into an octagon vault, under the emperor's palace, and forms a perfect whispering gallery, meant to be a communication between the offices of both houses: at its north end is the most magnificent hall of this palace, *Sala de Gomarez*, intended for the court receptions, and giving audience to ambassadors." Dr Traill found it a square of 456 with a height of between 50 and 60 feet; the walls exquisitely ornamented with costly fretwork of stucco enriched with gilding; and to the height of six feet from the floor, covered with glazed porcelain tiles.

"Opposite to the door of the communa through which you enter, is another leading into the *corte de los leones*, or court of the lions, which is an oblong court, 100 feet in length and 50 in breadth, environed with a colonnade seven feet broad on the sides, and 10 at the end. Two porticoes or cabinets, about 15 feet square, project into the court at the two extremities. The square is paved with coloured tiles, the colonnade with white marble. The walls are covered five feet up from the ground with blue and yellow tiles, disposed checquerwise. Above and below is a border of small escutcheons, enamelled blue and gold, with an Arabic motto on a bend, signifying, 'No conqueror but God.' The columns that support the roof and gallery are of white marble, very slender, and fantastically adorned. They are nine feet high, including base and capital, and eight inches and a half in diameter. They are very irregularly placed; sometimes singly, at others in groups of three, but more frequently two together. The width of the horse-shoe arches above them is four feet two inches for the large ones, and three for the smaller. The ceiling of the portico is finished in a much finer and more complicated manner than that of the communa, and the stucco is laid on the walls with inimitable delicacy: in the ceiling it is so artfully frosted and handled as to exceed belief. The capitals are of various designs, though each design is repeated several times in the circumference of the court; but not the least attention has been paid to placing them regularly or opposite to each other. Not the smallest representation of animal life can be discovered amidst the varieties of foliages, grotesques, and strange ornaments. About each arch is a large square of arabesques, surrounded with a rim of characters, generally consisting of quotations from the Koran. Over the pillars is another square of exquisite filigree work. Higher up is a wooden rim, or kind of cornice, as much enriched with carving as the stucco that covers the part underneath. Over this projects a roof of red tiles, the only thing that disfigures this beautiful square. This ugly covering is a modern addition made by a late prime minister, who a few years ago gave the Alhambra a thorough repair. In Moorish times the building was covered with large painted and glazed tiles, of which a few are still to be seen. In the centre of the court are twelve ill-made marble lions, their fore parts smooth, their hind parts rough, which bear upon their backs a polygonal basin, $15\frac{1}{2}$ feet in diameter, out of which rises a lesser basin. While the pipes were kept in good order, a great volume of water was thrown up, which, falling down into the basins, passed through the lions, and issued out of their mouths into a large reservoir, where it communicated by channels with the *jets d'eau* in the apartments. This fountain is of white marble, embellished with many festoons and Arabic distiches.



"Passing along the colonnade, and keeping on the south side, you come to a circular room occupied by the men as a place for drinking coffee, &c. A fountain in the middle refreshed the apartment in summer. The form of this hall, the elegance of its cupola, the cheerful distribution of light from above, and the exquisite manner in which the stucco is designed, painted, and finished, exceed all power of description. Every thing in it inspires the most pleasing, voluptuous ideas; yet in this sweet retreat, it is said that Abouabdoulah assembled the Abencerrages, and caused their heads to be struck off into the fountain. Continuing your walk round, you are next brought to a couple of rooms at the head of the court, which are supposed to have been tribunals, or audience-chambers.

"Opposite to the *sala de los Abencerrages* is the entrance into the *torre de las dos hermanas*, or the tower of the two sisters; so named from two very beautiful pieces of marble, laid as flags in the pavement. This gate exceeds all the rest in profusion of ornaments, and in the beauty of the prospect it affords through a range of apartments, where a multitude of arches terminate in a large window open to the country. In a gleam of sunshine, the variety of tints and lights thrown upon this enfilade are uncommonly rich. The first hall is the concert-room, where the women sat: the musicians played above in four balconies. In the middle is a *jet d'eau*. The marble pavement is equal to the finest existing, for the size of the flags and evenness of the colour. The *two sisters*, which give name to the room, are slabs that measure 15 feet by seven and a half, without flaw or stain. The walls, up to a certain height, are mosaic, and above are divided into very neat compartments of stucco, all of one design, which is also followed in many of the adjacent halls and galleries. The ceiling is a fretted cove. To preserve this vaulted roof, as well as some of the other principal cupolas, the outward walls of the towers are raised ten feet above the top of the dome, and support another roof over all, by which means no danger can ever be caused by wet weather or excessive heat and cold. From this hall you pass round the little myrtle garden of Lindaraxa, into an additional building made to the east end by Charles V. The rooms are small and low. His favourite motto, *Plus outre*, appears on every beam. This leads to a little tower projecting from the line of the north wall, called *el tocador*, or the dressing-room of the sultana. It is a small square cabinet, in the middle of an open gallery, from which it receives light by a door and three windows. The look-out is charming. In one corner is a large marble flag, drilled full of holes, through which the smoke of perfumes ascended from furnaces below; and here, it is presumed, the Moorish queen was wont to sit to perfume herself. The emperor caused this pretty room to be painted with representations of his wars, and a great variety of grotesques, which appear to be copies, or at least imitations, of those in the loggie of the Vatican. From hence you go through a long passage to the hall of ambassadors, which is magnificently decorated with innumerable varieties of mosaics, and the mottoes of all the kings of Granada. This long narrow antichamber opens into the communa on the left hand, and on the right into the great audience-hall in the tower of Comares; a noble apartment, 36 feet square, 36 high up to the cornice, and 18 from thence to the centre of the cupola. The walls on three sides are 15 feet thick, on the other nine; the lower range of windows 13 feet high. The whole wall is inlaid with mosaic of many colours, disposed in intricate knots, stars, and other figures. In every part various Arabic sentences are repeated.

"Having thus completed the tour of the upper apartments, which are upon a level with the offices of the new palace, you descend to the lower floor, which consisted of bed-chambers and summer-rooms: the back stairs and passages, that facilitated the intercourse between them, are without number. The most remarkable room below is the king's bed-chamber, which communicated by means of a gallery with the upper story. The beds were placed in two alcoves, upon a raised pavement of blue and white tiles; but as it was repaired by Philip V. who passed some time here, its former appearance can only be conjectured. A fountain played in the middle, to refresh the apartment in hot weather. Behind the alcoves are small doors that conduct to the royal baths. These consist of one small closet with marble cisterns for washing children, two rooms for grown-up persons, and vaults for boilers and furnaces that supplied the baths with water, and the stoves with vapours. The troughs are formed of large slabs of white marble; the walls are beautifully adorned with party-coloured earthen ware; and light is admitted by holes in the coved ceiling.

"Hard by is a whispering gallery, and a kind of labyrinth, said to have been made for the diversion of the women and children. One of the passages of communication is fenced off with a strong iron grate, and called *the prison of the Sultana;* but it seems more probable that it was put up to prevent any body from climbing into the division allotted to the women.

"Under the council-room is a long slip, called *the king's study;* and adjoining to it are several vaults, said to be the place of burial of the royal family. In the year 1574 four sepulchres were opened; but as they contained nothing but bones and ashes, they were immediately closed again."

This description of the Alhambra may be finished by observing how admirably every thing was planned and calculated for rendering this palace the most voluptuous of all retirements; what plentiful supplies of water were brought to refresh it in the hot months of summer; what a free circulation of air was contrived, by the judicious disposition of doors and windows; what shady gardens of aromatic trees; what noble views over the beautiful hills and fertile plains. "Alhambram," said the Italian, Peter Martyr, when he entered it in the train of the Gothic conquerors, "proh dii immortales! qualem regiam! unicam in orbe terrarum crede!" No wonder the Moors regretted Granada! no wonder that they still offer up prayers to God every Friday for the recovery of this city, which they regard as a terrestrial paradise!

ALHAURIN EL GRANDE, so called to distinguish it from a neighbouring village of the same name, a town of Spain, in the province of Malaga, 12 miles south-west of the town of that name. It is a favourite summer resort of the inhabitants of Malaga. Pop. 5514.

ALHAZEN, an Arabian author of the eleventh century, who is better entitled to the appellation of philosopher than most of those of his countrymen by whom it has been obtained. The place of his birth was Bassora; the year uncertain; but his death took place at Cairo in 1038. There was another author of the same name, who translated the *Almagest* of Ptolemy; but that writer lived during the reign of the caliph Almamun. In some accounts of Alhazen we find it said that he lived chiefly in Spain; but it appears from Casiri (*Bibl. Arabico-Hispana Escurialensis*), that after he had left his native city, Egypt was his place of residence. It also appears that he was invited to that country by one of the Fatemite caliphs, on account of some boasts which he had made of being able to obviate the evils attendant upon the alternate overflowing and decrease of the waters of the Nile. He surveyed the country with a view to this project, to aid which, every thing that he asked was liberally furnished by the caliph; but finding that his imagination had seduced him into a wild and impracticable scheme, he feigned madness, thereby to avoid the punishment which he dreaded; and he continued to play this humiliating part till the caliph's death relieved him from his apprehensions.



But, whatever figure he may have made as a projector, there can be no doubt that he was a skilful geometrician, and that his name deserves a conspicuous place among the improvers of the science of optics. He was not a mere compiler from the ancients, or commentator upon their works: he followed the bent of his own genius; and, striking into the right path of experiment and observation, his inquiries were productive of a real accession to the stock of knowledge, in regard to some of the most interesting phenomena of nature. He refuted the error of the ancient philosophers that vision was produced by rays emitted from the eye. He gave the first sensible explanation of the cause of the apparent increase of the sun and moon when seen near the horizon; showing that this is occasioned by their being then supposed, owing to the number of intermediate objects, to be at a greater distance from the spectator. He was the first who applied the laws of refraction to show how the heavenly bodies are sometimes seen as if above the horizon when still below it; and who, in the same way, explained the cause of the morning and evening twilight;—of that beneficent provision of nature by which the glories of day are made gradually to approach, and gradually to withdraw. These dioptrical discoveries of the Arabian philosopher have furnished M. Bailly with one of the many fine passages which embellish his celebrated work on the history of Astronomy. —*Astron. Moderne*, liv. vi., sec. 20.

As a writer, Alhazan is censurable for unmeaning prolixity and scholastic subtilty. It appears from Casiri that his works were numerous; but only two of them have been printed, namely his treatise on *Optics*, and that on the *Twilight*. They were both published in Latin in 1572, by Frederic Risner, under the title of *Opticæ Thesaurus.*

ALHUCEMAS. See Alucemas.

ALI, the son of Abu Taleb, is one of the most celebrated characters in Mahometan history. He was cousin to Mahomet, and at the age of fourteen engaged with youthful ardour in his cause. When Mahomet first revealed his prophetic character to his friends, and inquired who among them would undertake to be his companion, Ali exclaimed, "O prophet, I will be thy attendant; the man who dares to rise against thee I will break his legs, pluck out his eyes, dash out his teeth, and even rip up his belly." Mahomet accepted his services, and honoured him with the titles of brother, vicegerent, and Aaron to a new Moses. He was remarkable both for eloquence and valour; and the latter obtained him the surname of "*the Lion of God, always victorious.*" He succeeded to the chief dignity of the renowned house of Hashem, and was also hereditary guardian of the temple and city of Mecca. Mahomet gave him his daughter Fatimah in marriage, and the grandfather lived to embrace the children of his daughter. These advantages induced Ali to cast a wistful eye towards the regal succession: however, Abubeker, Omar, and Othman, reigned before him. But after the death of the latter he was saluted caliph by the chiefs of the tribes, and companions of the prophet, when he was repairing to the mosque of Medina at the hour of prayer, A.D. 656, Hegira 35.

Ayesha, the widow of the prophet, strenuously opposed his succession; and under her influence two powerful chiefs soon raised the standard of rebellion. Ali greatly increased his difficulties by the imprudent removal of all the governors of provinces from their stations. Telha and Zobeir, two chiefs of great influence, collected a numerous army, and induced Ayesha to attend them to the field of battle; but Ali gained a complete victory, and took Ayesha prisoner. Telha fell on the field, and Zobeir was assassinated after surrendering upon promise of quarter. This dastardly action was severely reprehended by Ali. He likewise kindly treated the captive widow, and sent her back to the tomb of the prophet.

Ali next attacked Moawiyah, who had been proclaimed caliph, and was strongly supported by a powerful and numerous party. When the two armies approached each other, Ali proposed to decide the matter by single combat; but to this his opponent would not agree. Several skirmishes were fought with considerable loss on both sides; but at length a "pious fraud" produced a division of sentiment in the army of Ali. They fixed to the points of lances a number of copies of the Koran, carried them before the troops, and exclaimed, "This is the book which forbids Mussulmans to shed each other's blood, and ought therefore to decide our disputes." Ali was constrained to yield, and umpires were mutually chosen; on the side of Ali, Abu Moussa; Amrou, the conqueror of Egypt, on the part of Moawiyah. The day of final decision arrived. Abu Moussa ascended the pulpit, and cried, "As I draw this ring from my finger, so I depose both Ali and Moawiyah from the caliphate." When Amrou ascended, he cried, "As I put on this ring, so I invest Moawiyah with the caliphate, and also depose Ali." He also added, that Othman, the former caliph, had declared Moawiyah both his successor and avenger. Thus began that memorable contest among the Mahometans which was long agitated with considerable violence by both parties.

Ali was highly enraged at this injustice, but, constrained for the present to yield, he retired to Kufa. A sect of enthusiasts, called the *Kharejites*, revolted against Ali; but he quickly reduced them to subjection, and again obtained possession of Arabia. But Syria, Persia, and Egypt, fell to the share of his rival.

An unexpected event terminated the existing disputes. Three Kharejites one day conversing together concerning the blood which had been shed, and the impending calamities, resolved to assassinate Ali, Moawiyah, and Amrou, the three authors of the present disasters. They provided themselves with poisoned swords, and hastened to accomplish their purpose. Moawiyah was wounded, but the wound did not prove fatal. A friend of Amrou fell in his stead. Ali was fatally wounded at the door of the mosque; and in the 63d year of his age, he expired on the fifth day after his wound, A.D. 661.

Ali had eight wives besides Fatimah, and left a numerous family, who were very remarkable for their valour. He also rose to high eminence for learning and wisdom; and of his works there are still extant a hundred maxims, a collection of verses, and a prophecy of all the great events which are to happen to the end of time.

The Mussulmans term Ali *the heir of Mohomet and the accepted of God;* and his particular followers have possessed various states in Africa and Asia, and the Persian part of the Usbek Tartars; and some sovereigns of India are at present of the sect of Ali. A monument is raised upon his tomb near Kufa, which the kings of Persia have successively decorated and religiously revered. Near the ruins of Kufa, a city named Meshed Ali has been built to his memory. Some of his deluded followers imagine that he is still alive, and that he will revisit the earth and fill it again with justice. A green turban still continues to distinguish the descendants of Ali.



Ali, a town of Sicily, at the mouth of the river of the same name, 15 miles S.S.W. of Messina. It has sulphurous baths of some celebrity, and contains 1300 inhabitants.

Ali *Bey*, an eastern adventurer, is said to have been a native of the Caucasus, and about the age of twelve or fourteen to have been sold for a slave in Cairo. The two Jews who became his masters presented him to Ibrahim, then one of the most influential men in the kingdom. In the family of Ibrahim, he received the rudiments of literature, and was also instructed in the military art. Both in letters and military skill he made rapid improvement. He gradually gained the affection of his patron to such a degree that he gave him his freedom, permitted him to marry, and promoted him to the rank of governor of a district. Afterwards he was elected to the elevated station of one of the governors of provinces. Deprived of his protector by death, and engaging in the dangerous intrigues that pave the way to power in that unstable government, he procured his own banishment to Upper Egypt. Here he spent two years in maturing his schemes for future greatness; and in 1766, returning to Cairo, he either slew or expelled the beys, and seized the reins of government.

Emboldened by success, he rescued himself from the power of the Porte, coined money in his own name, and assumed the rank of sultan of Egypt. Occupied in more important concerns, the Porte made no vigorous opposition to his measures, and Ali seized this opportunity to recover a part of the Said, or Upper Egypt, which had been taken possession of by an Arab sheik. He next sent out a fleet from Suez, which seizing upon Djedda, entered the port of Mecca; while a body of cavalry, commanded by Mohammed Bey, his favourite, took and plundered Mecca itself. Having formed an alliance in 1770 with one Sheik Daher, a rebel against the Porte in Syria, he aimed at the conquest of all Syria and Palestine. He first endeavoured to secure Gaza: then his army, forming a junction with that of Daher at Acre, advanced to Damascus. There on the 6th of June 1771 a battle was fought with the Turkish pashas, and Mohammed and Daher, Ali's generals, routed them with great slaughter. They instantly took possession of Damascus, and the castle itself had also capitulated, when all on a sudden Mohammed hastened back to Egypt with all his Mamelukes. Some ascribe this strange conduct to an impression made upon Mohammed by the Turkish agents, and others to a report of the death of Ali Bey.

Although unsuccessful, Ali never lost sight of his favourite object; and Mohammed, losing his confidence, was forced to save his life by exile. Mohammed, however, quickly returned with an army, and drove Ali Bey from Cairo. In this unfortunate state of affairs Ali fled to Daher, and, combining their forces, they attacked the Turkish commander at Sidon, and came off victorious, although the Turkish army was three times their number. After a siege of eight months, they next took the town of Jaffa. Deceived by letters from Cairo, which were only intended to ensnare him, and stimulated with recent victories, he returned to Cairo. Entering the deserts which divide Gaza from Egypt, he was furiously attacked by a thousand chosen Mamelukes led on by Murad Bey, who was enamoured with the beauty of Ali's wife, and had obtained the promise of her, provided that he could take Ali captive. Murad wounded and made Ali prisoner, and carried him up to Mohammed, who received him with affected respect; but in three days, either from the effects of poison or of his wounds, Ali breathed his last.

ALI PACHA. See Albania.

ALIAS, signifying *at another time*, is used in judicial proceedings to connect the several names of a person who attempts to conceal his true name, or to pass under a feigned one; as Smith alias Jones, James alias John.

ALIBI, in *Law*, denotes the absence of the accused from the place where he is charged with having committed a crime; or his being *elsewhere*, as the word imports, at the time specified.

ALICANTE, a city of Spain, in the new province of the same name, with a port on the Mediterranean Sea. The city forms a half moon on the sea-shore, and is defended by a castle built on a rock about 400 feet in height; and the bay in which vessels are anchored is well protected by various batteries. The commerce of this port, though still considerable, has much declined during the last eight or ten years. Two lakes on the coast furnish a large supply of salt made by spontaneous evaporation, which is shipped chiefly to England and Sweden. A fertile plain called the Huerta, near the city, which has been furnished with the means of irrigation at a vast expense, is covered with vines which produce excellent wines and raisins; with mulberry trees, which rear silk-worms; and with great quantities of almonds, olives, and figs, that supply articles for foreign commerce. On the coast near this city, the island of Plana, a barren rock, supplies the most beautiful marbles in great variety. The coast furnishes large quantities of barilla, which is one of the most important branches of the commerce of the city. As the exportable commodities engage the principal attention of the agriculturists, the quantity of corn grown is insufficient for the consumption of the city and its vicinity, though rice might be raised in great quantity; and the wheat is brought partly from La Mancha, and partly by sea from Africa and from Italy. The castle of Alicante is in Long. 0. 30. 51. W. and in Lat. 38. 20. 41. N. This city contains 1 cathedral, 3 parish churches, 6 hot springs, and 19,000 inhabitants. It is the seat of a bishop, and has manufactories of linen and woollen cloths, and of esparto matting. The harbour is but a road-stead in a deep bay, and only small vessels approach the quay. English and other European consuls reside here.

ALICATA, a city of Sicily, in the intendancy of Calatanisera. It is a seaport and a parliamentary city at the mouth of the river Salso, from which corn, fruit, and sulphur are exported. There is a roadstead, but no harbour. It contains 13,465 inhabitants. Near it are vestiges of the ancient city of Gela.

ALICUDI, one of the Lipari Isles.

ALIEN, obviously derived from the Latin *Alienus*, is the technical term applied by British constitutional law to any one who does not enjoy the privileges of a British subject. In all powerful and independent nations the right of citizenship has been restricted and guarded with more or less jealousy. Fears have been entertained that foreigners would obtain it for the purpose of undermining the institutions of the state receiving them, or of bringing it under the subjection of the government to which they originally belonged. But, generally, the jealousy against communicating the privileges of citizenship to foreigners has its foundation in mistaken views of political economy. It arose from the impression that the produce of the energy and enterprise of any community is a limited quantity, of which each man's share will be the less the more competitors there are; superseding the just view that the riches of a state depends on the number and energy of the producers. Thus the skilled workmen who would increase its riches have often been jealously kept out of a country. But, on the other hand, special temptations, including the gift of citizenship, have often been offered to skilled foreigners, by states desiring to acquire them as citizens. Britain has occasionally received industrious and valuable citizens driven forth by the folly or tyranny of other powers, as in the memorable instance of the revocation of the edict of Nantes which sent the Spitalfield colony, and many other Frenchmen, to this country. Looking on the full benefit of British citizenship as a transcendent boon, the principle of our older legislation on the subject has been to allow foreigners to possess at least a portion of it. There never existed in Britain a law so harsh as the *Droit d'Aubaine* of France, which confiscated to the crown all the property of a deceased alien. The courts of justice have ever been opened to them, and they have thus been entitled to protect themselves from any inequalities which do not apply to them by special law. Whether an alien can be sent furth of the realm by exercise of the crown's prerogative, is questioned. Though this is often spoken of as a power of the crown, subsidiary to that of declaring war against foreign nations, yet there is no known writ or form by which it could be enforced, against which a foreigner might not seek the protection of the law. On this ground it was felt that there would have been difficulty in dealing with the person of Napoleon, could his friends have brought him on British soil. The prerogative has been so far practically doubted, that whenever it has seemed necessary to extrude foreigners, a special act of Parliament has been obtained for the purpose. Thus, during the continental convulsions of 1848, a temporary act was passed for the removal of any foreigners whose presence might be dangerous to the peace of the country. A return to parliament in 1850 showed that this act had not been enforced in a single instance.



Our law, save with the special exceptions mentioned afterwards, admits to the privileges of subjects all who are born within the British dominions. In the celebrated question of the *post-nati* in the reign of James I. of England, it was found, after solemn trial, that natives of Scotland born before the union of the crowns were aliens in England, but that those born subsequently enjoyed the privileges of English subjects. A child born abroad, whose father or whose grandfather on the father's side was a British subject, may claim the same privilege, unless at the time of his birth his father was a traitor or felon, or engaged in war against the British empire (4th Geo. II. c. 22). Owing to this exceptional provision, some sons of Jacobite refugees born abroad, who joined in the rebellion of 1745, were admitted to the privilege of prisoners of war, because as the conduct of their fathers deprived them of the privileges of citizenship, they were not to be liable to its burdens. The main characteristic disabilities to which aliens have been subjected have been, incompetency to exercise political privileges, such as that of electing or being elected to sit in Parliament, and incapacity to hold landed property. The privilege of sitting in a jury has been counted among the political rights from which they are excluded; but when a foreigner is on trial, he has, in England, the privilege of the jury *medietatæ linguæ*, in which half the panel consists of foreigners. In Scotland it seems to be questioned if aliens are excluded from the privilege of voting on occupancy. The application of the restriction against holding property, to land and not to moveable effects, is the natural progeny of the feudal system, which attributed allegiance or fealty to land tenures.

Many of the special disabilities to which aliens were subject under the Navigation Act and other laws connected with our old restrictive commercial policy, have been removed or neutralised by the free trade measures of later years. Some of the disabilities of aliens have been by special laws applied to natural born subjects, as in the instance of Jews and Catholics. It was long a question in England whether a Jew could by the common law hold landed property. On the other hand, some of the privileges of citizenship have been specially communicated to persons coming naturally within the classification of aliens. As, for instance, to foreign seamen, on their serving two years in time of war on board a British ship under proclamation, and to foreign Protestants serving two years in the army in an American colony, or being three years employed there in the whale fishery, and not absenting themselves from the British dominions for more than a year (13th Geo. II. c. 3, 20th Geo. II. c. 44). Acts have, from time to time, been passed for regulating the manner in which aliens are bound to conduct themselves, and defining the extent of their privileges. The latest of these was passed in 1836, and amended in 1844 (6th and 7th Will. IV. c. 11, and 7th and 8th Vict. c. 66). By the former act masters of vessels required to intimate the arrival of all aliens, who were bound to have their names registered and to obtain certificates of registration. It is believed that these conditions, of a similar character to those contained in previous acts, have seldom been complied with or enforced. The act of 1844 was a considerable relaxation of the alien law. It communicated to the children born abroad of a British mother the privilege of acquiring land by purchase or succession. It gives friendly aliens the privilege of holding leases for any time not exceeding twenty-one years. Before this act the rights of citizenship could only be conferred on aliens by statute; and it was enacted at the commencement of the Hanover succession, that no private naturalisation bill should be brought in unless it contained a clause disqualifying the person it applied to from being a privy councillor or a member of Parliament, and from holding any office, civil or military, and from being a freeholder; but this restriction is repealed by the Act of 1844. Limited privileges could formerly be given by the sovereign's letters of denization; but by the act of 1844, an alien intending to reside and settle in Britain, may on application by memorial to the Home Secretary, obtain a certificate, giving him all the rights of a natural born subject, except those of eligibility as a privy councillor or a member of Parliament, along with any other exceptions specially set forth in the certificate. See farther, ALLEGIANCE; INTERNATIONAL LAW. (J. H. B.)

*ALIEN Priories*, a kind of inferior monasteries, formerly very numerous in England, and so called from their belonging to foreign abbeys.

ALIENATION, in *Law*, denotes the act of making over a man's property in lands, &c., to another person.

*ALIENATION in Mortmain*, is the making over of lands, &c., to a body politic, or to a religious house.

ALIMENT, in the *Law of Scotland*, is the reciprocal obligation of parents and children to contribute to each others' maintenance. It also indicated a similar obligation of other parties, as of creditors to imprisoned debtors, &c.

ALIMENTARIA LEX, was an old Roman law, whereby children were obliged to find sustenance for their parents.

ALIMENTARII PUERI, &c., were certain children publicly maintained and educated by the munificence of the Roman emperors. This was first done by Nerva, and afterwards by Trajan and Adrian. Antoninus Pius did the same for a number of girls, at the solicitation of Faustina; and hence, in some medals of that empress, we read PVELLAE FAVSTINIANAE.—Alexander Severus did the like at the request of Mammæa; and the maids thus educated were called *Mammæanæ*.

*ALIMENTARY Duct* or *Canal*. See ANATOMY.

ALIMENTS. See DIETETICS.

ALIMONY is usually applied in law to the proportion of allowance for maintenance that a wife is entitled to out of her husband's estate, on a legal separation, when not occasioned by her elopement or adultery.

ALIPILARIUS, or ALIPILUS, in *Roman Antiquity*, a servant belonging to the baths, whose business it was, by means of waxen plasters, and an instrument called *volsella*, to take off the hair from the arm-pits, arms, legs, &c., this being deemed a point of cleanliness.



ALIPTERIUM, ἀλειπτήριον, in *Antiquity*, a place in the ancient *palestræ*, where the *athletæ* were anointed before their exercises.

ALIQUANT PART, in *Arithmetic*, is that number which cannot measure any other without some remainder. Thus, 7 is an aliquant part of 16; for twice 7 wants two of 16, and three times 7 exceeds 16 by 5.

ALIQUOT PART, is that part of a number or quantity which will exactly measure it without any remainder. Thus, 2 is an aliquot part of 4, 3 of 9, 4 of 16, &c.

ALISON, REV. ARCHIBALD, author of essays on the Nature and Principles of Taste, was born at Edinburgh on the 13th November 1757. His father was the second son of Alexander Alison, Esq. of Newhall, an ancient family near Cupar in Forfarshire, and who having come to reside in Edinburgh, was for two years Lord Provost. Alison Square, near Nicolson Street, was called after him. The future essayist on taste, who was his third son, evinced an early and decided turn for literary pursuits, which led to his being sent at the early age of twelve to Glasgow College, where his talents procured for him a presentation to one of the bursaries from that university to Baliol College, Oxford, which determined his choice of the Church of England as a profession. There also he formed a friendship with Dugald Stewart, who afterwards became so celebrated as a metaphysician, which continued unbroken through the whole of life.

At Oxford he soon distinguished himself, and gained high honours. He there formed an intimacy with several men who afterwards became remarkable, particularly Mr, afterwards Sir William Jones, and Dr Matthew Baillie. There also he became acquainted with Mr William Gregory, son of Dr John Gregory, professor of the theory of medicine in the university of Edinburgh, who was also studying for the English Church; and this induced a friendship with his family, which led to the most important event in Mr Alison's life—his marriage in 1780 to Dorothea, youngest daughter of Dr Gregory, professor of the theory of physic in the university of Edinburgh, and sister of the Dr James Gregory whose talents afterwards rendered him so celebrated in that university.

Mr Alison's first ecclesiastical preferment was the curacy of Brancepeth near Durham, which he held from 1778 to 1780. His marriage with Miss Gregory, however, introduced him to Sir William Pulteney, of whose only daughter and heiress, Lady Bath, she was an intimate friend; and Sir William in consequence bestowed on him first the curacy of Sudbury in Northamptonshire, and afterwards the livings of High Ercall, Roddington, and Kenley, in Shropshire; at the last of which he lived in tranquillity and happiness, in the enjoyment of the highest domestic felicity, till 1800, when he removed for the education of his family to Edinburgh. In 1798 he was made a dignitary of the Church as one of the prebendaries of Sarum. The first edition of of his *Essays on Taste* was published in 1784; but though admired in the highest degree by a limited circle of men of taste and refinement, it did not, from being printed in quarto, in an expensive form, obtain, in the first instance, the general circulation which it ultimately attained.

In May 1800 he moved from Shropshire to the vicinity of Edinburgh, and obtained the situation of senior incumbent of St Paul's Chapel, Cowgate, there. There his great talents and eloquence as a preacher soon attracted universal attention, and caused that chapel, which held 1500 persons, speedily to overflow in every quarter with a congregation of the very highest caste which the metropolis could boast. On the days of national fast and thanksgiving, in particular, which occurred annually, and often more frequently at that period, the chapel was always crowded to suffocation with the *elite* of rank and talent in the city who flocked to listen to the highest specimens of pulpit oratory which the country could boast.

In 1809 a new edition of the *Essays on Taste*, in octavo, was published with considerable additions, which elicited a very able and flattering review from the pen of Lord Jeffrey, one of the ablest he ever wrote, in the Edinburgh Review, which at once brought it in into general notice. Since that period it has gone through five editions, and the copyright having expired, it has received the most unequivocal proof of general popularity in having been published in a cheap form, at the moderate price of 2s. 6d., which has brought it within the reach of all classes of readers. Whatever opinions philosophers may entertain on the abstract principles this work contains, whether beauty is to be resolved, as Mr Alison thinks, into the expression by material objects of the qualities of mind, or is itself an inherent quality of certain combinations of matter, as others suppose; all must agree in the beauty of its ideas, and the eloquence with which it is written, and join in the wish of its gifted author, with which it concludes, "that the world we inhabit is to be regarded, not as the abode merely of human passions or human joys, but as the temples of the living God, in which praise is due, and where service is to be performed."

Mr Alison's celebrity as a preacher led his friends, in 1814, to join in an earnest request that he would give some of his discourses in a durable form to the world; and to this he at length, with much reluctance, consented. They appeared, and at first met with eminent success. The first edition of 6000 copies was sold in a few weeks, and four subsequent editions of them, nearly of equal magnitude, speedily followed. The author, ere long, had the gratification of receiving the most decisive proof of the wide spread of their popularity, by receiving copies of two editions of them printed beyond the Allegany Mountains. Their subsequent reputation, however, has not kept pace with this early celebrity, chiefly from their relating to matters of transient and historical interest, and speaking more to the feelings and the heart rather than the intellect or the conscience. The most competent judges, however, among whom may be named Lord Brougham, have pronounced several of them, especially the one on autumn, as among the most finished models of composition in the English language; and Lord Jeffrey concluded his eloquent review of them with the words, "We cannot help envying Mr Alison the power of uniting so much wisdom to so much eloquence, and giving us in this same work the highest gratifications of taste, and the noblest lessons of virtue."

The success of Mr Alison in the pulpit enabled the directors of St Paul's chapel to pay off nearly the whole debt with which that building was charged, and to erect the new and beautiful structure in York Place, to the completion of which Mr Alison's numerous friends and admirers largely contributed. There he continued to do duty regularly till increasing years compelled him, in 1834, to retire from active life. In 1830 he was severed by death from Mrs Alison, with whom he had lived in happiness for eight and forty years; but he continued in the full enjoyment of his faculties; and his powers of imagination increased rather than the reverse till his death, which happened on May 17. 1839, at the advanced age of eighty-two. His latter years were chiefly spent at a beautiful villa he had purchased near Colinton, where he enjoyed, in the very highest degree, the society of his family and friends, and the beauties of nature, to which through life he had been passionately attached.

Mr Alison transmitted his literary tastes and habits to his sons. The eldest, who, after the example of a long line of ancestors by the mother's side, embraced the medical profession, rose to its very highest grade. He was successively made professor of medical jurisprudence and of the theory and practice of physic in the university of Edinburgh, once held by his uncle and grandfather; and in 1845, on the death of the lamented Dr Abercrombie, was appointed first physician to the queen in Scotland. He rose to the highest eminence as a consulting physician, and published a most valuable work on medical science. But he is more generally known as an unwearied and active philanthropist, and as having mainly contributed, by his strenuous exertions, and the startling facts he revealed in his pamphlets on the subject, to the great reformation in the management of the poor in Scotland, which was effected by the Act of 1845. His youngest son, Sir Archibald Alison, Bart., was bred to the bar, at which he rapidly rose, and was successively appointed advocate-depute in 1823, and sheriff of Lanarkshire, the highest judicial situation in Scotland next to the bench, in 1835, which office he still holds. He is the author of the History of Europe during the French Revolution, its continuation to 1852, the Principles of Population, the Life of Marlborough, a voluminous treatise on Criminal Law, and a variety of essays, chiefly in Blackwood's Magazine, a selection of which have been published in a collected form. In November 1850, he was, by a singular coincidence, elected Lord Rector of Glasgow College, where his father had commenced his career eighty years before; and in June 1852, under the administration of Lord Derby, he was created a baronet; but this dignity has not lessened his literary tastes, which still continue to be exerted in historic literature.



ALISONTIA, or Alisuntia, in *Ancient Geography*, a river of Belgic Gaul, now *Alsitz;* which, rising on the borders of Lorraine, and running through that duchy, waters the city of Luxemburg, and, swelled by other rivulets, falls into the Sour.

ALIWAL, in northern India, a village on the left bank of the Sutlej, 18 miles west of the town of Loodiana. The place, though in itself insignificant, is associated with historical recollections of interesting character. At the commencement of the year 1848, a large body of Sikhs crossed the river from the Punjaub for the purpose of intercepting the communications of the British army of the Sutlej. They were met at Aliwal by Major-General Sir Harry Smith, who, on the 28th January, attacked and routed them with great slaughter. The tactics displayed by the British officer commanding in this action were deemed by the best military judges of the day deserving of the highest praise. Lat. 30. 58. Long. 75. 37. (E. T.)

ALJAMEIA was the Moorish name for the Spanish language.

ALKADARII, a sect among the Mahometans who deny any eternal, fixed, divine decrees, and are assertors of free-will. The word is formed from the Arabic *alkadar*, which signifies "decree." The Alkadarii are a branch of Motazalites, and stand opposed to the Algiabarii.

ALKAHEST, or Alcahest, among alchemists, derived from a word which signifies *spirit of salt* or *all spirit*, was supposed to be a universal menstruum, capable of resolving all bodies into their principles. It is likewise used for all fixed salts volatilized.

ALKALI, in *Chemistry*, denotes a particular class of salts. The word *alkali* is of Arabian origin, and was introduced into chemistry after it had been applied to a plant which still retains the name of *kali*. When this plant is burnt, the ashes washed in water, and the water evaporated to dryness, a white substance remains, which is called *alkali*. See Chemistry.

ALKALIMETER, a name given to a small instrument, invented by M. Descroizilles for ascertaining the value of the alkalies in commerce. There is an account of it in the 28th vol. of Tilloch's *Philosophical Magazine*.

ALKALOID, the name given to the alkaline bases of organic compounds that appear to exist in certain vegetables combined with organic acid; such as *morphia* in opium, *strychnia* in nux vomica, &c. See CHEMISTRY.

ALKINDI, a celebrated Arabian physician and philosopher who flourished at Baghdad, and died about A.D. 880. From the extent of his knowledge, he has been styled the Thales and Pythagoras of Mahometans. He was the author of various excellent works on medicine, general philosophy, logic, music, arithmetic, geometry, and astronomy; and this too at a period when Europe was involved in a cloud of the deepest ignorance.—*D'Herbelot Bibl. Orient. Bayle. Moreri.*

ALKMAAR. See ALCMAER.

ALKANET, the root of *Anchusa tinctoria*, much used to give a fine red colour to oils and other fatty matters. See ANCHUSA.

ALKORAN. See ALCORAN.

ALL-HALLOW, or *All-Saints*, a festival celebrated on the first of November, in commemoration of all the saints in general. The number of saints being so excessively multiplied, it was found too burdensome to dedicate a feast-day to each. In reality, there are not days enough, scarce hours enough, in the year, for this purpose. Hence it was found expedient to have an annual aggregate commemoration of such as had not special days for themselves. Pope Boniface IV., in the ninth century, introduced the feast of *All-Saints* in Italy, which was soon after adopted in the other churches.

*ALL-Saints*, islands near Guadaloupe, in the West Indies.

*ALL-Saints' Bay*, a captainship in the middle division of Brazil, so called from the harbour of that name; bounded on the north by the Rio Real, on the south by that of Ilheos, on the east by the ocean, and on the west by three unconquered nations of Indians. It is reckoned one of the richest and most fertile captainships in all Brazil, producing great quantities of cotton and sugar. The bay itself is about two and a half leagues wide, interspersed with a number of small but pleasant islands, and is of immense advantage to the whole country. It has several cities and towns, particularly St Salvador, which is its capital. All-Saints' Bay lies in Lat. 13. 10. S. Long. 38. 50. W.

*ALL-Souls*, in the *Calendar*, denotes a feast-day, held on the second of November, in commemoration of all the faithful deceased. The feast of All-Souls was first introduced in the eleventh century by Oidlon, abbot of Cluny, who enjoined it on his own order; but it was not long before it became adopted by the neighbouring churches.

ALLA, or ALLAH, the Mahometan name for the Supreme Being. It is an Arabic word, derived from the verb *alah*, to adore. It is the same with the Hebrew *Elohi*, which signifies the *Adorable Being*.

ALLAGNA, a town in the province of Val Sesia, in the principality of Piedmont, in Italy. It has some rich copper mines, with gold mixed in the same ore. It is on the river Sesia, and contains 1800 inhabitants.

ALLAHABAD, a fortified town of Hindustan, and the principal place of the province of the same name, is situated in a dry and healthy soil, on a triangle, at the junction of the two mighty streams, the Ganges and the Jumna. It has been occasionally the residence of royalty, and contains some fine ruins; but notwithstanding its advantageous commercial position, the benefit derived from numerous visitors for devotional purposes, and the support afforded by the civil and military establishments, it is still a small city, with mean houses and narrow and irregular streets, confined to the banks of the Jumna. Its population is however gradually improving, both in character and amount. Hodges, the artist, who visited the place in 1782, describes all the dwellings without the fort as thatched huts. In 1803, the native population was computed at 20,000; in 1834 it had increased to 38,000, and a later return brings it up to 45,000. The fort, which is placed at the distance of a quarter of a mile, on a tongue of land washed by the Jumna and the Ganges, is lofty and extensive, and completely commands the navigation of the two rivers. It is strong both by nature and art, and has been a noble castle; but although it has gained in strength, it has lost in appearance, by some modern improvements which it has undergone, by which its lofty towers have been lowered into bastions and ravelins, and its high stone ramparts covered with turf parapets, and obscured by a green sloping glacis. It is still, however, according to Bishop Heber, a striking place, and its principal gate, surmounted by a dome, with a wide hall beneath, surrounded by arcades and galleries, and ornamented with rude, but glowing paintings, forms a fine entrance to a place of arms. The barracks are handsome and neat. On one side is a large range of buildings, which are in the oriental style, and contain some noble vaulted rooms, chiefly occupied as officers' quarters, and overlooking from a considerable height the rapid stream and craggy banks of the Jumna. The principal mosque is in good repair. This building, which is solid and stately, but without much ornament, is advantageously situated on the banks of Jumna, adjoining the city on one side, and an esplanade before the glacis of the fort on the other. It was at one time the residence of the general of the station, but has since been restored to its original destination. Among the finest buildings in the neighbourhood is the Serai of Prince Khoosro, the ill-fated son of the Emperor Jehangir. The structure is a noble quadrangle, with four fine Gothic gateways, surrounded within an embattled wall, by a range of cloisters for the accommodation of travellers. Adjoining the Serai is a garden planted with fine old mangoe trees, in which are three beautiful tombs raised over two princes and a princess of the imperial family. The houses of the civil and military servants of the company, are at some distance both from the fort and the town. These villas are surrounded by gardens: they are described as handsome and richly fitted-up buildings, and as giving a grand appearance to the neighbourhood.



Allahabad is one of the most noted resorts of Hindu pilgrimage, and such visits are now perfectly free, the government pilgrim-tax formerly levied having been abolished since 1840. The place owes its celebrity in this respect to the reputed confluence of three sacred rivers, the Ganges, the Jumna, and the Sereswati; but the third is by no means obvious to the sight, being lost in the sands of Sirhind, upwards of 400 miles to the north-west. The Hindus, however, assert that it joins the other two under ground, and that consequently the same religious merit is acquired by bathing at this sacred confluence as by bathing in all the three separate rivers. In former years instances frequently occurred of devotees drowning themselves in the sacred stream at the great annual meeting of Allahabad; this mode of self-immolation being regarded by Hindus as the most acceptable of all offerings. At the present time this meeting has assumed rather a festive than a gloomy character; and is described as a pretty scene, the platforms for the bathers being covered with canopies as booths in an English fair, and the women dressed in holiday clothes, and shining in coloured scarfs among the crowd. Allahabad was taken in the year 1765 by the British, from the Vizier of Oude, and assigned as the residence of Shah Alum, the titular emperor of Delhi. But the emperor having thrown himself into the hands of the Mahrattas, the place was resumed by the donors in 1771, and again transferred to the Nabob of Oude, by whom it was finally ceded to the British in 1801, in commutation of the subsidy which the vizier had agreed to pay for British protection. Distance from Calcutta 496 miles;

from Benares 75; from Lucknow 128; from Delhi 391. Lat. 25. 26. Long. 81. 55.

The district of Allahabad forms one of the provinces under the jurisdiction of the lieutenant-governorship of Agra; it has an area of 2801 square miles, and a population, composed chiefly of Hindus and Mahometans, amounting to 710,000. The history of the district is included in that of the city of Allahabad. (E. T.)

ALLAN, David, a Scottish historical painter of considerable celebrity, was born at Alloa, on the 13th February 1744. At a very early age he showed such marks of genius as attracted the notice of some gentlemen living in the neighbourhood. In a remote part of the country, and deprived of the ordinary means of indulging his propensity to drawing, he betook himself, when a boy, to such implements and materials as he could readily procure; and the mechanical skill and taste which he displayed, particularly in the use of his knife, have been mentioned as remarkable for his years. Mr Stewart, then collector of the Customs at Alloa, having mentioned these proofs of natural talent to Mr Foulis the printer, who some time before had instituted an academy in Glasgow for painting and engraving, young Allan was invited to study under his care. Here he remained about seven years, studying the elementary principles of his art; and, by the proficiency which he attained, justified the opinion of his talents which had procured him admission to that ill-fated seminary. But although the public taste for the fine arts in Scotland was at that time so feeble as to leave his liberal and public-spirited preceptor without support, Allan, on leaving the academy, had the good fortune to gain the patronage of individuals whose generosity enabled him to prosecute his views, and to improve his taste, by studying the works of art abroad. He devoted himself with great zeal to his profession at Rome, where he remained sixteen years; during which time his subsistence chiefly depended on the copies which he made from the most celebrated pictures of the ancient masters. Among the original works which he then painted, was one which gained for him the gold medal given by the Academy of St Luke, in the year 1773, for the best specimen of historical composition. This picture represents the *Origin of Painting*, and is well known by the excellent engraving of it by Cunego. His design of the *Calabrian Shepherds* is also a composition of great merit; and his four views of the Carnivals at Rome, etched by Paul Sandby, are said likewise to have been very successful.

On his return to his native country, he took up his residence at Edinburgh; and soon after, on the death of Alexander Runciman, in 1786, was appointed director and master of the academy established by the Board of Trustees for Manufactures in Scotland. There he executed a great variety of works, of various degrees of merit; but perhaps none such as might have been expected from the author of the *Origin of Painting*. Those, indeed, by which he is most known, are of a cast altogether different, being remarkable for the comic humour which they display. The *Scotch Wedding*, the *Highland Dance*, the *Repentance Stool*, with his *Illustrations of the Gentle Shepherd*, are all of this class, and so generally known, from his own spirited etchings in aqua-tinta, as to need no description.

Mr Allan was long remembered and spoken of as an excellent private character. He died at Edinburgh on the 6th August 1796, in the 53d year of his age.

Allan, *Sir William*, R.A., and President of the Scottish Royal Academy for the Fine Arts, raised himself from obscurity, by the force of native genius and indefatigable perseverance, to a high rank among the painters of his age and country. A detail of the steps by which this eminent artist and excellent man overcame the difficulties of his first position, however valuable as an example to the young aspirant for distinction, would be here misplaced. We shall content ourselves with an outline of his professional career.

William Allan was born at Edinburgh, in 1782, of humble but respectable parents, who afforded him the elements of a classical education in the High School of his native city. He early showed a strong attachment to drawing; and it was intended that he should become an ornamental coach-painter. With this view he was entered as a pupil in the School of Design established by the Board of Trustees for Arts and Manufactures, then under the direction of Mr Graham as master. This able teacher had the good fortune to have among his first pupils *Allan* and *Wilkie*. The two youthful artists were placed at the same table, and for months studied the same designs. During this time they contracted a friendship which terminated only with their lives. In the Edinburgh school Allan remained for several years, and exhibited such proficiency that he aspired to the higher branches of painting. He subsequently was for some time a student in the Royal Academy of London; and afterwards attempted to practise his art in the vast field of the metropolis. But not meeting with the encouragement he had hoped to find, young Allan, with that decision which was one of his characteristics, speedily determined, with very scanty resources, to seek his fortunes abroad. Some circumstances made him think of Russia as a probable field; and having procured a few introductions, especially one to Sir Alexander Crichton, then the imperial family physician, our artist, in 1804, embarked for Riga; but was carried by a succession of storms to Memel in Prussia, where the state of his finances compelled him to remain for some time, supporting himself, as he best could, by the exercise of his pencil. At last he was enabled to set out for St Petersburg by land; and on his way he encountered the Russian army, then on its route for the campaign that terminated in the bloody field of Austerlitz. He soon arrived in the Russian capital, where the kindness of Crichton, and his other introductions, procured him abundant employment. Allan remained long in Petersburg, where the emoluments of his profession enabled him to indulge his eager desire to travel for improvement in his art; and for several years he made occasional excursions into Southern Russia, Turkey, the Crimea, and Circassia, where he stored his mind, and filled his portfolio, with those vivid sketches of Cossacks, Tartars, Turks, Circassians, and other orientals, of which he made such admirable use in his subsequent pictures.

After a ten years' residence abroad, Mr Allan, in 1814, took up his abode in his native place; where his talents, his unassuming manners, and his interesting conversation, won him the esteem and friendship of Walter Scott, and the other literary ornaments of the northern capital. At this time he produced his masterly picture, *The Circassian Captives*, which, after delighting the eyes of his fellow citizens, was exhibited at London in 1815. This beautiful composition, which united graceful forms and powerful expression with novel and picturesque costumes, established Allan's reputation as a master in the highest walk of art. But liberal collectors were then comparatively rare amongst us; and the picture remained in the studio of the artist, until some of his admiring friends resolved to subscribe what would be a remunerating price, and thus decide by lot who should obtain the picture. The fortunate possessor is the Earl of Wemyss, of whose collection it is a chief ornament. About the same time, the Grand Duke Nicolas, now emperor of Russia, visited Edinburgh, and purchased two of Allan's capital pictures, *Siberian Exiles*, and the Circassian prince *Haslan Gheray crossing the River Kuban with his followers*. This imperial patronage gave a very favourable turn to the fortunes of the painter, whose pictures were now sought for by collectors.

Mr Allan, however, had the misfortune to suffer from ophthalmia, which threatened him with total blindness. Obliged to suspend his loved profession, he was advised to spend the winter in the milder air of Italy. He went to Rome during that season, and to Naples in the hot weather, from whence he passed to Constantinople. With renovated health, he returned home by the classic shores of Asia Minor and Greece, and with rich stores of materials for future compositions, as appeared in his fine picture of the *Constantinopolitan Slave-Market*, and other productions of his pencil. For several years he uninterruptedly pursued his profession in Edinburgh; but in 1834, the care of his health, and his desire of further improvement in his art, induced him to visit the south of Spain; and he made a short excursion to the opposite coast of Marocco. In 1841 he went again to Petersburg; when he was employed by his imperial patron to paint *Peter the Great as a Naval Architect*, a fine composition, which is now in the winter palace of the emperor, after having been exhibited in London in 1845. The author of this memoir met him in Holland in 1847, on his return from a professional tour in Germany and Belgium; making, as was his custom, his relaxation from the pencil subservient to his love of his art.

Mr Allan had been elected an *Associate* of the Royal Academy of London in 1826, and an *Academician* in 1835. Honours now flowed in upon him. On the death of his early friend Sir David Wilkie, he was appointed *Limner to Her Majesty for Scotland.* On the decease of the president of the Scottish Academy in 1838, Allan was elected to that office, which he held till his death; in 1842 he received the honour of knighthood; and in 1849, he was appointed one of the commissioners of the Board of Arts and Manufactures; but the declining state of his health, which was but too obvious to his friends, induced him to decline the honourable office, to the sincere regret of the members of that Board.

Sir William Allan was now confined to the house by a chronic bronchitis. But his professional energy and love for his art remained unabated; and, till increasing debility interrupted his labours, he was assiduously engaged on a grand picture—the subject being *Bruce at Bannockburn*—which, though far advanced, remains unfinished. It exhibits no trace of impaired powers; and it is as conspicuous as his two fine pictures of the *Battle of Waterloo*, for the spirit of the composition, and the skill with which the artist has contrived to vary the formality of armies drawn up in battle array, by interesting episodes, all conducive to the main story.

Sir William Allan died on Friday, 22d of February 1850, unmarried, in the 68th year of his age, deeply regretted by numerous friends, and by the public, who justly considered him as an ornament to the country that gave him birth. The following is a chronological list of the principal works of this eminent artist:—

1. Circassian Captives. 2. Tartar Bandits. 3. Haslan Gheray crossing the Kuban. 4. Polish-Jewish Wedding. 5. Siberian Exiles with their Cossack Guards. 6. Slave-Market at Constantinople. 7. Lord Byron after crossing the Hellespont at Abydos. 8. Assassination of David Rizzio; by many considered his masterpiece. 9. Moorish Love-Letter. 10. Battle of Prestonpans. 11. Incident in the campaign of Robert Bruce in Ireland. 12. Peter the Great teaching Shipbuilding to his Subjects. 13. Polish Exiles on their route to Siberia. 14. Naval Battle. 15. Battle of Waterloo from the French position; purchased by the Duke of Wellington. 16. Napoleon and the English Sailors at Boulogne. 17. Battle of Waterloo from the English position. This picture was painted for the competition of artists in Westminster Hall in 1846; but though highly prized by the best judges, was not successful. 19. Several fine landscapes of Scottish scenery. 20. Battle of Bannockburn, left unfinished. (T. S. T.)



ALLAN, a river of Perthshire, in Scotland, which passes by Dunblane, and falls into the Forth near Stirling.

ALLAN, *Bridge of*, a beautiful village on the above river, three miles from Stirling, much frequented in summer on account of its mineral well. It has rapidly increased in size within the last few years.

ALLANTOIS, or ALLANTOIDES, a thin transparent bag investing the fœtus of quadrupeds, as cows, goats, sheep, &c., filled with a urinous liquor conveyed to it from the bladder of the young animals by means of the urachus.

ALLATIUS, LEO, keeper of the Vatican library, a native of Scio, and a celebrated writer of the seventeenth century. He was of great service to the Port Royalists in their controversy with M. Claude, touching the belief of the Greeks with regard to the eucharist. No Latin was ever more devoted to the See of Rome, or more inveterate against the Greek schismatics, than Allatius. He never was married, nor did he take orders; and when Pope Alexander VII. asked him one day why he did not enter into orders, he answered, "Because I would be free to marry." The pope rejoined, "If so, why do you not marry?" "Because," replied Allatius, "I would be at liberty to take orders." "Thus," as the sarcastic Bayle observes, "he passed his whole life, wavering between a parish and a wife; sorry, perhaps, at his death, for having chosen neither of them; when, if he had fixed upon one, he might have repented his choice for thirty or forty years." In his works he discovers more erudition and industry than sound judgment; and his style is perplexed and diffuse. He died at Rome in 1669, aged 83.

ALLECTUS, the prime minister and confidential friend of Carausius, emperor of Britain. In order to avoid the punishment due to the several enormous crimes with which he was chargeable, he fell upon the desperate expedient of murdering his master, and usurping the imperial dignity, which he maintained for three years. With the design of recovering Britain, the Cæsar Constantius despatched a portion of his fleet and army under the command of the prætorian præfect Asclepiodotus. The fleet of Allectus was stationed off the Isle of Wight to receive them; but under the cover of a thick fog, the invaders escaped their notice, and landed in safety on the western coast, and, according to Gibbon, convinced the Britons "that a superiority of naval strength will not always protect their country from a foreign invasion." In expectation of an attack from Constantius, who commanded the fleet off Boulogne, the usurper had taken his station in the vicinity of London; but informed of the descent of Asclepiodotus, he made forced marches to oppose his progress. In the battle which ensued Allectus was slain, and his forces received a total defeat; and thus Britain, after a separation of ten years, was restored to the Roman empire, A.D. 297.

ALLEGANY, the name of several counties in the United States of North America.—1. In the state of New York, with a population in 1850 of 37,880. 2. In Pennsylvania, Pop. 138,098. 3. In Maryland, Pop. 22,873. 4. In the valley district of Virginia, Pop. 3516.

ALLEGANY MOUNTAINS, situated between the Atlantic Ocean, the Mississippi River, and the Lakes, are a long and broad range of mountains, composed of several ridges, tending north-east and south-west, nearly parallel to the sea-coast, about 1100 miles in length, and from 50 to 200 miles in breadth. The ridges which compose this immense range of mountains have different names in the different states, viz., the *Blue Ridge*, the *North Mountain* or *North Ridge*, *Laurel Ridge*, *Jackson's Mountains*, and *Cumberland Mountains*. All these different and immense ridges are penetrated by rivers, which appear to have forced their way through solid rocks. The principal ridge is more especially called *Allegany*, and is descriptively named the *Back Bone of the United States.* The general name of the whole range, taken collectively, is the *Allegany Mountains.* Mr Evans calls them the *Endless Mountains;* others have called them the *Appalachian Mountains*, from a tribe of Indians who lived on a river which proceeds from this mountain, called the *Appalachicola ;* but the most common name is the *Allegany Mountains.*

They pass through the states eastward of the Mississippi like a spine or back-bone, and give rise to nearly all the rivers in that region. They approach the sea at the river Hudson, but take a direction inland from that point, and in Georgia are above 200 miles from the sea. They are generally covered with natural wood, and capable of cultivation, with some exceptions. The soil in the valleys between the ridges is found to be superior to that between the mountains and the sea, and is indeed among the best in the United States. Towards the northern extremity of the Alleganies, the primitive rocks cover a great breadth of country; but southward of New York they are chiefly confined to the eastern slope of the mountains. A zone of transition rocks from 20 to 40 miles in breadth extends nearly the whole length of the chain ; and beyond this to the westward the country is chiefly limestone. They are not confusedly scattered, but run along in ridges generally of a uniform height, estimated on an average at 3000 feet. The ground rises to them from the sea so gradually that their height does not much strike the eye. They contain a considerable variety of minerals, and on the western side great beds of coal.

*Allegany River*, in Pennsylvania, rises on the western side of the Allegany Mountains, and after running about 300 miles in a south-west direction, meets the Monongahela at Pittsburg, and both united form the Ohio. The lands on each side of this river, for 150 miles above Pittsburg, consist of white oak and chesnut ridges, and in many places of poor pitch pines, interspersed with tracts of good land and low meadows. It is navigable for boats of ten tons for 260 miles above Pittsburg.

ALLEGATA, a word anciently subscribed at the bottom of rescripts and constitutions of the emperors; as *signata* or *testata* was under other instruments.

ALLEGIANCE, either derived from the French *Allegeance*, or taken from the same Latin source, has been used to express that duty which a person possessing the privileges of a citizen owes to the state to which he belongs, and is technically applied in law to the duty which a British subject owes to the sovereign as representing the state. It has been divided by the English legal commentators into natural and local; the latter applying only to the deference which a foreigner must pay to the institutions of the country in which he happens to live; but it is in its wider sense that the word is important, as representing a condition attached to mankind, of which it is very difficult in theory, and still more in practice, to adjust the true character and limits. For a state to decide what persons are bound to it by allegiance may be easy, but for a man to know where his allegiance lies when two or more states claim him—and hence for jurists to decide what is the reasonable extent to which any state ought to make such a claim, is often involved in difficulty. In oriental nations caste and tribe seem to have been the barriers of nationality; and when these were once overcome, people seem to have been in general free to choose their allegiance. But in most ancient nations, including Greece and Rome, the absence of the courtesies of war, since introduced by chivalry and feudality, prevented an opening for the nice questions arising in later days, since the enemy overcome in war, whether he might have been alien or denizen according to our modern notions, was slain or enslaved. Nice as is the question, what should constitute the allegiance which makes war against a state high treason in the soldier, and renders him liable to be punished as a criminal instead of being received as a prisoner of war, British constitutional law has defined it in the broadest manner. By its doctrine every person born within the British dominions, though he should be removed in infancy to another country wherein his family resides, owes an allegiance to the British Crown, which he can never resign or lose. This was found in the case of Æneas Macdonald, tried for accession to the rebellion of 1745, who, though born in Britain, had been removed in childhood, and having been educated in France held a commission in the French army (Foster's Reports, 59). It will not apparently affect this broad principle, then, that the parents are foreigners. But further, according to the strict rule of the law, as the son or grandson of a British subject is entitled to the privilege of a natural born subject (see ALIEN) he must acquire it with its obligation, and commits high treason if he make war against Britain. The cause of so hard and irrational a principle is that the English law has taken the theory of allegiance entire from the feudal system, where it involved fidelity approaching to bondage due by the vassal to the lord. Hence the great English lawyers have exhausted their eloquence in describing the illimitable character of allegiance. In the celebrated case of the *Post-nati*, Bacon said, "Allegiance is of a greater extent and dimension than laws or kingdom, and cannot consist by the laws merely, because it began before all laws: it continueth after laws, and it is in vigour when laws are suspended and have not their force." Coke, on the same occasion, said "whatsoever is due by law or constitution of man may be altered: but natural ligeance or obedience of the subject to the sovereign cannot be altered."—(St. Tr. II. 596, 652), and in his Institutes he defines allegiance as "The greatest obligation and duty that can be." Though our law counts every one a liege subject who is not an alien, yet it permits aliens to acquire rights without exacting the burden of allegiance [ALIEN]. In other countries the same classification will be found more or less to apply—aliens will be able to obtain some rights of citizens without coming under the obligations of allegiance, and the rights and obligations of allegiance will be impartable to persons who have not lost a similar position in the country of birth. It would be interesting to possess an account, throughout the civilised world, of the way in which citizenship may be lost to a native and acquired by a stranger in each state. Any attempt to lay down such particulars from law books would incur the risk of making statements which have been superseded; and there is the farther difficulty, that while the practical extent of the law is often to be known only by practice, wherever its principles are invidious or oppressive there is a reluctance to carry it out. No man, for instance, would be put on trial for high treason, for taking service against Britain, because his grandfather was an Englishman. It may be maintained, however, that a great deal of information on the methods of acquiring citizenship in foreign states is to be found in the evidence taken by the select committee of 1843, on the laws affecting aliens (Parl. Pap. No. 307). It will be in questions between European governments and the United States, that the true rule by which citizenship should be lost or acquired will come out in its broadest shape, since it is the principle of that empire to receive and enrol among the citizens owing it allegiance, people from all parts of Europe, without inquiring whether they have lost or can give up their native allegiance. The enactment of naturalisation laws is reserved by the constitution for Congress, and it is a characteristic part of the system that only free white persons can acquire the privilege. The general tenor of the acts of Congress from 1802 to 1828, regulating naturalisation is, that the person received must be a native of a country at peace with the States, that he be qualified by a five years' residence, abjure any title or order of nobility he may have possessed, and take an oath of allegiance in which he obliges himself to support the constitution of the United States, and abjures his previous allegiance (Kent's Com. 3d edition. i. 63–4.) (J. H. B.)

Allegiance, *Oath of*, one of the oaths required of people in public office or trust, and which by laws either repealed or in virtual disuse might be tendered to any person. The oath having assumed a servile character was, at the Revolution, modified into a simple engagement to bear allegiance to the sovereign.

ALLEGORY, in *Composition*, consists in choosing a secondary subject, having all its properties and circumstances resembling those of the principal subject, and describing the former in such a manner as to represent the latter. The principal subject is thus kept out of view, and we are left to discover it by reflection.

Nothing gives greater pleasure than an allegory, when the representative subject bears a strong analogy, in all its circumstances, to that which is represented. But most writers are unlucky in their choice, the analogy being generally so faint and obscure, as rather to puzzle than to please; or on the other hand, so obvious as not to awaken our curiosity. As an example of a well-sustained allegory we may point to Bunyan's *Pilgrim's Progress*. Spenser's *Faëry Queen*, again, has both the defects we have mentioned. Allegories, as well as metaphors and similes, are unnatural in expressing any severe passion which totally occupies the mind. For this reason, the latter part of the following speech of Macbeth is justly condemned by the learned author of the *Elements of Criticism:*

Methought I heard a voice cry, Sleep no more!
Macbeth doth murder Sleep, the innocent sleep;
Sleep, that knits up the ravell'd sleeve of care,
The birth of each day's life, sore labour's bath,
Balm of hurt minds, great Nature's second course,
Chief nourisher in life's feast. *Act* ii. *sc.* 2.

ALLEGRI, Antonio, called *Coreggio*, from the place of his birth, a most celebrated historical painter, was born in the year 1494. It is a mistake to represent Coreggio as of mean descent. His family was respectable, and the place of his birth, a small, neat city. Of his studies we know little, except that he entered the school of Francesco Bianchi, and was an expert modeller. Even A. Caracci, his admirer, was ill-informed on his history, which is still obscure, notwithstanding the researches of Mengs, Tiraboschi, and Lanzi. He saw none of the statues of ancient Greece or Rome, nor any of the works of the established schools of Rome and Venice: but Nature was his guide; and Coreggio was one of her favourite pupils. To express the facility with which he painted, he used to say that he always had his thoughts at the end of his pencil.

The agreeable smile, and the profusion of graces, which he gave to his madonnas, saints, and children, have been taxed with being sometimes unnatural; but still they are lovely and attractive. An easy and flowing pencil, a union and harmony of colours, and a perfect intelligence of light and shade, give an astonishing relief to all his pictures, and have been the admiration both of his contemporaries and his successors. Annibale Caracci, who flourished fifty years after him, studied and adopted his manner in preference to that of any other master. In a letter to his cousin Lodovico, he expressed with great warmth the impression which was made on him by the first sight of Coreggio's paintings: "Every thing which I see here," says he, "astonishes me; particularly the colouring, and the beauty of the children. They live, they breathe, they smile with so much grace and so much reality, that it is impossible to refrain from smiling and partaking of their enjoyment. My heart is ready to break with grief when I think on the unhappy fate of poor Coreggio—that so wonderful a man (if he ought not rather to be called an angel) should finish his days so miserably, in a country where his talents were never known!"

From want of curiosity or of patronage, Coreggio never visited Rome, but remained during his whole life at Parma, where the art of painting was little esteemed, and of consequence poorly rewarded. This concurrence of unfavourable circumstances at last occasioned his premature death at the age of forty. He was employed to paint the cupola of the cathedral at Parma, the subject of which is the Assumption of the Virgin, which he executed in a manner that has long been the admiration of every person of good taste, for the grandeur of the design, and especially for the boldness of the fore-shortenings; an art which he first, and at once, brought to the utmost perfection. When he went to receive his payment, the canons of the church, either through ignorance or baseness, found fault with his work; and although the price originally agreed upon had been very moderate, they alleged that it was far above the merit of the artist, and forced him to accept of the paltry sum of 200 livres; which, to add to the indignity, they paid him in copper money. To carry home this unworthy load to his wife and children, poor Coreggio had to travel six or eight miles from Parma. The weight of his burden, the heat of the weather, and his chagrin at his villanous treatment, immediately threw him into a pleurisy, which in three days put an end to his life and his misfortunes. The story of the extreme poverty and sufferings of Coreggio is, it seems, untrue; for we are told by Lanzi that he left his family not in indigence, though probably not in affluence.

For the preservation of this magnificent work, the world is indebted to Titian. As he passed through Parma, in the suite of Charles V., he ran instantly to see the *chef d'œuvre* of Coreggio. While he was attentively viewing it, one of the principal canons of the church told him that such a grotesque performance did not merit his notice, and that they intended soon to have the whole defaced. "Have a care of what you do," replied the other; "if I were not Titian, I should certainly wish to be Coreggio."

Coreggio's exclamation upon viewing a picture by Raphael is well known. Having long been accustomed to hear the most unbounded applause bestowed on the works of that divine painter, he by degrees became less desirous than afraid of seeing any of them. One, however, he at last had occasion to see. He examined it attentively for some minutes in profound silence; and then, with an air of satisfaction, exclaimed, *I am still a painter*. Giulio Romano, on seeing some of Coreggio's pictures at Parma, declared they were superior to anything in painting he had yet beheld. One of these, no doubt, was the famous Virgin and Child, with Mary Magdalene and St Jerome. The no less famous *Notte*, or Night, of Coreggio, was sold for a great sum of money to Augustus II. the king of Poland, and is now in his *family* gallery at Dresden.

When speaking of his more finished works, Mengs, a most able critic, places Coreggio second in the triad with Raphael and Titian. He considers him inferior to the former in exquisite delineation of the affections of the soul, but before him in the expression of external character, from his unrivalled colouring and admirable chiaroscuro, which clothe his compositions with a very natural species of ideal beauty. This praise has chiefly been bestowed on his St Jerome and his *Notte* by Annibale Caracci, by Mengs, and Algarotti. His design, indeed, exhibits not the daring depth of Buonarotti; but he is at once so grand and judicious in this

Allegri.

respect, that the two Caracci adopted him as their model of excellence. True, his compositions have not the varied outline of Raphael, or of the ancients, because his principle was to avoid angles and straight lines; and he studied a softly undulating outline, to which Mengs attributes his grace. His draperies are much commended for the fine disposition of their general masses, rather than for his attention to particular folds. His infantine and youthful heads are beaming with nature and simplicity. But the variety of his daring fore-shortenings is truly astonishing; and by introducing them freely in his ceilings, which Raphael rather avoided, he overcomes difficulties in that species of painting till his time never conquered. His greatest charm, however, lies in the exquisite harmony of his lucid colouring, which must be acknowledged by all who have ever attentively examined his magnificent 'Communion of St Jerome,' his 'Notte,' his 'Reposing Magdalen,' or the 'Ecce Homo,' and 'Mercury teaching Cupid in the presence of Venus,' of the British National Gallery.

The principle of Coreggio's design is the soft transition from the convex to the concave outline, combining power with grace. The principle of his harmonious lights and shadows is a central globe of light, softly passing through clear semitones into rich reflex shadows. This is the keynote to his compositions, to which every other quality is made subordinate, and gives a mellowness to his colouring which no other artist ever obtained. This great painter's death happened in 1534.—Lanzi, *Stor. Pittor.* iv.; Mengs, *Opere;* Tiraboschi, *Storia della Lit. Italiana.* (T. S. T.)

Allegri, *Gregorio*, an ecclesiastic by profession, and a celebrated composer of music of the seventeenth century, was a native of Rome. He was the disciple of Nanini, the intimate friend and contemporary of Palestrina. His abilities as a singer were not remarkable, but he was deemed an excellent master of harmony, and so much respected by all the musical professors of his time that the pope, in the year 1629, appointed him to be one of the singers in his chapel. To his uncommon merit as a composer of church music, he united an excellent moral character, exhibiting in his actions the devotion and benevolence of his heart. The poor crowded daily to his door, and were relieved to the utmost of his ability; and not content with these beneficent actions, he daily visited the prisons of Rome, in order to relieve the most deserving and afflicted objects immured in these dreary mansions. With such exquisite simplicity and purity of harmony did he compose many parts of the church service, that his loss was severely felt, and sincerely was it lamented by the whole college of singers in the papal service. He died on the 18th February 1650, and was interred in the Chiesa Nuova, in a vault destined for the reception of deceased singers of the pope's chapel, before the chapel of S. Filippo Neri, near the altar of the annunciation.

Among his other musical works preserved in the pontifical chapel, is the celebrated *Miserere*, which is still annually performed at that chapel on Wednesday and Good Friday in Passion Week, by the choral band and the best singers in Italy. It is, however, generally believed that it owes its reputation more to the manner in which it is performed than to the composition itself. The beauty and effect of the music is not discernible upon paper, but the singers have by tradition certain customs, expressions, and graces of conventions, which produce wonderful effects. Some of the effects produced may be justly attributed to the time, the place, and the solemnity of the ceremonials observed during the performance. "The pope and conclave are all prostrated on the ground, the candles of the chapel and the torches of the balustrade are extinguished one by one, and the last verse of this psalm is terminated by two choirs; the *maestro di cappella* beating time slower and slower, and the singers diminishing or rather extinguishing the harmony by little and little, to a perfect point." Padre Martini says that there never were more than three copies made by authority, "one of which was for the emperor Leopold, one for the late king of Portugal, and the other for himself;" but a very complete one was presented by the pope to King George III. as an inestimable curiosity.

Allegro || Alleluiah.

ALLEGRO, in *Music*. See Music.

ALLEIN, Joseph, the son of Tobias Allein, was born at Devizes, in Wiltshire, in 1633, and educated at Oxford. In 1655 he became assistant to Mr Newton, in Taunton-Magdalen, in Somersetshire; but was ejected for nonconformity. He died in 1668, aged 35. He was a man of great learning and greater charity; preserving, though a nonconformist, and a severe sufferer on that account, great respect for the church, and loyalty to his sovereign. He wrote several books of piety, which are highly esteemed,—especially his *Alarm to Unconverted Sinners.* There have been many editions of this pious little work, the sale of which has been very great.

Allein, *Richard*, an English nonconformist divine, was born at Ditchet, in Somersetshire, in 1611. His father was rector of Ditchet, and conducted the education of his son until he was prepared for the Oxford university. There he soon obtained the degree of master of arts; and after he entered into holy orders, first as an assistant to his father, and afterwards as rector of Batcomb, in Somersetshire, he discharged the duties of a clergyman with great industry, and singular fidelity. He was a zealous puritan, and was appointed assistant to the parliamentary commissioners whose business it was to eject "scandalous ministers;" in which office his father also bore a part. At the Restoration he in his turn was ejected from the rectory of Batcomb, which he had creditably held for twenty years, because he could not conscientiously accede to the terms of the act of conformity. But in the house of Mr More, who had been a member of the long parliament, he continued to exercise his ministerial functions in defiance of the penalties imposed by that act. Although frequently reprimanded for his conduct in this matter, his piety and exemplary conduct procured him a mitigation of the punishment. No dangers could deter him from duty; for although constrained to remove from Batcomb, in consequence of the "five-mile act," he continued in the discharge of his ministerial office at Frome-Selwood. Here he remained until his labours were terminated by death, in 1691.

His most celebrated work is called *Vindiciæ Pietatis*, which is still esteemed by theologians of the nonconformist school; another is *Heaven Opened*, and a third *The World Conquered;* all giving proof of his fervent piety.

ALLELUIAH, or Halleluiah, a Hebrew word signifying *Praise the Lord*, to be met with either at the beginning or end of some psalms; such as psalm cxlvi. and those that follow to the end. Alleluiah was sung upon solemn days of rejoicing, Tobit xiii. 18. St John in the Revelation (xix. 1, 3, 4, 6) says, that he "heard a great voice of much people in heaven, saying, Alleluiah: . . . and the four and twenty elders and the four beasts fell down and worshipped God that sat on the throne, saying, Amen, Alleluiah." This hymn of joy and praises was transferred from the synagogue to the church. So much energy has been observed in this term, that the ancient church thought proper to preserve it, without translating it either into Greek or Latin, for fear of impairing its softness and expression. The fourth council of Toledo has prohibited the use of it in time of Lent, or other days of fasting, and in the ceremonies of mourning; and, according to the present practice of the Romish Church, this word is never repeated in Lent, nor in the obsequies of the dead: notwithstanding which, it is used in the mass for the dead, according to the Mosarabic ritual, at the introit, when they sing, *Tu es portio mea, Domine, Alleluiah, in terra viventium, Alleluiah, Alleluiah.*

ALLEMOND, a town of Upper Dauphiny, in the arrondissement of Grenoble, in France. In the mountains of Chalanches, near it, a lead mine with silver was discovered in 1767, which yielded by smelting, in somewhat less than twenty years, upwards of 300,000 ounces of silver.

ALLEN, John, archbishop of Dublin in the reign of King Henry VIII., was born in 1476, and educated in the university of Oxford. From thence he removed to Cambridge, where he took the degree of bachelor of laws. He was sent by Dr Warham, archbishop of Canterbury, to the pope, on certain business relating to the church. He continued at Rome nine years, and was created doctor of laws, either there or in some other university of Italy. After his return he was appointed chaplain to Cardinal Wolsey, and was commissary or judge of his court as legate *a latere;* in the execution of which office he was suspected of great dishonesty, and even perjury. He assisted the cardinal in visiting, and afterwards suppressing, forty of the smaller monasteries, for the erection of his college at Oxford and that at Ipswich. In 1528 he was consecrated archbishop of Dublin; and about the same time was made chancellor of Ireland. He was cruelly murdered in July 1534, by Thomas Fitzgerald, eldest son of the earl of Kildare.

Allen, *John*, M.D., was born near Edinburgh in 1770, and educated at the university of that city, where he took the degree of M.D. in 1791. With youthful enthusiasm, Allen joined the Scottish movement of that period for parliamentary reform; and this circumstance, according to the policy of the day, probably being an impediment to professional employment, induced him to become a lecturer on physiology in Edinburgh, where he was distinguished by the precise philosophical views and clearness of his prelections.

Some years afterwards, he took up his abode in Holland House, as the friend and private secretary of the late Lord Holland. In 1811 he was elected warden of Dulwich College; and in 1820 obtained the comfortable sinecure of master of that institution, where he died in 1843.

Allen's detached publications, though well-written, are not very important, if we except his valuable "*Inquiry into the growth of the Royal Prerogative*," which appeared in 1830; but he was an able contributor to the *Edinburgh Review*, of not less, it is said, than forty articles, chiefly on physiological, metaphysical, and political subjects; and some of his contributions on French and Spanish history are very interesting. To this last department he was probably directed by his intimacy with Lord Holland. Dr Allen was a man of vigorous mind, and extensive information. (T. S. T.)

Allen, *Thomas*, a famous English mathematician, was born at Uttoxeter, in Staffordshire, on the 21st of December 1542. He was admitted scholar of Trinity College, Oxford, on the 4th of June 1561; and in 1567 took his degree of master of arts. In 1580 he quitted his college and fellowship, and retired to Gloucester Hall; where he studied very closely, and became famous for his knowledge in antiquity, philosophy, and mathematics. Having received an invitation from Henry, earl of Northumberland, a great friend and patron of mathematicians, he spent some time at the earl's house, where he became acquainted with those celebrated mathematicians, Thomas Harriot, John Dee, Walter Warner, and Nathaniel Torporley. Robert, earl of Leicester, had a particular esteem for Allen, and would have conferred a bishopric upon him; but his love of solitude and retirement made him decline the offer. His great skill in the mathematics earned him, as was usual in those times, the credit of being a magician; and the sagacious author of a book entitled *Leicester's Commonwealth*, accuses him of employing the art of "figuring" to further the earl of Leicester's unlawful designs, and of endeavouring by the black art to bring about a match between him and Queen Elizabeth. Allen was indefatigable in collecting scattered manuscripts relating to history, antiquity, astronomy, philosophy, and mathematics. A considerable part of his collection was bestowed on the Bodleian Library by Sir Kenelm Digby. He published in Latin the second and third books of Claudius Ptolemy of Pelusium, *Concerning the Judgment of the Stars*, or, as it is commonly called, of the *Quadripartite Construction*, with an exposition. He wrote also notes on many of Lilly's books, and some on John Bale's work *De Scriptoribus M. Britanniæ*. He died at Gloucester Hall on the 30th September 1632, at the great age of 90.



Allen, *William*, an eminent pharmaceutical chemist, and chemical lecturer in London, was born in 1770. He early showed a predilection for experimental investigations, and was placed in a respectable pharmaco-chemical establishment in Plough Court, in which he afterwards became a partner with Luke Howard. While successfully pursuing his business Allen engaged in various important experimental investigations. In 1804, he was appointed lecturer on chemistry at Guy's Hospital, an office from which he did not finally retire till 1827. He became a fellow of the Royal Society in 1807; and several of his communications appear in the *Philosophical Transactions*, especially the important experimental researches by him and Mr Pepys on *Respiration*. He was a zealous member and a president of the pharmaceutical society. But along with his scientific occupations, he was an active promoter of various schemes of benevolence. He had purchased an estate near Lindfield in Sussex, to which he retired several years before his death. There he devoted himself to the establishment of schools, to which workshops for the children, a library, and experimental laboratory were attached, and where he himself gave occasional instruction to the young experimentalists. He was highly esteemed in private life, and died, much regretted, at his house near Lindfield, in 1843. (T. S. T.)

ALLENDORF, a city, capital of the bailiwick of the same name in Hesse-Cassel. It contains 3935 inhabitants. In the suburb is a salt-spring of great strength, and works for granulating and drying the salt.

ALLER, a river which rises in the district of Magdeburg in Prussia, and passing through the duchy of Luneburg falls into the Weser a little below Verden.

Aller, sometimes written *alder*, an old Saxon form of superlative. Thus *aller-good* signifies the greatest good.

ALLERION, or Alerion, in *Heraldry*, a sort of eagle without beak or feet, having nothing perfect but the wings. They differ from marlets in having their wings expanded; and denote imperialists vanquished and disarmed; for which reason they are more common in French than in German coats of arms.

ALLESTREE, or ALLESTRY, Richard, D.D., was born at Uppington in Shropshire in 1619, and educated in the grammar school of Coventry, and afterwards at Christ Church in Oxford. His natural talents, which were uncommonly vigorous, were carefully improved by unwearied application to study. Accordingly, his promotion was rapid. After passing as bachelor of arts, he was made successively moderator in philosophy, canon of Christ Church, doctor of divinity, chaplain in ordinary to the king, and regius professor of divinity. His early studies, however, were interrupted by the hostilities of the times. In the year 1641 he and many other students of Oxford entered the royal service, and gave eminent proofs of their courage and loyalty. A short interval of hostilities permitted Allestry to return to his literary pursuits; but soon after he again took up arms, and was present at the battle of Keinton-field. On his way to Oxford to prepare for the reception of the king he was taken prisoner, but was released by the king's forces. A violent disease which then prevailed in the garrison of Oxford brought Allestry to the brink of the grave; but recovering, he again joined a regiment of volunteers, chiefly consisting of Oxford students. Here he served as a common soldier, and was often seen with the musket in one hand and a book in the other. At the close of the revolutionary struggle, he returned to his favourite studies, but still continued true to his party. This occasioned his expulsion from the college; but he was provided with a comfortable retreat in the families of the Honourable Francis Newport and Sir Anthony Cope.

Such was the confidence reposed in him, that when the friends of Charles II. were secretly preparing the way for his restoration, they intrusted him with personal messages to the king. In returning from one of these interviews he was seized at Dover, and upon examination committed a prisoner to Lambeth House. The Earl of Shaftesbury obtained his release in a few weeks. Returning to visit his friends, and among others the learned Dr Hammond, he met his corpse at the gate of his house, on its way to the grave. This melancholy occurrence deeply affected his mind. The doctor left him his library, assigning as a reason that "he well knew that his books in his hands would be useful weapons for the defence of that cause he had so vigorously supported." This valuable library, along with his own, Allestry bequeathed at his death to the university. He died in January 1681.

Allestry erected at his own private expense the west side of the outward court of Eton College, and the grammar school in Christ Church College; besides settling several liberal pensions upon individual persons and families. A volume of sermons, printed at Oxford in 1684, is all by which posterity can judge of his literary abilities.

Allestry, *Jacob*, an English poet of the seventeenth century, was the son of James Allestry, a bookseller of London. He was educated at Westminster School, entered at Christ Church, Oxford, in the act-term 1671, at the age of 18, and was elected student in 1672. He died young on the 15th October 1686. Some of his poems are to be found in a collection of "Miscellany Poems," published in 1721.

ALLEY, William, bishop of Exeter in the reign of Queen Elizabeth, was born at Great Wycomb in Buckinghamshire. From Eton School, in the year 1528 he removed to King's College, Cambridge, where he took the degree of bachelor of arts. He also studied some time at Oxford: afterwards he married, was presented with a living, and became a zealous reformer. Upon Queen Mary's accession he left his cure and retired into the north of England, where he maintained himself and his wife by teaching a school, and practising physic. When Elizabeth came to the throne, he went to London, where he acquired great reputation by reading the divinity lecture at St Paul's; and in July 1660 was consecrated bishop of Exeter. He died on the 15th of April 1570, and was buried at Exeter, in the cathedral. He wrote, among other things, The Poor Man's Library, 2 vols. folio, London 1571, containing twelve lectures on the first epistle of St Peter, read at St Paul's; and a Hebrew Grammar. He also translated the Pentateuch, in the version of the Scriptures known as *the Bishop's Bible*.

ALLEYN, Edward, a celebrated English actor in the reigns of Queen Elizabeth and King James, and founder of the college of Dulwich in Surrey, was born at London, in the parish of St Botolph, on the 1st of September 1566, as appears from a memorandum of his own writing. Dr Fuller says that he was bred a stage-player, and that his father would have given him a liberal education, but that he was not turned for a serious course of life. He was, however, a youth of excellent capacity, cheerful temper, tenacious memory, graceful elocution, and stately aspect, advantages that might probably have induced their possessor to adopt the theatrical profession. By several authorities we find he must have been on the stage some time before 1592; for at that time he was in high favour with the town, and greatly applauded by the best judges, particularly by Ben Jonson.

Heywood, in his prologue to Marlowe's *Jew of Malta*, calls him

Proteus for shapes, and Roscius for a tongue.

He usually played the capital parts, and was one of the original actors in Shakspeare's plays: in some of Ben Jonson's he was also a principal performer; but what characters he personated in any of their plays, it is difficult now to determine. This is owing to the inaccuracy of their editors, who did not print the names of the players opposite to the characters they performed, as the modern custom is; but gave one general list of actors to the whole set of plays, as in the old folio edition of Shakspeare; or divided one from the other, setting the dramatis personæ before the plays, and the catalogue of performers after them, as in Jonson's.

It may appear surprising that one of Alleyn's profession should be enabled to erect such an edifice as Dulwich College, and liberally endow it for the maintenance of so many persons. But it must be observed that he had some paternal fortune, which, though small, might lay a foundation for his future affluence; and it is to be presumed that the profits he received from acting must have considerably improved his fortune: besides, he was not only actor, but proprietor of a playhouse built at his own expense, by which he is said to have amassed considerable wealth. He was also master of the royal bear-garden, which was frequented by vast crowds of spectators; and the profits arising from these sports are said to have amounted to L.500 per annum. He was thrice married; and the portions of his first two wives, they leaving him no issue, would probably increase his wealth. Aubrey mentions a tradition, that when Alleyn was personating a demon, with six others, in one of Shakspeare's plays, in the midst of the play he was surprised by an apparition of the devil; which so worked on his fancy, that he made a vow, which he performed by building Dulwich College. The foundation of this college was begun under the direction of Inigo Jones, in 1614; and the buildings, gardens, &c., on which he is said to have expended about L.10,000, were finished in 1617. After the college was built, he met with some difficulty in obtaining a charter for settling his lands in mortmain; for he proposed to endow it with L.800 per annum, for the maintenance of one master, one warden, and four fellows, three whereof were to be clergymen, and the fourth a skilful organist; also six poor men and as many women; besides twelve poor boys to be educated till the age of fourteen or sixteen, and then put out to some trade or calling. The obstruction he met with arose from the Lord Chancellor Bacon, who wished King James to settle part of those lands for support of two academical lectures, and wrote a letter to the Marquis of Buckingham, dated August 18, 1618, entreating him to use his interest with his Majesty for that purpose. Alleyn's solicitation was, however, at last complied with, and he obtained the royal license, giving him full power to lay his foundation, by his Majesty's letters-patent, bearing date the 21st of June 1619. He was himself the first master of his college; so that, to make use of the words of Heywood, one of his contemporaries, "He was so mingled with humility and charity, that he became his own pensioner, humbly submitting himself to that proportion of diet and clothes which he had bestowed on others." We have no reason to think he ever repented of this distribution of his substance; but, on the contrary, that he was entirely satisfied, as appears from the following memorial in his own writing, found amongst his papers:—"May 26. 1620. My wife and I acknowledged the fine at the common pleas bar, of all our lands to the college: blessed be God that hath given us life to do it." His wife died in the year 1623; and about two years afterwards he married Constance Hinchtoe, who survived him. He died on the 25th of November 1626, in the 61st year of his age, and was buried in the chapel of his new college, where there is a tombstone over his grave, with an inscription. His original diary is also there preserved.

Alleyn lived on the most friendly terms with both Shakspeare and Ben Jonson. They used frequently to spend their evenings together at the sign of the Globe, somewhere near Blackfriars, where the playhouse then was. The following letter gives a small but interesting glimpse of these *noctes cœnæque Deorum.* The writer was a student of Christ Church, Oxford, a dramatic poet, who belonged to the Club.

"Friend Marle,

"I must desyr that my syster hyr watch, and the cookerie book you promysed, may be sente bye the man. I never longed for thy company more than last night: we were all very merrye at the Globe, when Ned Alleyn did not scruple to affyrme pleasauntly to thy Friende Will, that he had stolen his speech about thee Qualityes of an actor's excellencye in Hamlet hys Tragedye, from conversations manyfold which had passed betweene them, and opinyons given by Alleyn touching the subjecte. Shakspeare did not take this talke in good sorte: but Jonson put an ende to the strife with wittylye remarkinge, *This affaire needeth no Contentione; you stole it from Ned, no doubte; do not marvel: Have you not seen him act tymes out of number?*—Believe me most syncerilie yours, G. Peele."

ALLIA, a small river of Italy, in the Sabine territory, which joins the Tiber eleven miles from Rome; famous for the great slaughter of the Romans by the Gauls under Brennus, when 40,000 were killed or put to flight; hence *Alliensis dies*, an unlucky day (Virgil, Ovid, Lucan).

ALLIANCE in the *Civil* and *Canon Law*, the relation contracted between two persons or two families by marriage.

Alliance is also used for a treaty entered into by sovereign princes and states, for their mutual safety and defence. In this sense, alliances may be distinguished into such as are offensive, whereby the contracting parties oblige themselves jointly to attack some other power; and into defensive ones, whereby they bind themselves to stand by and defend each other in case they are attacked by others. The forms or ceremonies of alliances have been various in different ages and countries. In ancient times eating and drinking together, chiefly offering sacrifices together, were the customary mode of ratifying an alliance. Among the Jews and Chaldeans, heifers or calves, among the Greeks, bulls or goats, and among the Romans, hogs were sacrificed on this occasion. Among the ancient Arabs, alliances were confirmed by drawing blood out of the palms of the hands of the two contracting princes with a sharp stone, dipping therein a piece of their garments, and therewith smearing seven stones, at the same time invoking the gods Vrotalt and Alilat, *i. e.*, according to Herodotus, Bacchus, and Uranius. Among the people of Colchis, the confirmation of alliances was said to be effected by one of the princes offering his wife's breasts to the other to suck, which he was obliged to do till the blood flowed.

ALLIER, a department of France, on a river of the same name, which runs at the foot of a branch of the Cevennes Mountains. It extends over 2828 square miles, and in 1851 contained 336,758 inhabitants. It is composed of a part of the ancient province of Bourbonnois, and is divided into four arrondissements, viz., Mount Luçon, Moulins, Gannat, and La Palisse.



Allier, *Louis*, who afterwards assumed the name of Hauteroche, was a famous French antiquary and numismatist, and the author of several very erudite archæological and numismatical essays. He died in 1827 at the age of 61.

ALLIGATI, in *Roman Antiquity*, the basest kind of slaves. The Romans had three degrees or orders of slaves or servants; the first employed in the management of their estates; the second in the menial or lower functions of the family; and the third, the *alligati*, who worked in fetters, whence their name.

ALLIGATION, the name of a method of solving all questions that relate to the mixture of one ingredient with another. Though writers on arithmetic generally make alligation a branch of that science, yet as it is plainly nothing more than an application of the common properties of numbers, in order to solve a few questions that occur in particular branches of business, we choose rather to keep it distinct from the science of arithmetic.

Alligation is generally divided into *medial* and *alternate*.

Alligation *Medial*, from the rates and quantities of the simples given, discovers the rate of the mixture.

*Rule.* As the total quantity of the simples,
To their price or value;
So any quantity of the mixture,
To the rate.

*Example.* A grocer mixes 30 lb. of currants, at 4d. per lb., with 10 lb. of other currants, at 6d per lb.: What is the value of 1 lb. of the mixture? *Ans.* $4\frac{1}{2}$d.

| *lb.* | | *d.* | | *d.* |
|---|---|---|---|---|
| 30 | at | 4 | amounts to | 120 |
| 10 | at | 6 | ——— | 60 |
| — | | | | —— |
| 40 | | | | 180 |

*lb.* *d.* *lb.* *d.*
If 40 : 180 : : 1 : $4\frac{1}{2}$.

Alligation *Alternate*, being the converse of alligation medial, from the rates of the simples, and rate of the mixture given, finds the quantities of the simples.

*Rules.* I. Place the rate of the mixture on the left side of a brace, as the root; and on the right side of the brace set the rates of the several simples, under one another, as the branches. II. Link or alligate the branches, so as one greater and another less than the root may be linked or yoked together. III. Set the difference between the root and the several branches right against their respective yoke-fellows. These alternate differences are the quantities required. *Note* 1. If any branch happen to have two or more yoke-fellows, the difference between the root and these yoke-fellows must be placed right against the said branch, one after another, and added into one sum. 2. In some questions the branches may be alligated more ways than one; and a question will always admit of so many answers as there are different ways of linking the branches.

Alligation alternate admits of three varieties, viz., 1. The question may be unlimited, with respect both to the quantity of the simples and that of the mixture. 2. The question may be limited to a certain quantity of one or more of the simples. 3. The question may be limited to a certain quantity of the mixture.

*Variety* I. When the question is unlimited, with respect both to the quantity of the simples and that of the mixture, this is called *Alligation Simple.*

*Example.* A grocer would mix sugars at 5d., 7d., and 10d. per lb., so as to sell the mixture or compound at 8d. per lb.: What quantity of each must he take?

| | | | *lb.* |
|---|---|---|---|
| 8 | 5 | 2 | 2 |
| | 7 | 2 | 2 |
| | 10 | 3,1 | 4. |

Here the rate of the mixture 8 is placed on the left side of the brace as the root; and on the right side of the same brace are set the rates of the several simples, viz., 5, 7, 10, under one another, as the branches; according to Rule I.

The branch 10 being greater than the root, is alligated or linked with 7 and 5, both these being less than the root, as directed in Rule II.

The difference between the root 8 and the branch 5, viz., 3, is set right against this branch's yoke-fellow 10; the difference between 8 and 7 is likewise set right against the yoke-fellow 10; and the difference between 8 and 10, viz., 2, is set right against the two yoke-fellows 7 and 5, as prescribed by Rule III.

As the branch 10 has two differences on the right, viz., 3 and 1, they are added; and the answer to the question is, that 2 lb. at 5d., 2 lb. at 7d., and 4 lb. at 10d., will make the mixture required.

The truth and reason of the rules will appear by considering, that whatever is lost upon any one branch is gained upon its yoke-fellow. Thus, in the above example, by selling 4 lb. of 10d. sugar at 8d. per lb. there is 8d. lost: but the like sum is gained upon its two yoke-fellows, for by selling 2 lb. of 5d. sugar at 8d. per lb., there is 6d. gained; and by selling 2 lb. of 7d. sugar at 8d. there is 2d. gained; and 6d. and 2d. make 8d.

Hence it follows, that the rate of the mixture must always be mean or middle with respect to the rates of the simples; that is, it must be less than the greatest, and greater than the least; otherwise a solution would be impossible. And the price of the total quantity mixed, computed at the rate of the mixture, will always be equal to the sum of the prices of the several quantities cast up at the respective rates of the simples.

*Variety* II. When the question is limited to a certain quantity of one or more of the simples, this is called *Alligation Partial.*

If the quantity of one of the simples only be limited, alligate the branches, and take their differences, as if there had been no such limitation; and then work by the following proportion:—

As the difference right against the rate of the simple whose quantity is given,
To the other differences respectively;
So the quantity given,
To the several quantities sought.

*Example.* A distiller would, with 40 gallons of brandy at 12s. per gallon, mix rum at 7s. per gallon, and gin at 4s. per gallon: How much of the rum and gin must he take, to sell the mixture at 8s. per gallon?

$$\begin{array}{c} \\ 8\left\{\begin{array}{l}12\\7\\4\end{array}\right. \end{array}\begin{array}{c}\\ \begin{array}{r}1,4\\4\\4\end{array}\end{array}\begin{array}{c}\\ \left|\begin{array}{c}5\\4\\4\end{array}\right.\end{array}\begin{array}{l}\textit{Galls.}\\ \left|\begin{array}{l}\text{40 of brandy,}\\\text{32 of rum,}\\\text{32 of gin.}\end{array}\right\}\end{array}\textit{Ans.}$$

The operation gives for answer, 5 gallons of brandy, 4 of rum, and 4 of gin. But the question limits the quantity of brandy to 40 gallons; therefore say,

If 5 : 4 : : 40 : 32.

The quantity of gin, by the operation, being also 4, the proportion needs not be repeated.

*Variety* III. When the question is limited to a certain quantity of the mixture, this is called *Alligation Total.*

After linking the branches, and taking the differences, work by the proportion following:—

As the sum of the differences,
To each particular difference;
So the given total of the mixture,
To the respective quantities required.

*Example.* A vintner has wine at 3s. per gallon, and would mix it with water, so as to make a composition of 144 gallons, worth 2s. 6d. per gallon: How much wine, and how much water, must he take?

$$\begin{array}{l}\quad\textit{Galls.}\\ 30\left\{\begin{array}{l}36\\0\end{array}\right.\begin{array}{r}30\\6\\\hline 36\end{array}\left|\begin{array}{l}\text{120 of wine,}\\\text{24 of water.}\\\hline \text{144 total.}\end{array}\right.\end{array}\Big\}\ \textit{Ans.}$$

$$120 \times 36 = 4320$$
$$24 \times 0 = 0$$

Proof 144)4320(30

As 36 : 30 : : 144 : 120

As 36 : 6 : : 144 : 24.

There being here only two simples, and the total of the mixture limited, the question admits but of one answer.

ALLIGATOR (a corruption of the Spanish *el lagarta, i.e. the lizard*), the common name of the American crocodile, called *Cayman* by the Indians. See REPTILIA, *Index.*

ALLIOTH, a star in the tail of the Greater Bear, of much use for finding the latitude at sea.

ALLITERATION, an ornament of language chiefly used in poetry, and consisting in the repetition of the same letter at certain intervals.

We apprehend the principal operation of this ornament to be quite mechanical. It is easier for the organs of speech to resume, at short intervals, one certain conformation, than to throw themselves into a number of different ones, unconnected and discordant. For example, a succession of labials, interspersed at regular distances with dentals and gutturals, will be more easily pronounced than the succession of all the three at random. Sounds of which the articulation is easiest are most completely in the power of the speaker. He can pronounce them slowly or rapidly, softly or with force, at pleasure. In this, we imagine, the power and advantage of alliteration are founded; for we would not lay any stress on the pleasure which can result to the ear from the repetition of the same letter. It has been compared to the frequent returns of the key-note in a musical strain; but that analogy is extremely faint. The ear. we presume, can be pleased with alliteration only in so far as it contributes to the superior easiness of recitation; for what is recited with ease must naturally be more pleasing.

It is true, however, as is remarked by Dr Thomas Brown (Lect. 36), that though the alliteration itself consist only in the similarity of sounds, it is not indifferent on what words of the sentence the alliteration is made to fall. That ingenious writer mentions *resemblance* and *contrast* as the qualities which give particular point to alliterative expression, and cites as an example the line of Pope,

Puffs, powders, patches, *bibles, billets-doux;*

the first words indicating objects naturally connected, and the last deriving their point from the contrast of ideas.

These remarks might be confirmed and illustrated by numberless passages from the best poets. Some few lines will suffice, taken from Gray, who seems to have paid particular attention to this grace. He professed to have learned his versification from Dryden, as Dryden did from Spenser; and these three abound in alliteration above all the English poets. We choose Gray for another reason, that alliteration contributes not only to the *sweetness*, but also to the *energy*, of versification; for he uses it chiefly when he aims at strength and boldness. In the *Sister Odes*, as Dr Johnson styles them, almost every strophe commences and concludes with an alliterative line. The poet, we suppose, wished to begin with force, and end with dignity.

"*R*uin seize thee *r*uthless king."
"To *h*igh-born *H*oel's *h*arp, or soft *L*lewellyn's *l*ay."
"*W*eave the *w*arp, and *w*eave the *w*oof."

"Stamp we our vengeance *d*eep, and ratify his *d*oom."
"Regardless of the *s*weeping whirlwind's *s*way."
"That hush'd in grim re*p*ose, ex*p*ects his ev'ning *p*rey."

It must be observed here, that we hold a verse alliterative which has a letter repeated on its accented parts, although those parts do not begin words; the repeated letter bearing a strong analogy to the bars in a musical phrase. Gray seems to have had a particular liking to those sorts of balanced verses which divide equally, and of which the opposite sides have an alliterative resemblance.

"Eyes that *g*low, and fangs that *g*rin."
"Thoughts that *b*reathe, and words that *b*urn."
"*H*auberk crash, and *h*elmet ring."

All these lines have a force and energy, arising from alliteration, which renders them easy to be recited. For the same reason the following passage appears sad and solemn, by the repetition of the labial liquid.

"*M*ountains, ye *m*ourn in vain."
"*M*odred, whose *m*agic song."—&c.

If alliteration thus contribute to enforce the expression of a poetical sentiment, its advantages in poetry must be considerable. An epithet should not be selected merely for its initial letters, unless it suit the purpose well in every other respect; for the beauty of alliteration, when happy, is not greater than its deformity when affected. A couplet from Pope will exemplify both; the first line being bad, and the second good;

"Eternal beauties grace the shining scene,
*F*ields ever *f*resh, and *g*roves for ever *g*reen."

In the dearth of poetical talent in the middle ages, alliterative composition was cultivated as a distinct poetical exercise. As a specimen of these ridiculous feats of poetical legerdemain, we give three lines from the performance entitled *Pugna Porcorum per Publium Porcium, Poetam*, a *poem* in which every word began with the letter *P*.

Propterea properans Proconsul, poplite prono,
Præcipitem Plebem, pro Patrum pace poposcit.
Persta paulisper, Pubes preciosa! precamur, &c., &c.

ALLIUM, a genus of plants of the natural order of *Asphodeleæ*, including garlic, the onion, the leek, &c.

ALLIX, Pierre, a French Protestant divine, was born at Alençon in France, in the year 1641. At the time when the edict of Nantes tolerated and protected the Protestants of France, he entered upon the clerical profession, and remained minister of Rouen until the 35th year of his age. During this period he wrote several pieces upon the controversy between the Papists and the Protestants, by which he obtained great fame among his own party. The unwise revocation of the edict of Nantes drove Allix and many others to seek refuge in England. Three years after his arrival in England, he had made himself so perfectly master of the English language as to be able to write very correctly a *Defence of the Christian Religion*. This work he dedicated to James II. in testimony of gratitude for his kind reception of the distressed refugees of France. Not long after his arrival in England, he was honoured with the title of doctor of divinity, and also received the more substantial honour of being appointed treasurer of the church of Salisbury.

After having exercised his talents with much industry and learning in defence of Protestantism, he employed his pen to support the doctrine of the Trinity against the Unitarians, who contended that the idea of Christ's divinity could be traced up no higher than the time of Justin Martyr. With a great display of erudition, he attempted to prove that the Trinitarian doctrine was believed by the Jewish church. But the reputation which he had acquired for learning and ability was somewhat diminished by the ridicule he brought on himself in attempting to prove that Christ should again appear upon earth in the year 1720, or, at the latest, in 1736. This able divine died at London in 1717, at the age of 76.



ALLOA, a seaport town of Scotland, in the county of Clackmannan. It is situated on the north shore of the Firth of Forth, 27 miles from Edinburgh, 6 from Stirling by land and 12 by water. It has a safe and commodious harbour, having 16 feet of water in neap, and 22 in spring tides. The town is irregularly built. The chief public building is the church, which was first opened in 1819. It is a fine building, in the pointed style of architecture, with a handsome spire. Alloa has several distilleries in its neighbourhood, from which large quantities of spirits are shipped for England; and its breweries are noted for producing a very fine quality of ale, which is in great repute. Among the principal manufactories of this place are extensive brick and tile works; a copper work, at which are made most of the implements or apparatus for distilleries; the Devon iron-works; and a glass-work, where, in addition to the ordinary green glass bottles, they now manufacture all sorts of finer glass. There are extensive collieries in the immediate vicinity, from which abundant supplies of fuel are brought by a waggon-way direct to these works from the mouth of the pit. The exports from Alloa consist of pig-iron, ale, spirits, glass, and coals; and the imports are timber, oak, bark, hides, and great quantities of grain for malting. Adjoining the harbour is an excellent dry dock, capable of receiving ships of the greatest burden; and to the west is a ferry across the Forth, which is there 500 yards broad, with piers projecting down to low water-mark. A daily communication is maintained with Edinburgh and other towns along the Forth by means of steam-boats. It has a custom-house, which comprehends under the port of Alloa the creeks on both sides of the Forth from Kincardine to Stirling inclusive. In the immediate vicinity of the town there is an ancient tower 89 feet high, with walls 11 feet in thickness, which was built about the year 1315. This was the residence of the Erskines, the descendants of the Earls of Mar, once a powerful family; and here many of the Scottish princes received their education, having been for more than two centuries the wards of the Lords Erskine and the Earls of Mar. The last heir of the Scottish monarchy educated here was Henry Prince of Wales. Pop. in 1851, 6676. Long. 3. 46. W. Lat. 56. 7. N.

ALLOCATION denotes the admitting or allowing of an article of an account, especially in the exchequer. Hence

*Allocatione Facienda* is a writ directed to the lord treasurer, or barons of the exchequer, commanding them to allow an accountant such sums as he has lawfully expended in the execution of his office.

ALLOCUTIO, an oration addressed by a Roman general to his soldiers, to animate them to fight, to appease sedition, or to keep them to their duty.

ALLODIUM, or Alleud, denotes lands which are the absolute property of their owner, without being obliged to pay any service or acknowledgment whatever to a superior lord. This tenure of land was common in the north of Europe, is the *udal* tenure of the Scandinavians, and still exists, in a few instances, in the county of Orkney. What existed of it in England was destroyed by William I., who introduced the stringent *feudal* tenure, by which all lands are held of the crown.

ALLORI, Alessandro, a Florentine painter of the third epoch of the school, who introduced fine anatomy into his pictures. He also wrote an essay on painting, of considerable merit. Born 1535, died 1607. He was a nephew of Bronzino, whose name he assumed.

Allori, *Cristofano*, the son of the former, was a superior colourist and excellent painter of portraits, and some reckon him among the best painters of the fourth epoch of the Florentine school. Born 1577, died 1621.—*Lanzi*, I.

ALLOXAN, a crystallised substance, formed by the action of nitric on uric acid. It forms oblique four-sided prisms. It is capable of further oxidation, and becomes alloxanic acid.

ALLOY, or ALLAY, properly signifies a proportion of a baser metal mixed with a finer one. The alloy of gold is estimated by carats, that of silver by pennyweights. In different nations different proportions of alloy are used; whence their moneys are said to be of different degrees of fineness or baseness, and are valued accordingly in foreign exchanges. The chief reasons alleged for the alloying of coin are, 1. the mixture of the metals, which, when smelted from the mine, are not perfectly pure; 2. the saving of the expense it must otherwise cost if they were to be refined; 3. the necessity of rendering them harder, by mixing some parts of other metals with them, to prevent the diminution of weight by wearing in passing from hand to hand; 4. the melting of foreign gold or coin which is alloyed; 5. the charges of coinage, which must be made good by the profit arising from the money coined; 6. and lastly, the duty belonging to the sovereign, on account of the power he has to cause money to be coined in his dominions.

ALLSTADT, a bailiwick in the grand duchy of Saxe-Weimar, containing one city and eleven villages. Its capital, of the same name, is on the Rhone, 22 miles W.S.W. of Halle, and 26 north of Weimar. This city is of considerable antiquity; and as early as 974, an imperial diet was held there under Otho II. A ducal castle crowns an adjoining eminence. It has some manufactures of cloth, saltpetre, and potash. Pop. 2550.

ALLSTON, WASHINGTON, an American historical painter, distinguished for his excellence in colouring. His picture of "The Dead Man resuscitated by Elisha's Bones," obtained the L.220 prize of the British Institution in 1811. His first wife was a sister of Dr Channing. He was born in South Carolina in 1779, and died in Massachusetts in 1843.

ALLUMEE, an *Heraldic* term, applied to indicate eyes of animals depicted sparkling, or of a red hue.

ALLUMINOR, from the French *allumer*, to lighten, an old term for one who coloured or painted upon paper or parchment; because he gave light and ornament by his colours to the letters or other figures. Such ornaments are styled *illuminations*. The term is used in statute 1 Richard III. cap. 9; and is still traceable in the word *limner*.

ALLUSION, in *Rhetoric*, a figure by which something is applied to, or understood of, another, on account of some similitude between them.

ALLUVION, in *Law*, denotes the gradual increase of land along the sea-shore, or on banks of rivers.

ALLUVIUM, or ALLUVIAL, is used in *Geology* to denote those deposits of sand, gravel, stone, &c., which are brought down by streams and rivers, and spread over lower lands. See GEOLOGY.

ALLYGHUR, in the East Indies, a fort in the British district of the same name, within the territory of the lieutenant-governorship of Agra. Its site is an elevated plain, skirted by swamps and morasses. The fort is now dismantled; and it was proposed some years since to convert it into a provincial jail, but the undertaking was abandoned in consequence of the alleged insalubrity of the locality. Towards the close of the year 1802, the Peishwa, driven from his capital by Holcar, fled to Bassein, and there concluded the treaty whereby he secured the co-operation of the British in re-establishing his sovereignty. This alliance excited the jealousy of the principal Mahratta chiefs, who shortly after confederated for the purpose of defeating the objects of the treaty. Among the operations planned by the British for the destruction of this confederacy, was an attack upon General Perron the French adventurer, who held a large force in readiness in the Dooab to co-operate with the Mahrattas. In furtherance of this measure, General Lord Lake, in August 1803, marched from Cawnpore towards the Mahratta territory, and on the 29th of that month, came up with Perron, who was strongly posted in the vicinity of Allyghur. Perron, however, retreated upon the advance of the English, leaving the fort of Allyghur in charge of a French officer, with injunctions to defend it to the last extremity. In addressing this commander, Perron observed, "You will have received the answer you are to make to the propositions of General Lake. I never could have believed that, for an instant, you could have thought of a capitulation. Remember you are a Frenchman; and let no action of yours tarnish the character of your nation. I hope in a few days to send back the English general as fast or faster than he came. Make yourself perfectly easy on this subject. Either the Mogul emperor's army, or that of General Lake, shall find a grave before the Fort of Allyghur. Do your duty and defend the fort while one stone remains upon another. Once more, remember your nation. The eyes of millions are fixed upon you." Upon being summoned to surrender, the commandant declared his resolution to defend the fort. It was obvious to the British general that delay could only render the conquest more difficult, and preparations were ordered for the assault. On the morning of the 4th September, Lieutenant-Colonel Monson led the attack: the defence was obstinate and vigorous, and continued for nearly an hour, when the fortress, hitherto deemed impregnable, fell before the spirit and intrepidity of the assailants. Its acquisition transferred to the captors a large proportion of the military stores of the French party who had constituted it their grand depôt. The loss of the British amounted to 59 killed and 206 wounded; that of the enemy exceeded 2000.



The value of the conquest was duly appreciated at the time, and its memory has not been suffered to pass away. So late as the year 1851, a medal was struck in commemoration of the event, and presented under the sanction of Her Majesty to the surviving officers and soldiers who took part in the capture. Elevation above the sea, 740 feet. Distance from Delhi, S.E. 84 miles; from Calcutta N.W. 803. Lat. 27. 56. Long. 78. 8. (E. T.)

ALMACANTARS. See ALMUCANTARS.

ALMADA, a Portuguese town upon the Tagus, opposite Lisbon, in the province of Estremadura, with one monastery, 900 houses, and 4000 inhabitants. Not far from this place is one of the entrances to the Tagus, defended by the tower of St Sebastian. Lat. 38. 37. 20. N.

ALMADEN, a town in Spain, in the province of Ciudad Real, with 9000 inhabitants. It is distinguished by the rich mines of quicksilver in its vicinity. Formerly these mines were wrought partly by convicts, but now wholly by free labourers. The government of late years has leased these mines to private speculators. In 1848 they yielded 40,000 quintals of mercury. The principal mines are at Almaden, and at Almadenejos, two leagues from the former, with some less important in Valencia. The whole amount of quicksilver obtained in Spain in 1848 was 48,868 quintals, or about 40,578 cwt. Lat. 38. 41. N. Long. 4. 49. W.

ALMADIE, a kind of canoe or small vessel, about four fathoms long, commonly made of bark, and used by the negroes of Africa. At Calicut the same name is applied to a kind of long boats, 80 feet in length and six or seven in breadth. They are exceedingly swift, and are otherwise called *cathuri*.

ALMAGEST, compounded of the Arabic *al* and μεγιστη, an epithet of distinction conferred on a collection or book composed by Claudius Ptolemy, containing various problems of the ancients both in geometry and astronomy. Other collections have received the same name. Thus, Riccioli has published a book of astronomy, which he calls the *New Almagest;* and Plukenet, a book which he calls *Almagestum Botanicum.*

ALMAGRE, a fine, deep red ochre, very heavy, and of a dense yet friable structure, and rough, dusty surface. It adheres very firmly to the tongue, has scarcely any taste, and seems analogous to the ore of iron called in England *Red Reddle.* It is the *Sil Atticum* of the ancients. It is found in immense quantities in many parts of Spain, and is used at Seville to colour snuff.

ALMAGRO, a city of Spain, the capital of one of the districts of Ciudad Real. It was built by the Archbishop Roderic of Toledo, who finished it in 1214, and put a considerable garrison into it, to restrain the incursions of the Moors. They soon afterwards besieged it, but were obliged to retire with loss. The town is now celebrated for its lace manufacture. Pop. 12,605.

Almagro, *Diego de*, a Spanish commander, was of such obscure birth and mean parentage that he derived his name from the village where he was born in 1463. Deprived of the means of early instruction, he could neither read nor write; but nevertheless, in consequence of his improvements in the military art, he formed an association with Francisco Pizarro and Hernando de Luque, for the purpose of discovery and conquest upon the Peruvian coast. The governor of Panama having sanctioned their enterprise, they devoted their united exertions to that undertaking. Pizarro directed the conquest, and Almagro was appointed to conduct the supplies of provisions and reinforcements. In the first two unsuccessful attempts he performed this office with persevering fidelity and uncommon activity. His perseverance was followed with complete success; for they at last discovered the coast of Peru, and landed at Tumbez, situated about three degrees south of the line, and distinguished by its temple and a palace of the incas or sovereigns. Pizarro was sent over to Spain to solicit further powers, after the three adventurers had previously adjusted their future preferments, and agreed that Pizarro should be governor, Almagro lieutenant-governor, and Luque bishop. In this negotiation Pizarro obtained the clerical dignity for Luque, but chiefly concerned for his own interest, he neglected the preferment of Almagro. On his return, Almagro was so enraged that he refused to act with such a perfidious companion, and resolved to form a new association. Pizarro, for the present, artfully endeavoured to avert the indignation of Almagro, and gradually soothed the rage and disappointment of the soldier. The union was renewed upon the former terms; and it was solemnly stipulated that they should mutually share the expenses and the advantages.

In February 1531, leaving Almagro at Panama to supply provisions and reinforcements, Pizarro set sail for Peru. He attacked a principal settlement of the natives in the province of Coaque, obtained immense spoil, and made such ample remittances to Almagro as enabled him to complete his reinforcement; and, in the close of the year 1532, Almagro arrived at St Michael, with a body of men nearly double the number of those whom Pizarro had with him. The Spaniards about this time took captive the unfortunate Inca Atahualpa, and, after they had received an immense sum for his ransom, they barbarously put him to death. Ferdinand Pizarro sailed for Spain with the news of their success, and with remittances to a great amount; and consequently Almagro gained that elevated station he had so long and so eagerly desired. But no sooner did he receive the intelligence of his promotion by the royal grant than he attempted to seize Cuzco, the imperial residence of the Incas, under pretence that it lay within his destined territory. This produced a new quarrel; but peace was restored upon condition that Almagro should attempt the conquest of Chili, and, if he did not find in that province an establishment adequate to his merit, that Pizarro should yield up to him a part of Peru.

In 1535 he accordingly set out at the head of 570 Europeans. In crossing the mountains he suffered great hardships and losses by mistaking the route; but at length he descended into the plains of that devoted region. Here he met with a more vigorous resistance from the natives than the Spaniards had ever experienced in other countries. He had, however, made some progress, when he was recalled to Peru by the news of the natives having risen in great numbers, and attacked Lima and Cuzco. He pursued a new route, and marching through the sandy plains on the coast, he suffered, by heat and drought, calamities not inferior to those which he had endured from cold and famine on the summits of the Andes. Arriving at a favourable moment, he resolved to hold the place, both against the Indians and his Spanish rivals. He attacked the Peruvian army with great vigour, and, making a great slaughter, proceeded to the gates of Cuzco without any further interruption. The open, affable, and generous temper of Almagro, gained over to his side many of the adherents of the Pizarros, who were disgusted with their harsh and oppressive conduct. With the aid of these he advanced towards the city by night, surprised the sentinels, and surrounding the house where the two brothers Ferdinand and Gonzalo Pizarro resided, compelled them, after an obstinate resistance, to surrender at discretion. A form of government was settled in the name of Almagro, and his jurisdiction over Cuzco was universally acknowledged. This was the origin of a civil war, the beginning of which was very advantageous to Almagro, who, by skilful manœuvres, entirely routed a body of Spanish troops advancing to the relief of Cuzco, and made Alvarado, their commander, prisoner. But instead of improving these advantages, he unwisely marched back to Cuzco, and there awaited the arrival of Pizarro, who, convinced of his own feeble resources, proposed an accommodation, and, with his usual art, protracted the negotiation till he found himself in a condition to meet his antagonist in the field of battle. Meanwhile Alvarado and one of the Pizarros, by bribing their keepers, found means to escape, and persuaded sixty of the men who guarded them to attend them in their flight; and the governor released the other. When Pizarro thought himself sufficiently prepared to settle the dominion of Peru, he marched with an army of 500 men to Cuzco. Almagro, worn out with age and infirmity, had previously resigned the command to Orgognez. A fierce and bloody battle ensued, in which Almagro's army was defeated, and the commander wounded. About 140 soldiers fell in the field, and Orgognez, along with several officers of distinction, was massacred in cold blood. During that fatal day, Almagro, placed in a litter which was stationed on an eminence, beheld from thence the total discomfiture of his troops, and felt all the indignation of a soldier who had seldom experienced defeat. He was taken prisoner, remained several months in confinement, and was afterwards tried and condemned to death. In the view of an ignominious death, the courage of the veteran forsook him, and he unsuccessfully supplicated for life in a manner unworthy of his former character. All the arguments he could employ were ineffectual. The Pizarros remained unmoved by all his entreaties. As soon, however, as Almagro saw that his fate was inevitable, he resumed his courage, and exhibited all his usual dignity and fortitude. In the year 1538, and in the 75th year of his age, he was strangled in prison, and afterwards beheaded. He left one son by an Indian woman of Panama; and, in consequence of a power which the emperor had granted him, he declared his son his successor in the government, although he was then a prisoner in Lima.

Almagro, the Younger, by his courage, generosity, and other accomplishments, was placed at the head of the party after the death of his father. The father, conscious of his own inferiority from the total want of education, used every possible means to improve the mind and embellish the manners of his son; so that he soon acquired those accomplishments which rendered him respected by illiterate adventurers, who cheerfully ranged round his standard, and, in his dexterity and skill, sought deliverance from the oppressions of Pizarro. Juan de Herrada, an officer of great abilities, continued still to direct his councils, and to regulate his enterprises; and while Pizarro confided in his own security, a conspiracy was formed against him which terminated in his death. The assassins, exulting in their success, and waving their bloody swords, hastened to the street, proclaimed the death of the tyrant, and compelled the magistrates and principal citizens of Lima to acknowledge Almagro as lawful successor of his father. But his reign was of short duration; for, in 1541, Vaca de Castro, arriving at Quito, produced the royal commission appointing him governor of Peru, together with all the privileges and authority of Pizarro. The talents and influence of the new governor soon overpowered the interest of Almagro, who, perceiving the rapid decline of his influence, hastened with his troops to Cuzco, where his opponents had erected the royal standard under the command of Pedro Alvarez Holguin. Herrada, the guide of his councils, died during this march; and from that time his measures were conspicuous for their violence, concerted with little ingenuity, and executed with little address. At length, on September 16. 1542, the forces of Almagro and Vaca de Castro met, and victory long remained doubtful, till at last it declared for the new governor. Almagro conducted the military operations of that fatal day with a gallant spirit, worthy of a better cause, and deserving of a better fate; and his followers displayed uncommon valour. In proportion to the number of combatants, the carnage was very great. Of 1400 men, 500 fell in the field, and many more were wounded. Almagro escaped, but being betrayed by some of his own officers, he was publicly beheaded at Cuzco; and in him the name and spirit of the party of Almagro became extinct.

ALMAMUN, or the *Trustworthy*, the surname of Abu l'Abbas Abdallah, eldest son of the caliph Haroun Alraschid, who was born at Baghdad A.D. 785. By the will of his father, the younger brother Al Amin, as the son of his favourite wife, succeeded to the caliphate, while the elder Almamun was left second in the order of succession. He was at that time governor of Khorassan, and in obedience to his father's will acknowledged the supremacy of his brother. He, however, repaid his good-will with open hatred, and unjust attempts to exclude him from the succession. Almamun was thus forced to consult measures for his own safety and promotion, and caused himself to be proclaimed caliph. After various struggles, his general Thaher, in the year 813, took possession of Baghdad, pursued Al Amin to his retreat, and caused him to be assassinated, so that Almamun remained without a competitor. Various rebellions disturbed the tranquillity of the first years of his reign; but, by his prudent administration and vigorous exertions, these were at length extinguished. Instigated by the advice of his vizier, he soon after raised greater commotions, and exposed his dignity to greater dangers, by countenancing the sect of Ali. He invited to court Iman Rizza, gave him his daughter in marriage, and even declared him his successor in the empire. He assumed the green turban, the colour of the house of Ali, and obliged his courtiers and soldiers to imitate his example. Alarmed at these proceedings, the orthodox Mussulmans, and the house of Abbas, excited a great revolt in Baghdad, and proclaimed Ibrahim, Almamun's uncle, caliph. A civil war was just about to commence, when Fadel the vizier was assassinated, and Rizza died. The people of Baghdad then deposed Ibrahim, and returned to their former allegiance. Taking advantage of Almamun's absence, Thaher seized upon the government of Khorassan, where he founded a dynasty which existed but sixteen years.

Almamun employed the period of tranquillity that followed, in introducing literature into his dominions, and in its improvement; which constitutes the greatest glory of his reign. During the days of his father he discovered an ardent thirst after knowledge, by forming a college in Khorassan, adorned by the most eminent men of various countries; and appointed Mesue, a famous Christian physician of Damascus, for their president. When his father remonstrated against conferring such an honour upon a Christian, he reminded him that the most learned men and most skilful artists in his dominions were Jews and Christians; and added, that he had chosen Mesue as a preceptor in science and useful arts, and not as a teacher of religion. Under his auspices Baghdad became the seat of literature, of private and academical instruction, and the habitation of men of eminence from all quarters. Many valuable books in the Greek, Persian, Chaldean, and Coptic languages, among which were the works of Aristotle and Galen, were translated into the Arabic at his own expense. This caliph himself deemed it an honour to set an example to others of the becoming respect due to mental cultivation, by visiting the schools, and treating the professors with great regard. In mathematics, astronomy, and philosophy, he made a rapid and extensive progress. He was the author of astronomical tables, which, on account of their accuracy, have been much admired. By these various exertions the character of the Saracens was suddenly changed from rudeness and ferocity to politeness and civilisation, while the most powerful and extensive of the European states were involved in ignorance and barbarism. Literature has sustained some irreparable losses from his too great partiality to the Arabic writers, which induced him to destroy the originals of the translated manuscripts. He is represented by the Sonnites, or orthodox Mahometans, as little better than an infidel, because of his attention to philosophy and letters. His conduct, however, shows that he was not sufficiently careful to preserve a philosophical mean between the different religious parties during the time of his administration, as he openly manifested a predilection for the doctrines of the Motazeli, who asserted the free-will of man, and denied the eternity of the Koran. Some allege that, on account of the murmurs which arose against him, he was induced to exhibit too great a zeal, by establishing a kind of inquisition, to compel all his subjects to profess Islamism. The experiment, however, soon terminated in the better and juster expedient of universal toleration; and it is abundantly evident that the Christains in his dominions never felt the power of his inquisition.

The public transactions of his reign are in themselves important. In the years 822 he sent a body of his troops to the assistance of Thomas, a Greek, who made war on Michael the Stammerer, the emperor of Constantinople, and besieged his capital. This expedition, which on the part of the caliph seems to have been founded in justice, proved unsuccessful; Thomas was taken prisoner, and suffered death. In the years 829 and 830 he commenced hostilities upon the Greeks, rendered himself master of many places, and carried devastation into their territories. He was successful in supressing a revolt in Egypt in the year 831. In this country he was led to discover a treasure buried under

Almanack. two columns by Merwan, the last caliph of the house of Ommijah. In repairing a decayed *mikias* or measuring pillar, and erecting a new one for determining the gradation of the increase of the Nile, Almamun displayed his love of science. In the year 833 he again visited Egypt: on his return he penetrated into the territories of the Greek emperor, even into Cilicia. Returning home, he encamped on the banks of a river, and, excited by thirst, drank too freely of the water, and at the same time indulged himself immoderately in eating a particular kind of dates, which brought on a complaint in his stomach, and reduced him to the most imminent danger. Sensible of his approaching dissolution, he sent letters into all the provinces, declaring his brother Motassem his successor, and then patiently waited the event. After a tedious struggle under the pressure of his disease, and while uttering this ejaculation, "O thou who never diest, have mercy on me, a dying man!" he expired at the age of 48 or 49 years, after a reign of 27 years and some months.

ALMANACK, a book or table, containing a calendar of days and months, the rising and setting of the sun, the age of the moon, the eclipses of both luminaries, &c.—Authors are divided with regard to the etymology of the word; some deriving it from the Arabic particle *al*, and *manach*, to count; some from *almanach*, new-year's gifts, because the Arabian astrologers used at the beginning of the year to make presents of their ephemerides; and others from the Teutonic *almaen achte*, observations on all the months. Dr Johnson derives it from the Arabic particle *al*, and the Greek *μην*, a month. But the most simple etymology appears from the common spelling; the word being composed of two Arabic ones, *Al Manack*, which signify *the Diary*. All classes of the Arabs are commonly much given to the study of astronomy and astrology; to both of which they are inclined by their belief in fate, and by their pastoral life, which affords time and opportunity to cultivate them. They neither sow, reap, plant, nor undertake any expedition or business, without previously consulting the stars, or, in other words, their almanacks, or some of the makers of them. From these people, by their vicinity to Europe, this art, no less useful in one sense than trifling and ridiculous in another, has passed over to us; and those astronomical compositions have still everywhere not only retained their old Arabic name, but were, like theirs, for a long while, and still are among many European nations, interspersed with a great number of astrological rules for planting, sowing, bleeding, purging, &c., down to the cutting of the hair and paring of the nails. Regiomontanus appears to have been the first in Europe, however, who reduced almanacks into their present form and method, gave the characters of each year and month, foretold the eclipses and other phases, calculated the motions of the planets, &c. His first almanack was published in 1474.

The essential part of an almanack is the calendar of months and days, with the risings and settings of the sun, age of the moon, &c. To these are added lists of posts, offices, dignities, public institutions, with many other articles, political as well as local, and differing in different countries.

England has abounded in almanacks, some of them of no very creditable description, though widely circulated among the people for a long period of years. Such, in particular, were *Moore's Almanack*, and *Poor Robin's Almanack*, now happily, with several others of the same class, either extinct or about to become so. This change has been mainly owing to the publication of an entirely new almanack by the Society for the Diffusion of Useful Knowledge. The following statement is extracted from a curious article upon *English Almanacks*, in the *London Magazine*, third series, vol. ii. p. 591. "For a century and a half, the two universities and the Stationers' Company held the monopoly of them, by letters-patent of James I. During this period, according to the condition of the patent, almanacks received the *imprimatur* of the Archbishop of Canterbury and the bishops of London; and yet it would be difficult to find, in so small a compass, an equal quantity of ignorance, profligacy, and imposture, as was condensed in these publications. By the persevering exertions of one individual, the monopoly was overthrown about 1779; and the parties claiming the patent-right then applied to parliament for an act to confirm it. That bill was introduced by the minister of the day; but Erskine, then first coming into repute, appeared at the bar to oppose it,—and the monopoly was destroyed for ever, by a solemn vote of the House of Commons. From that time the Stationers' Company proceeded upon a different course. They secured their monopoly by buying up all rival almanacks; and they rendered the attempts of individuals to oppose them perfectly hopeless, by those arts of trade which a powerful corporation knew how to exercise. For the last fifty years they have rioted, as of old, in every abomination that could delude the vulgar to the purchase of their commodity. On a sudden a new almanack started up, under the superintendence and authority of a society distinguished for its great and successful labours to improve the intellectual condition of the people. For the first time in the memory of man, an almanack at once rational and popular was produced. From that hour the empire of astrology was at an end. The public press, infinitely to their honour, took up the cause. The blasphemy of Francis Moore, and the obscenity of Poor Robin, were denounced and ridiculed through all quarters of the kingdom. In one little year the obscene book was discontinued, the blasphemous book retreated into pure stupidity, and the publishers of the blasphemy and the obscenity applied themselves, in imitation of the first powerful rival they had ever encountered, to make a rational and useful almanack." The almanack of the Society for the Diffusion of Useful Knowledge is entitled the *British Almanack;* the improved one published in imitation of it by the Stationers' Company, is called the *Englishman's Almanack.* Of other British Almanacks, the most deserving of mention are *Oliver and Boyd's Edinburgh Almanack*, and *Thom's Irish Almanack and Official Directory;* of foreign almanacks, the *Almanach Royal de Belgique*, and the small but excellent *Almanach de Gotha*, now in its 89th year.

The French *Almanach Royal* is one of the most extensive publications of this class, the volume generally extending to about a thousand octavo pages.

*Almanack, Nautical.* This, which in some respects is a national almanack, is published under the sanction of the Board of Longitude, and is designed chiefly to facilitate the use of Mayer's Lunar Tables, by superseding the necessity of making calculations to determine the longitude at sea. It commenced with the year 1767, and has ever since been continued annually, but two or three years in advance. The late Dr Maskelyne was the originator of this very valuable publication. It is now published under the immediate superintendence of the secretary to the Board. Similar to this almanack is the French publication entitled *Connoissance des Tems*, directed by the *Bureau de Longitude*, and which commenced so early as the year 1698. At Berlin, the celebrated Bode for about 50 years conducted the excellent astronomical almanack, *Astronomisches Jahrbuch*, which is still continued.

Almanack, among *Antiquaries*, is also the name given to a kind of instrument, usually of wood, inscribed with various figures and Runic characters, and representing the order of the feasts, dominical letters, days of the week, and golden number, with other matters necessary to be known throughout the year; used by the ancient northern nations in their computations of time, both civil and ecclesiastical. Almanacks of this kind are known by various names among the different nations in which they have been used, as rimstocks, primstaries, runstocks, runstaffs, clogs, *Scipiones Runici, Bacculi Annales*, &c. They appear to have been used only by the Swedes, Danes, and Norwegians. From the second of these people their use was introduced into England, whence divers remains of them in the counties. Dr Plot has given the description and figure of one of these clogs, found in Staffordshire, under the title of *The Perpetual Staffordshire Almanack*. The external figure and matter of these calendars appear to have been various. Sometimes they were cut on one or more wooden leaves, bound together after the manner of books; sometimes on the scabbards of swords, or even daggers; sometimes on tools and implements, as portable steelyards, hammers, the helves of hatchets, flails, &c. Sometimes they were made of brass or horn; sometimes of the skins of eels, which being drawn over a stick properly inscribed, retained the impressions of it. But the most usual form was that of walking staves, or sticks, which they carried about with them to church, market, &c. Each of these staves is divided into three regions; whereof the first indicates the signs, the second the days of the week and year, and the third the golden number. The characters engraven on them are, in some, the ancient Runic; in others, the later Gothic characters of Ulfilas. The saints' days are expressed in hieroglyphics, significative either of some endowment of the saint, the manner of his martyrdom, or the like. Thus, against the notch for the 1st of March, or St David's day, is represented a harp; against the 25th of October, or Crispin's day, a pair of shoes; against the 10th of August, or St Lawrence's day, a gridiron; and, lastly, against New-year's day, a horn, the symbol of liberal potations, which our ancestors indulged in at that period.

ALMANSA, a small city of Spain, in the province of Albacete, to the north of the river Segura. A pyramid erected near it commemorates the decisive battle fought here in 1707, when the French and Spaniards, under the Duke of Berwick, gained a complete victory over the united forces in the interest of the Archduke Charles. It now contains 8700 inhabitants.

ALMANSUR, *i. e., the Victorious*, the second caliph of the house of Al Abbas, succeeded his brother Abul Abbas Al Saffah in the year 753, of the Hegira 136, and in the following year was inaugurated at Al Hashemiyah. Although Al Saffah had declared him presumptive heir of the crown, and he had been proclaimed caliph in the imperial city of Anbar, yet immediately upon his inauguration his uncle Abdallah ebn Ali had sufficient interest to cause himself to be proclaimed caliph at Damascus. In Arabia, Syria, and Mesopotamia, he collected a numerous army, and arrived at the banks of the Masius, near Nisibis, where he encamped, ready to dispute his royal accession by arms. Almansur collected an immense army in Persia, Khorassan, and Irak, and gave the command of it to Abu Moslem, who harassed his uncle's troops for five months, and at last totally defeated him, A.D. 754. Notwithstanding the services which Abu Moslem had rendered to the family of Al Abbas, after this victory he became an object of jealousy, and was assassinated in the presence of Almansur himself, by his express order. After the death of Abu Moslem, the standard of rebellion was raised by Simon, a Magian, who seized on the treasures of the deceased governor of Khorassan, and excited the people of that country to a general revolt; but this insurrection was suddenly quelled by the general of Almansur, Jamhur ebn Morad. The caliph avariciously seized the spoils of this victory, which so incensed Jamhur that he immediately turned his arms against his royal master; but he was soon defeated by the caliph's forces. The patriarch of Antioch was about this time detected in an illicit correspondence with the Grecian emperor, and consequently was banished into an obscure part of Palestine; and in the mean time the Christians in the dominions of the caliph were prohibited from building or repairing any churches, and also were laid under several other severe restraints.



Almansur sent a large army into Cappadocia in the year 757, fortified the city of Malatia or Melitene, and deposited in it a great part of his treasures. But in this year he was attacked by a sect of believers in the metempsychosis, called the *Rawandians*. This sect assembled at Al Hashemiyah, the residence of the caliph, and, by the ceremony of going in procession round his palace, intimated their purpose of invoking him as a deity, and paying him divine homage. Incensed by their impiety, the caliph ordered several of these sectaries to be imprisoned, which roused their resentment, and led them to form the design of his assassination. The generous interposition, however, of Maan ebn Zaidet, an Ommiyan chief, who had been under the necessity of concealing himself from the caliph's resentment, defeated their intention. This insult, received in his capital, induced him to build the city of Baghdad, and to fix his residence there, A.D. 762. In the preceding year a plan was formed to dethrone him; but it being discovered, he severely punished all who were either directly or indirectly concerned in it. He set out on a pilgrimage to Mecca in the year 774, and being seized on the road with a dangerous disease, he sent for his son and intended successor Al Mohdi, and gave him some salutary advice. "I command you," said he, "to treat publicly your relations with the greatest marks of distinction, since this conduct will reflect no small degree of honour and glory upon yourself. Increase the number of your freedmen, and treat them with all kindness, as they will be of great service to you in your adversity; but neither this nor the other injunction will you fulfil. Enlarge not that part of your capital erected on the eastern bank of the Tigris, as you will never be able to finish it; but this work I know you will attempt. Never permit any of your women to intermeddle in affairs of state, or to have any influence over your councils; but this advice I know you will not take. These are my last commands; or, if you please, my dying advice; and to God I now recommend you." In parting they both gave vent to their feelings in a flood of tears. He pursued his journey to Bir-Maimun, *i. e.*, the well of Maimun, where he died in the 63d year of his age and 20th of his reign. His remains were interred at Mecca.

ALMARAZ, a small town of Estremadura in Spain. About two miles south of the town flows the Tagus, which is here crossed by a bridge built by Charles V. in 1552. The defeat of the French here by Lord Hill on 18th May 1812, was one of the most brilliant actions of the peninsular war.

ALMARIC, the name of a tenet introduced in France by one Almaric, in the thirteenth century. It consisted in holding that every Christian was actually a member of Christ, and that without this faith no one could be saved. His followers went farther, and affirmed that every one is to be saved by the internal operation of the Holy Spirit alone, without any external act of religion. Their morals were as infamous as their doctrine was absurd. Their tenets were condemned by a public decree of the council of Sens, in the year 1209.

ALMAZARRON. See MAZARRON.

ALMAZORA, a Spanish town on the sea-shore, in the province of Castellon de la Plana, remarkable for a grand tunnelled aqueduct, executed in the year 1640, for conducting the waters of the Mijares to irrigate the fine plain of Castellon. Lat. 39. 53. N. Pop. 3636.

ALME, or ALMA, singing and dancing girls in Egypt, who, like the Italian *Improvisatori*, can occasionally pour forth "unpremeditated verse." They are called *Almé*, from having received a better education than other women. They form a celebrated society in that country. To be received into it, according to M. Savary, it is necessary to have a good voice, to understand the language well, to know the rules of poetry, and be able to compose and sing couplets on the spot, adapted to the circumstances. The Almé know by heart all the new songs. Their memory is furnished with the most beautiful tales. There is no festival without them, no entertainment of which they do not constitute the ornament. They are placed in a rostrum, from whence they sing during the repast. They then descend into the saloon, and form dances which have no resemblance to ours. They are pantomime ballets, in which they represent the usual occurrences of life. The mysteries of love, too, generally furnish them with scenes. The suppleness of their bodies is inconceivable; and the mobility of their features gives at pleasure the impression suited to the characters they play. The indecency of their attitudes is often carried to excess. The common people have also their Almé. They are girls of the second class, who try to imitate the former; but have neither their grace nor their intelligence.

ALMEHRAB, a niche in the Mahometan mosques, pointing towards the kabba or temple of Mecca, to which they are obliged to bow in praying.

ALMEIDA, a strong fortress of Portugal, in the province of Beira. It is situated between the rivers Coa and the Duas Casas, which forms a branch of the Agueda. The capture of it by the duke of Wellington in 1811, after it had fallen into the hands of the French, was deemed one of the most brilliant exploits of the peninsular war. It is about four leagues from the Spanish fortress of Ciudad Rodrigo. It is well fortified, though till the late war it was not considered so important as it was then deemed. The Spanish engineers did not estimate it as a defence to Lisbon, but merely as covering the province of Beira, into which, according to their judgment, a Spanish army ought never to attempt to penetrate. This place contains 6200 inhabitants, an hospital, one monastery, one church, and a poor-house. Lat. 40. 37. N. Long. 6. 52. W.

ALMEISAR, a celebrated game among the ancient Arabs, performed by a kind of casting of lots with arrows, and strictly forbidden by the law of Mahomet, on account of the frequent quarrels occasioned by it.

ALMELO, an arrondissement in the province of Overyssel, in the Netherlands, containing five cantons and 62,000 inhabitants. Its capital, of the same name, contains 3200 inhabitants, chiefly engaged in the linen manufacture.

ALMERIA, a modern province of Spain, comprehending the eastern portion of the ancient kingdom of Granada. It is bounded on the north by Jaen and Murcia, on the east and south by Murcia and the Mediterranean, and on the west by Granada. It embraces an area of about 3800 square miles; with a population in 1849 of 292,234. Its whole extent is traversed by mountain-ridges, some of them of considerable elevation; with corresponding valleys and plains of great fertility. This province is one of the richest in minerals of all Spain; the mountains yielding silver, mercury, lead, antimony, copper, and iron. The silver mines of the Sierra de Almagrera, opened in 1839, produced in 1843 nearly 1,700,000 ounces; while the lead mines of the Sierra de Gador, a branch of the Alpujarras, are computed to have yielded, from 1795 to 1841 inclusive, 11,000,000 quintals of lead. The principal rivers are the Almanzora, running from west to east, with a course of about 50 miles; the Almeria north-west to south-east; and the Adra from north to south, watering the fertile district between the Sierra de Gador and the Alpujarra proper. The climate is mild, except in the interior, where the winter is cold. On the coast rain seldom falls, and south-west winds prevail. The inhabitants are principally engaged in mining and in agriculture. All kinds of grain are raised in abundance. The common fruits are plentiful, as well as oranges, lemons, and vines. Much excellent silk is produced in the western districts. Cattle are extensively bred; those of the valley of the Almeria are especially remarkable for their size and beauty. The manufactures consist chiefly of esparto cordage, white-lead, shot, soap, saltpetre, and leather. The principal exports are lead, esparto, barilla, and soap. The imports consist of woollen and cotton stuffs from Catalonia; silk from Valencia and Malaga, and linen from Marseilles and Gibraltar. Education in this province is in a backward state; the means of instruction not extending to half the population. The ratio of crime is consequently high, being to the population as 1 to 355.



ALMERIA, the capital of the above province, is situated on a rocky promontory near the Cabo de Gata, and from the strength of the port was deemed by the Moorish kings of Granada the most valuable of their fortresses and commercial ports; from whence their cruisers overawed the Catalans and Italians, and the merchants conveyed their various merchandise to Africa, Egypt, and Syria. Almeria is the see of a bishop, and has a splendid cathedral. Its exports consist chiefly of lead, esparto, and barilla; its imports of woollen, cotton, linen, silk, and hardware. Pop. 18,000. Long. 2. 32. 54. W. Lat. 36. 51. N.

ALMEYDA, DON FRANCISCO, was the son of the count d'Abrantes, a grandee of Portugal, who served with great distinction in the war of Ferdinand of Castile with Granada. His important services gained him high esteem in the court of his sovereign. Without any solicitation on his part he was nominated the first viceroy of the newly conquered countries in the East Indies, and set sail from Lisbon in March 1505 with a powerful fleet. He touched at the Cape Verde islands, doubled the cape at a considerable distance to the south, and arrived at Guiloa. From thence he proceeded to Mombaza, a well-fortified city in an island, which he reduced, and proceeded to the Angediva islands, not far from Goa, where he built a fort: he likewise erected and garrisoned another fort at Cananore, and arriving at Cochin, he secured it to the Portuguese interest. The island of Madagascar was discovered during his government; and his son Don Lorenzo first surveyed the Maldive islands, and about the same time discovered the island of Ceylon, the principal sovereign of which he brought under submission to the crown of Portugal. Returning from this expedition, while employed in the fleet destined against Calicut, he lost his life in a sea-fight against the Zamorin. His father sustained his loss with an heroic firmness, saying that "Lorenzo could not die better than in the service of his country." On the arrival of Alphonso d'Albuquerque, who was destined to be his successor, Almeyda yielded to the impressions of jealousy; and under the pretence of misconduct he confined him to the citadel of Cananore. He engaged in 1508 the whole force of the Mahometans in the port of Diu; and, gaining a complete victory, facilitated the enterprises of Albuquerque his successor, by contributing to break that formidable league by which the Zamorin was in hopes of being able to compel the Portuguese to abandon their Indian conquests. Returning home with the great riches which he had acquired, he unfortunately touched at Saldanha Point, on the coast of Africa, where some of the sailors, in quest of water, quarrelled with the natives, who attacked and drove them to their ships. With a view to revenge this pretended affront, they persuaded Almeyda himself to go ashore, with a body of 150 men, armed only with swords and lances.

While stepping into the boat, Almeyda exclaimed, "Whither do you carry my sixty years?" The Portuguese furiously rushed on to attack the natives, whose numbers were greatly augmented; and Almeyda, with fifty-seven of his men, was killed in this rash and unprovoked attempt.

ALMIGGIM. See ALMUGGIM.

ALMISSA, a small but strong town at the mouth of the Cetina, in Dalmatia, famous for its piracies; 16 miles south-east of Spalatro. Long. 16. 40. E. Lat. 43. 30. N.

ALMOHEDES, or ALMOHADES, a Mahometan dynasty that flourished in Africa and in Spain during the twelfth and thirteenth centuries. This title was derived from the religious sect of *Al-Mou-ah-hedi*, which in Arabic signifies Unitarians. Mohammed-ben-Toumert, the founder of this sect, was the son of a lamp-lighter in the great mosque at Sous-el-Aksa, and was a person of bold, subtle, and ambitious character. He prepared himself for the part he intended to play by travelling in the East; and at Baghdad he became the disciple of the famous philosopher Algazeli, from whom he acquired a knowledge of those abstruse mysteries by which he hoped to impose on his superstitious countrymen. For this purpose he connected himself with Abdelmoumen, a young Mussulman of great abilities, whom he sent forth as his apostle to propagate the new doctrine; while in his own person he affected an unusual degree of piety and mortification, appearing in tattered garments, and interdicting the use of wine, music, and every gratification of the senses. His fame spread rapidly among the mountain tribes of Mahgreb, and the ignorant multitude adopted his opinions with eager zeal. Entering the city of Marocco, this new prophet foretold the downfall of the existing dynasty, and mocked the authority of the reigning prince Ali-ben-Yusseff. Ali, lulled in security, despised his predictions as the mere ravings of a fanatic; and it was not without some difficulty that he was at length prevailed on to banish him from the city. Mohammed retired to the mountains, and fortified the town of Tinmal, which he defended against every assault of his enemies. Here throwing off the mask, he gave out that he was the Imam Mahdi, who had miraculously disappeared, and now was come as the vicegerent of Mahomet, invested with all temporal and spiritual authority for the purpose of restoring the true religion. His retreat became the rendezvous of a numerous sect, who assumed the title of Almouahhedi, or Almohedes, and asserted that they alone of all the Mussulmans maintained the religion of Islam in its original purity. Many Arab and Berber tribes acknowledged this impostor as their political chief, and 20,000 soldiers rallied around his standard. Ali only perceived the error he had committed when it was too late: his armies, at each encounter, were panic-struck, and fled. Yet notwithstanding the great success of the Almohedes, the vast empire of the Almoravides was not all at once subdued: and Mohammed, after an ineffectual attempt to reduce the city of Marocco, died in the year 1130, having failed to accomplish the object of his ambition, the possession of a throne. He was succeeded by Abdelmoumen, who assumed the title of *Emir-el-Moumenin*, or commander of the Faithful. During the thirty years that he reigned, and under his descendants, Yusseff, and Yacoub called Almanzor-Billah, the dynasty of the Almohedes was exceedingly illustrious, and the arts flourished greatly. They rendered themselves masters of the provinces of Fez, Marocco, Tremcen, Oran, and Tunis; and passing into Spain, they overran Andalucia, Valencia, and a part of Aragon and of Portugal, as far as the Ebro on one side, and the Tagus on the other. But this vast empire was not of long continuance: for in the year 1212, when the Moslems under Mohammed were defeated by the Christian princes of Spain in the great battle of Las Navas, near Tolosa, the governors of the several provinces took advantage of that disaster to throw off their allegiance, and declared themselves independent; an example that was the signal for a general revolt. The dynasty of the Almohedes became extinct in Spain in the year 1257, and in Africa in 1269. The last sovereign of this race, who had with difficulty maintained a shadow of power in the city of Marocco, was assassinated by a slave. They were succeeded by the dynasties of the Hassides, the Meyanides, and the Merinides. See ALMORAVIDES.



ALMOND (*Amygdalus communis*), a tree belonging to the natural order Rosaceæ, a native of Asia and Northern Africa, but also acclimated and cultivated in the milder parts of Europe. On account of its beautiful vernal flowers and ornamental appearance it is much grown in England; but in this climate the fruit seldom arrives at maturity. It attains the height of 12 or 14 feet; the flowers are of a pink colour, growing in pairs, and pentapetalous; the leaves oval, pointed, and delicately serrated. The covering of the fruit is a thick-set down on a thin coriaceous pericarp, enclosing a hard shell which contains an emulsive kernel. The bitter almond is produced by a variety of the same species: it yields a yellowish volatile oil when distilled from contact with water, and is heavier than that fluid. The oil obtained by expression from either kind is bland and tasteless. The flavour of the bitter almond is not derived from hydrocyanic acid alone, but from an essential oil, which, however, is only produced when water comes into contact with the vegetable albumen of bitter almond; for the dry kernel has no flavour, and the essential oil is only generated when water is added to the bruised kernel. Some individuals are highly susceptible of the poison of bitter almonds; and instances have occurred where even death has ensued from eating them in no great quantity. The leaves also of this tree contain the hydrocyanic or prussic acid.

Valencia was long famous for its almonds, but the best now come from Malaga, and the bitter kind chiefly from Mogadore in Barbary. The quantity imported into Britain in 1849 was as follows:—sweet almonds, 25,897 cwt.; bitter almonds, 6141 cwt. The quantity exported was—sweet almonds, 14,087 cwt.; bitter almonds, 2866 cwt. (T. S. T–L.)

ALMOND *Furnace*, among refiners, that in which the slags of litharge, left in refining silver, are reduced to lead again by the help of charcoal.

ALMONDBURY, a township of the wapentake of Agbrigg, in the west riding of the county of York. It is situated on the river Calder, and had formerly a cathedral and a strong castle. It is 186 miles distant from London, in a manufacturing district near Huddersfield, and is noted for its extensive manufactures of woollens. It has a good grammar-school. The population in 1841 was 8828; in 1851, 9749.

ALMONDS, in *Anatomy*, a name sometimes given to two glands, generally called the *tonsils*.

ALMONDS, among lapidaries, signify pieces of rock-crystal, used in adorning branch-candlesticks, &c., so called from the resemblance they bear to the fruit of that name.

ALMONER, in its primitive sense, denotes an officer in religious houses, to whom belonged the management and distribution of the alms of the house. By the ancient canons, all monasteries were to spend at least a tenth part of their income in alms to the poor. The almoner of St Paul's is to dispose of the moneys left for charity, according to the appointment of the donors, to bury the poor who die in the neighbourhood, and to breed up eight boys to singing, for the use of the choir. By an ancient canon, all bishops are required to keep almoners.

*Lord* ALMONER, or *Lord High* ALMONER *of England*, is an ecclesiastical officer, generally a bishop, who has the forfeiture of all deodands, and the goods of a *felo de se*, which he is to distribute among the poor. He has also, by virtue of an ancient custom, the power of giving the first dish from the king's table to whatever poor person he pleases, or, instead of it, an alms in money.

ALMORAH, in Northern India, the chief town of the British province of Kumaon, in the territories of the lieutenant-government of Agra. It is built on a ridge of the Himalaya Mountains, 5337 feet above the level of the sea, and consists chiefly of a single street, about three fourths of a mile long, and about 50 feet wide, which runs along the ridge of the mountain, with scattered dwellings, chiefly inhabited by Europeans, to the right and left hand on the descent of the hill. The main street has a gate at each end; and Bishop Heber mentions that it reminded him, on a small scale, of Chester. The houses all stand on a lower story of stone, where the shops are. This is open in front, while the upper stories are faced with a framework of wood, occasionally carved and painted, supported on the projecting side-walls below, and surmounted by a sloping roof of heavy gray slate, on which many of the inhabitants pile up their hay in small stacks, as winter provender for their cattle. The town is very neat, and the street has a natural pavement of slaty rock, which is kept beautifully clean. It is very strongly situated, and is approached by a long, steep, and winding road, which a handful of men might defend against an army. From Almorah the vast range of the Himalaya Mountains bounds the prospect to the north. Nundidevi, one of the highest peaks in the world, being 25,689 feet above the level of the sea, is within 40 miles from Almorah in a direct line, though it is a nine days' journey by the only accessible road through the mountains. There is an old Ghorkha citadel, which stands on a commanding point of the ridge, at the eastern extremity; and several martello towers have been erected. A citadel, named Fort Moira, has been constructed on a small eminence at the western extremity of the town. It is, according to Bishop Heber, very ill contrived, and incapable of defence against a resolute enemy. The surrounding country is of a bleak and desolate character, and there is scarcely a tree within a circuit of four miles from the walls. Almorah was conquered in 1790 by the Ghorkhas. It subsequently attained some celebrity as the scene of the British victory which terminated the war with Nepaul. The attack of the heights and town by Colonel (now Sir Jasper) Nicolls, on the 25th April 1815, was crowned with complete success. The breastworks of the enemy were carried in rapid succession, and before the evening the British had established themselves in the occupation of a considerable section of the town. On the succeeding day preparations were commenced for an assault upon the fort, but while these were in progress, the Ghorkha commander proposed a suspension of hostilities preparatory to a permanent pacification. The result was the conclusion of a convention under which the Nepaulese evacuated Kumaon, and the province was forthwith incorporated with the British dominions. Distant north-west from Calcutta by Lucknow and Bareilly 910 miles. Lat. 29. 35. Long. 79. 42. (E. T.)

ALMORAVIDES, a family of Mahometan princes who reigned in Africa and in Spain in the eleventh and twelfth centuries. This appellation was derived from the sect of *Al-Morabethin*, which in Arabic signifies 'dedicated to the service of God.' The sect which assumed this title arose about the middle of the eleventh century, among a poor ignorant tribe of Berbers inhabiting the Mountains of Atlas on the shores of the Atlantic Ocean, and at a time when all Western Africa was in the possession of strangers, and a prey to anarchy. At the request of a sheik of Lamtouna, who had acquired some taste for learning by travelling in the East, Abdallah-ben-Yazim, an Arabian of extraordinary erudition, consented to instruct the people in the truths of Islam. The enthusiasm of Abdallah created a like zeal in the hearts of his ignorant hearers. All the chief persons were filled with admiration at his wisdom; and by the energy and novelty of his discourses he so inflamed the minds of his disciples, that they compelled those whom persuasion could not move to embrace the new religion. Thus Abdallah found himself at the head of a numerous sect, who soon began to regard him as their leader, both in temporal and spiritual matters. A wide field was opened to his ambition; and by fostering the fanatical zeal of his adherents, he spread the terror of his arms far and wide. Under the name of Almorabethin or Almoravides, they overran the country of Daza, lying between the desert of Sahara and the ancient Getulia; and ultimately extended their conquests from the shores of the Mediterranean to the frontiers of Nigritia. This extraordinary man died on the field of battle in the year 1058. He was succeeded by Abou-Bekr-ben-Omar, a man whose abilities were scarcely equal to the difficulties of the position in which he was placed. The commencement of his career, indeed, was prosperous; for he seized upon the province of Fez, conquered Mequinez and Lewata, and founded the city of Marocco: but, when an insurrection among the Berbers required his presence in Atlas, he had the imprudence to entrust the government to the ambitious Yusseff-ben-Taxefien, a person whose abilities were superior to his own; and on his return he accordingly found himself supplanted by his rival. Yusseff possessed every requisite of a conqueror and a legislator; and when he was firmly established in power, he resolved to turn his arms against Spain. He passed the straits, and after receiving re-inforcements from all the emirs who had partitioned among themselves the empire of the Ommiades, he marched against Alonzo VI., the most potent prince in Christendom. They met in the plains of Zalaca, and Alonzo was defeated with terrible slaughter. The news of Yusseff's success induced many of the Arabs of Spain to enlist under his victorious banner. He then attacked Mohammed, king of Andalucia; and after a protracted siege he became master of Seville. This conquest was followed by the subjugation of Almeria, Denia, Xativa, and Valencia. The acquisition of the Balearic Isles was the completion of this vast empire, which extended from the Ebro and the Tagus to the frontiers of Soudan. Although Marocco was his capital, he frequently visited his Spanish dominions; and on the last occasion, having assembled the governors of the provinces at Cordova, he appointed Ali, the youngest of his sons, as his successor. He then returned to Marocco, where he died at a very advanced age, A.D. 1106 (of the Hegira 500), after a reign of forty years.

Few kings have received so noble a heritage as that to which Ali succeeded. The first years of his reign were prosperous, though disturbed by the Almohedes, who were preparing the way for the destruction of the Almoravides. Ali was at last obliged to recal from Spain his son Taxefien, who was using his utmost endeavours to oppose the victorious career of Alonzo of Aragon, surnamed the Fighter. But the valour of Taxefien was of little avail against the rising power of the Almohedes: disaster followed disaster; and when, in 1143, he succeeded to the throne, but a moiety of the kingdom remained. It was in vain that he received succours from Spain, the troops from that soft climate being little fitted for service in the wild regions of Atlas. Driven from Tlemecen, he sought refuge in Oran; but Abdelmoumen appeared before its walls, and by threats so intimidated the inhabitants that Taxefien was compelled to provide for his safety by flight. Concealed by the darkness of night he escaped on horseback, with his favourite wife behind him; but being closely pursued, he urged his horse over a precipice, and with his wife was dashed to pieces. Such was the end of this prince; and with him expired the domination of the Almoravides: for although they still remained in possession of the city of Marocco, their power was completely broken. Ishak-Ibrahim, the son of Taxefien was taken and put to death at Alcazar in 1146, on the surrender of Marocco by treachery, after a siege which was attended with all the horrors of famine and disease; and with him the dynasty of the Almoravides became extinct. (*For the history of the Arabians in Spain, see the works of Cartas, Cardonne, Condé, Dombay, St Hilaire, and D'Herbelot.*)

ALMS, a general term for what is given out of charity to the poor. In the early ages of Christianity, the alms of the charitable were divided into four parts; one of which was allotted to the bishop, another to the priests, and a third to the deacons and subdeacons, which formed their whole means of subsistence: the fourth part was employed in relieving the poor, and in repairing the churches. No religious system is more frequent or warm in its exhortations to almsgiving than the Mahometan. The Koran represents alms as a necessary means to make prayer be heard. Hence that saying of one of their caliphs: "Prayer carries us halfway to God, fasting brings us to the door of his palace, and alms introduce us into the presence-chamber." Hence many illustrious examples of this virtue among the Mahometans.

ALMS also denotes lands or other effects left to churches or religious houses, on condition of praying for the soul of the donor, a tenure by which many of the old monasteries and religious houses in Britain held their lands. Lands thus held were free of all rent or service. Hence

*Free ALMS, Frank Almoign*, that which is liable to no rent or service.

*Reasonable ALMS*, a certain portion of the estates of intestate persons, allotted to the poor.

*ALMS Box* or *Chest*, a small chest or coffer, called by the Greeks Κιβωτιον, wherein anciently the alms were collected, both at church and at private houses.

The alms-chest, in English churches, is a strong box, with a hole in the upper part, having three keys, one to be kept by the parson or curate, the other two by the church-wardens. The erecting of such alms-chest in every church is enjoined by the book of canons, as also the manner of distributing what is thus collected among the poor of the parish.

ALMUCANTARS, in *Astronomy*, an Arabic word, denoting circles of the sphere passing through the centre of the sun or a star, parallel to the horizon, being the same as *PARALLELS of Altitude*.

*ALMUCANTAR's Staff* is an instrument usually made of pear-tree or box, having an arch of 15 degrees; used to take observations of the sun, about the time of its rising and setting, in order to find the amplitude, and consequently the variation of the compass.

ALMUCIUM, denotes a kind of cover for the head, worn chiefly by monks and ecclesiastics. It was of a square form, and seems to have given rise to the bonnets of the same shape still retained in universities and cathedrals.

ALMUDE, a liquid measure in Portugal. At Lisbon, 26 almudes make a pipe. It is applied also to a corn measure in Spain and Barbary.

ALMUGGIM, ALMIGGIM, or ALMUG TREE, a certain kind of wood mentioned in the First Book of Kings (x. 11), which the Vulgate translates *ligna thyina*, and the Septuagint *wrought wood*. The Rabbins generally render it *coral;* others, *ebony, brazil*, or *pine*. But it is observed, that the almug tree can by no means be coral, because that is not fit for the purposes for which the Scripture tells us the almug tree was used, such as musical instruments, staircases, &c. The word *thyinum* is a name for the citron tree, known to the ancients, and very much esteemed for its sweet odour and great beauty. It came from Mauritania. The almug tree, or almuggim, or simply gummim, taking *al* for a kind of article, is, therefore, by the best commentators, understood to be an oily and gummy sort of wood, and particularly that sort of tree which produces the gum ammoniac; which is also thought to be the same with the shittim wood so frequently mentioned by Moses.



ALMUNECAR, a small city of the province of Granada, in Spain. The soil around it is productive of all the tropical vegetables. Sugar-canes grow as large and as juicy as in the West Indies, the cotton is of excellent quality, and the rum made here is deemed equal to that of Jamaica. The anchorage is fit for small vessels only, and its exposure to gales from the east, which are frequent, renders it insecure. It contains 5000 inhabitants. Long. 3. 54. W. Lat. 36. 42. N.

ALNAGE, or AULNAGE, the measuring of woollen manufactures with an ell. It was at first intended as a proof of the goodness of that commodity; and accordingly a seal was invented as a mark that the commodity was made according to statute.

ALNAGER, ALNEGER, or AULNEGER, signifies a sworn public officer, who, by himself or deputy, was to look to the assize of woollen cloth made throughout the land, *i. e.*, the length, width, and work thereof; and to the seals for that purpose ordained. The office of king's alnager seems to have been derived from the statute of Richard I., A.D. 1197, which ordained that there should be only one weight and one measure throughout the kingdom; and that the custody of the assize or standard of weights and measures should be committed to certain persons in every city and borough. His business was, for a certain fee, to measure all cloths made for sale. The office was abolished by stat. 11th & 12th Gul. III., cap. 20.

ALNUS, a botanical genus to which our common alder belongs.

ALNWICK, a thoroughfare town in Northumberland, on the road to Scotland. Here, in 1093, Malcolm king of Scotland, making an inroad into Northumberland, was killed, with Edward his son, and his army defeated, by Robert Moubray, earl of this county. Here also William king of Scotland, in 1174, invading England with an army of 80,000 men, was encountered, his army routed, and himself made prisoner. The town is in general well built; and has a large town-house, where the quarter-sessions and county-courts are held, and members of parliament elected. It has a spacious square, in which a market is held every Saturday. From the vestiges of a wall still visible in many parts, and three gates which remain almost entire, Alnwick appears to have been formerly fortified. This borough is governed by four chamberlains, and 24 common council men. It is ornamented by a stately old Gothic castle, the seat of the noble family of Percy, dukes of Northumberland. The manner of making freemen is peculiar to this place, and is indeed as ridiculous as singular. The persons who are to be made free, or, as the phrase is, "leap the well," assemble in the market-place, very early in the morning, on the 25th of April, being St Mark's day. They appear on horseback, with every man his sword by his side, dressed in white, and with white nightcaps, attended by the four chamberlains and the castle bailiff, mounted and armed in the same manner. From hence they proceed, with music playing before them, to a large pool called *Freeman's Well*, where they dismount, and draw up in a body, at some distance from the water; and then rush into it all at once, and scramble through the mud as fast as they can. As the water is generally very foul, they come out in a dirty condition; but they put on dry clothes, remount their horses, and ride at full gallop round the confines of the district; then re-enter the town, sword in hand, and are met by women dressed in ribbons, with bells and garlands, dancing and singing. They are called *timber-wasts*. The houses of the new freemen are on this day distinguished by a great holly bush, as a signal for their friends to assemble and make merry with them after their return. The establishment of this singular ceremony is traditionally referred to King John, who was mired in this well, and, as a punishment for not mending the road, made this a part of their charter. Alnwick is 310 miles north by west from London, 33 north of Newcastle, and 29 south of Berwick. Long. 1. 42. W. Lat. 55. 24. N. Pop. in 1851, 6231.

ALOA, in *Grecian Antiquity*, a festival kept in honour of Demeter and Dionysius by the husbandmen, and resembling our harvest-home.

ALOE or ALOES, the name of a genus of plants of the natural order of *Asphodeleæ*. See BOTANY. But the name is also applied to an extract obtained from several species, and employed in medicine as a cathartic. The most valued kind is named Socotrine aloes; although the small island in the Arabian seas from which it has obtained its name, produces but a small part of the drug that goes under its name. Six kinds are known in commerce. 1. Clear garnet red aloes, a very rare variety. 2. Socotrine aloes, now chiefly brought from India. 3. Common East Indian aloes. 4. Barbados, or Hepatic aloes, much used in farriery. 5. Cape aloes, often sold as the Socotrine variety. 6. Caballine aloes, a soft inferior sort, formerly much used by farriers, but now superseded by the Barbados aloes. The active principle in this drug is a peculiar extractive matter soluble in water and in proof spirit, but not in strong alcohol; from which it was considered as allied to gum resins; but it is now believed to be a highly oxidated extract. This substance, called *Aloesine*, varies in quantity in each species, from 52 to 80 per cent.—See *Christison's Dispensatory*.

ALOGI (α, privative, and λογος), in *Church History*, a sect of ancient heretics, towards the close of the second century, so called because they denied that Jesus Christ was the Logos. They likewise denied the continuance of the *charismata*, or special spiritual gifts, in the Christian church, and accordingly rejected the prophetical portions of the New Testament, besides the Gospel of John. They were particularly opposed to the Montanists; but our information regarding them is very scanty. They are first mentioned by Epiphanius.

ALOGOTROPHIA, among *Physicians*, a term signifying the unequal growth or nourishment of any part of the body, as in the rickets.

ALOPECIA, a term used among physicians to denote a total falling off of the hair from certain parts.

ALOPECURUS, a genus of the natural order of grasses or gramineæ. *A. pratensis* is our meadow foxtail: *A. arvensis*, field foxtail: *A. geniculatus*, float foxtail.

ALORA, a Spanish town, in the judicial district of the same name, and province of Malaga. Pop. 6794. This is the ancient *Iluro* or *Lauro*, where Cn. Pompeius the younger was slain after the battle of Munda.—Florus, Hirtius (*De Bell. Hispan.*)

ALOSA, a fossil genus of fishes of the Cycloïd order. It is also the trivial name of a living *Clupea*, our herring.

ALOST or AALST, a town of Belgium, in the province of East Flanders, and chief town of the arrondissement of the same name. It is situated on the Dender, about half way between Brussels and Ghent; and vessels of small size come up to the town. It is clean and well built; has a college and other educational establishments; and carries on a considerable trade in corn, hops, beer, and the produce of its linen, cotton, and lace manufactories. By the census of October 1846, it had 3010 houses, and 17,226 inhabitants. The arrondissement of the same name is divided into 11 cantons, 81 communes, and, by the same census, had a population of 138,251. Lat. 50. 57. N. Long. 4. E.



ALP ARSLAN, or AXAN, the second sultan of the dynasty of Seljuk, in Persia, and great-grandson of Seljuk the founder of the dynasty. He was born in the year 1030, of the Hegira 421. In place of Israel, which was his original name, he assumed that of Mohammed when he embraced the Mussulman faith; and, on account of his military prowess, he obtained the surname *Alp Arslan*, which in the Turkish language signifies *a valiant lion*. Having held the chief command in Khorassan for ten years as lieutenant of his uncle Togrul Beg, he succeeded him in the year 1063, and, at the commencement of his reign, saw himself sole monarch of Persia, from the river Amu to the Tigris. When he assumed the reins of government, faction and open rebellion prevailed in his dominions; in subduing which he was ably assisted by Nadham al Molk, his vizier, one of the most distinguished characters of his time, whose prudence and integrity in the administration of the affairs of the kingdom proved of most essential service to this prince and to his successor. Peace and security being established in his dominions, he convoked an assembly of the states; and having declared his son Malek Shah his heir and successor, he exacted an oath of fidelity to him from the principal officers of the empire. With the hope of acquiring immense booty in the rich temple of St Basil in Cæsarea, the capital of Cappadocia, he placed himself at the head of the Turkish cavalry, crossed the Euphrates, and entered and plundered that city. He then marched into Armenia and Georgia, which, in the year 1065, he finally conquered. In the former country the very name of a kingdom and the spirit of a nation were totally extinguished; but the native Georgians, who had retired to the woods and valleys of Mount Caucasus, made a more vigorous resistance. They too, however, overpowered by the arms of the sultan and his son Malek, were forced to submission, and reduced to slavery. To punish them for the brave defence which they had made, and as a badge of their humiliating condition, Alp Arslan obliged them to wear at their ears horse-shoes of iron. Some, to escape this mark of cruelty and ignominy, professed to embrace the religion of Mahomet.

In the year 1068 Alp Arslan invaded the Roman empire, the seat of which was then at Constantinople. Romanus Diogenes, the Greek emperor, assuming in person the command of his forces, met the invaders in Cilicia. In three several campaigns his arms were victorious; and the Turks were forced to retreat beyond the Euphrates. In the fourth he advanced with an army of 100,000 men into the Armenian territory, for the relief of that country. Here he was met by Alp Arslan, with 40,000 cavalry, or, according to some authors, a much smaller number; and the sultan having proposed terms of peace, which were insultingly rejected by the emperor, a bloody and decisive engagement took place, in which the Greeks, after a terrible slaughter, were totally routed. Romanus, deserted by the main body of his army, with unshaken courage kept his station, till he was recognised by a slave, taken prisoner, and conducted into the presence of Alp Arslan. When the terms of his ransom were about to be settled, Romanus was asked by Alp Arslan what treatment he expected to receive. To this question the emperor, with seeming indifference, replied, "If you are cruel, you will take my life; if you follow the dictates of pride, you will drag me at your chariot wheels; if you consult your interest, you will accept a ransom, and restore me to my country." "But what," says the sultan, "would you have done in such circumstances?" "Had I been victorious," said the insolent Romanus, "I would have inflicted on thy body many stripes." The conqueror smiled at the fierce and unsubdued spirit of his captive; observed that the Christian precepts strongly inculcated the love of enemies and the forgiveness of injuries; and, with a noble greatness of mind, declared that he would never imitate an example which he disapproved. A ransom of a million, an annual tribute of 3000 pieces of gold, an intermarriage between the families, and the deliverance of all the captive Mussulmans in the power of the Greeks, were at last agreed to as the terms of peace and the liberty of the emperor. Romanus was now dismissed loaded with presents, and respectfully attended by a military guard. But the distracted state of his dominions, the consequence of a revolt of his subjects, precluded him from fulfilling the terms of the treaty, and remitting the stipulated price of his ransom. The sultan seemed disposed to favour and support the declining fortunes of his ally; but the defeat, imprisonment, and death of Romanus interrupted the accomplishment of his generous, or rather ambitious, design.

At this time the dominion of Alp Arslan extended over the fairest part of Asia: 1200 princes, or sons of princes, surrounded his throne; and 200,000 soldiers were ready to execute his commands. He now meditated a greater enterprise, and declared his purpose of attempting the conquest of Turkistan, the original seat of his ancestors. After great preparations for the expedition, he marched with a powerful army, and arrived at the banks of the Oxus. Before he could pass the river with safety, it was necessary to gain possession of some fortresses in its vicinity, one of which was for several days vigorously defended by the governor, Yúsuf Cothual, a Carizmian. He was, however, obliged to surrender, and was carried a prisoner before the sultan, who, enraged at his obstinacy and presumption, addressed him in very reproachful terms. Yúsuf replied with so much spirit, that he roused the resentment of Alp Arslan, and was commanded instantly to be fastened by the hands and feet to four stakes, to suffer a painful and cruel death. Yúsuf, on hearing this sentence, became furious and desperate; and drawing a dagger which he had concealed in his boots, rushed towards the throne to stab the sultan. The guards raised their battle-axes, and moved forward to defend their sovereign; but Alp Arslan, the most expert archer of his age, checking their zeal, forbade them to advance, and drew his bow: his foot slipped, and the arrow missed Yúsuf, who rushed forward, and plunging his dagger in the breast of the sultan, was himself instantly cut in pieces. The wound proved mortal, and the sultan expired a few hours after he received it, in the year 1072.



ALPACA, a species of the South American family of quadrupeds called *Llama*, the soft hairy wool of which is now largely employed in the fabrication of cloths of different sorts. There would appear to be three species of this family, the *Guanaco* or wild Llama; the *Alpaca*, which was domesticated as a beast of burden by the ancient Peruvians, and hence considered as the camel of the new world; and the *Vicuña*, a small species, chiefly valued for the softness of its fine wool. Some consider the *paco* a fourth species: but the descriptions of travellers are too indefinite to enable us to decide this point. The fleece of the alpaca is fine, long, and shaggy; and the animal exceeds much in size the other two.

ALPARGATES, sandals made of the *Esparto* rush or *matweed*, *Stipa tenacissima*, which the Spanish peasantry also manufacture into mats and thread.

ALPHA, the name of the first letter of the Greek alphabet, answe ing to our A. As a numeral, it stands for one, or the first of anything. It is particularly used among ancient writers to denote the chief or first man of his class or rank. In this sense the word stands contradistinguished from *beta*, which denotes the second person. Plato was called the *Alpha* of the wits. Eratosthenes, keeper of the Alexandrian library, whom some call a *Second Plato*, is frequently named *Beta*.

Alpha is also used to denote the beginning of anything; in which sense it stands opposed to *omega*, which denotes the end. (Rev. i. 8.) These two letters were made the symbol of Christianity, and accordingly were engraven on the tombs of the ancient Christians, to distinguish them from those of idolaters. It was the opinion of Morales that this custom only commenced since the rise of Arianism, and that it was peculiar to the orthodox, who hereby made confession of the eternity of Christ; but there are tombs prior to the age of Constantine whereon the two letters were found, besides that the emperor just mentioned bore them on his labarum before Arius appeared.

# ALPHABET.

We have received the word *Alphabet* immediately from the Latin, *alphabetum*, for which substantive, however, there is no better authority in that language than the writings of Tertullian and St Jerome. The more classical Juvenal writes, "*Hoc discunt omnes ante alpha et beta puellæ*," which is literally, "girls learn this before their A, B, C." We do not find the word in Greek. Athenæus uses the adjective αναλφαβητος to signify a man who does not know the first two letters; and it is from these two letters that our word *alphabet* is evidently derived. Whatever the subsequent arrangement may be, the letters A and B stand at the beginning of a great number of alphabets. The ordinary definition of the word is a table or list of characters, which are the signs of particular sounds. Mathematicians have amused themselves by calculating the number of combinations which may be made of these signs or sounds. Tacquet, according to Harris, writes thus: "*Mille milliones scriptorum mille annorum millionibus non scribent omnes* 24 *litterarum alphabeti permutationes, licet singuli quotidie absolverent* 40 *paginas, quarum unaquæque contineret diversos ordines litterarum* 24." We may doubt, perhaps, whether this pomp of numbers will give any very clear notion even to a mathematician; but the passage shows, that for any practical purpose the combinations of elementary sounds, and consequently the number of words, may well be considered infinite. The consideration of the peculiar sets of combinations which constitute, at least in part, what is called the genius of a language, would be a curious inquiry, that has received but little attention; but it does not belong to this head. It has been asserted that the words of no two languages are respectively so unlike as the words in the same language are to themselves, and to one another when read backwards; but this consideration also, of whatever value it be, rather appertains to language itself than to the elements of which it is composed.

When we read the volumes of Lord Monboddo on the origin of language, we know not whether to laugh more at his countless absurdities and boundless credulity, or to wonder at his ingenuity and learning. Many other works have been composed on the same subject, less ridiculous and less admirable, but equally unsuccessful in clearing up the difficulties which they sought to solve. The attempt which is sometimes made to illustrate the invention of writing by that of language, proves invariably to be an impotent effort to explain one unknown thing by another. The invention of alphabetic writing is in truth an inexplicable mystery; we cannot touch it in any way, or approach it on any side. As this opinion is contrary to the commonly received notions, we will briefly state our reasons for adopting it.

It is generally believed that certain steps may be observed, by means of which we are able to trace the gradual progress of the invention. These are the songs and rude drawings of savages, and some simple contrivances for preserving the memory of numbers by beads and similar devices; but especially the Egyptian hieroglyphics, the Chinese characters, and certain alphabets that are said to be syllabic. Learned men have thought fit to assert that there once was a time when no nation was able to write; but they are unable to bring any proof of this assertion, and the evidence of history seems to contradict it. They tell us that men composed songs and ballads to preserve the remembrance of past events, and used paintings and knots to assist the memory. We know that some nations who are unacquainted with letters use these artifices; and we can readily believe that five beads on a string may represent five men, or five days, or five years, but such a memorial has no connection with writing. We know, moreover, that in times when writing is universal, ballads are made and sung, and paintings are produced; and a person who is unwilling to forget an engagement sometimes ties a knot on his pocket-handkerchief. Those who can write often avail themselves of other aids; and those who cannot, have been obliged in all ages to do as well as they can without. It is manifest that we shall not be able to find any firm ground for placing the first step amongst the operations of savages. In common with their civilized brethren, they have the desire to remember certain events; but they have not done any thing to advance the peculiar means of which we treat.

The learned president Goguet, in his instructive and popular work, *De l' Origine des Loix, des Arts, et des Sciences*, discourses at some length and with much ability of the invention of writing. Having mentioned the substitutes which are adopted by savages, he brings forward the Egyptian hieroglyphics thus: "We have been a long time in error as to the first use of hieroglyphics: men believed that the Egyptian priests invented them for the purpose of hiding their knowledge from the vulgar, but it is through want of attention that they have been thus deceived. We may easily satisfy ourselves, that at the beginning they only employed hieroglyphics to hand down and make known their laws, their usages, and their history. Nature and necessity, not choice, have produced the different kinds of hieroglyphic writing. It is an imperfect and defective invention, suitable to the ignorance of the first ages: it was through want of the knowledge of letters that the Egyptians had recourse to them. If this nation had found out alphabetic writing before, they would have been too sensible of its advantages to employ any other. The mistake concerning hieroglyphics has come from the Greeks. They were only acquainted with the Egyptians in much later times. This people had then the use of alphabetic characters. The ancient method of writing in hieroglyphics had been neglected by the mass of the nation; but the Egyptian priests, who, according to the custom of all the learned men of antiquity, were only concerned about the means of hiding their learning, retained the hieroglyphic writing as a fit veil to hide the knowledge of what they did not choose to divulge. It is thus that, after the discovery of alphabetic writing, hieroglyphics became in Egypt a secret and mysterious kind of writing." It is plain that a sensible and learned man here speaks too positively about matters which no one can know. If the Greeks, who were acquainted with the Egyptians, although in later times, are mistaken, how can we, who only know the Egyptians through their report, venture to correct them? "But how did they arrive at this discovery?" The president afterwards candidly asks, "how did they pass from hieroglyphics, and even from syllabic writing, to alphabetic characters?" (It would not have been difficult to have passed from syllabic writing if it had ever existed.) "This is not easy to imagine. Hieroglyphics and syllabic writing certainly have no connection with the letters of the alphabet." (The latter undoubtedly has, for it represents sounds.) "It was necessary, then, to change entirely the nature of the signs which were used. In vain shall we have recourse to the writers of antiquity to clear up this question. They do not show us in what manner these singular transitions could have been made. We may conjecture that the abridged marks of hieroglyphic writing, of which I have spoken above, conducted to the still more abridged method of alphabetic letters, which by their different combinations express all the articulations of the voice in a simple and easy manner. This conjecture becomes very probable. When we cast our eyes upon the alphabets of some ancient nations, the letters which compose them appear, both by their forms and their names, to have been taken from hieroglyphic signs. If we compare with attention what remains of the Egyptians with the hieroglyphic figures engraved on the obelisks and other monuments, we shall perceive that the Egyptian letters derive their origin from the hieroglyphics." "The Ethiopic alphabet, and the majuscule letters of the Armenians, also supply proofs of what I advance: we find there very distinct traces of the ancient hieroglyphic character." We know not what he means by "the ancient Egyptian characters," unless it be the Coptic alphabet, which is posterior to and derived from the Greek, as Plate XXI. demonstrates. It shows also the Ethiopic letters, and the ordinary Armenian, which are not ancient: still less are the majuscules or capitals: the latter are undoubtedly formed in the shape of animals, &c.; but they are like the illuminated letters that were used as initials in the middle ages. These certainly were not taken from hieroglyphics, but were designed for ornament; and so is it likewise with the majuscules of the Armenians, which were a very late invention; and it is matter of history, and not of conjecture, that they were taught them by the Greeks. It is very doubtful whether the paintings of the Mexicans, of which some writers have treated largely, had any connection with writing, or were intended for any thing but pictures; in truth nothing is known about them, and we may at once dismiss them as having no relation to the subject.

The hieroglyphics appear to be related to the alphabet; and as they are very extraordinary in themselves, and have received much attention from the learned, we must speak somewhat fully of them; although they will not enable us to trace any transition or progress towards alphabetic writing, which is perfect and complete wherever it exists, the instances usually adduced of imperfect and incipient writing being in our opinion entirely unfounded; and it is an unwarranted assumption, that the Egyptian hieroglyphics preceded the use of the letters of the alphabet, of which there is no proof, whatever testimony exists being to the contrary. In every generation there have been a few gifted interpreters, who have professed that they were able to read the hieroglyphics; nor have these been wanting in our own times. The expedition of the French to Egypt, and especially the discovery of the famous Rosetta stone, which, the late Dr Young declares, was an ample compensation for all that the two armies suffered, gave a powerful impulse to these studies. It had been observed on the Egyptian monuments, that clusters of figures were often included in a ring, scroll, or cartouch; and it was deemed expedient that these should represent proper names. To meet the exigency of the case the *Phonetic* system was devised, which is briefly this: if we suppose that the scroll contains a dog, an ass, and a yew-tree, the initials of the three words are taken, and they form the word Day; and this by the hypothesis is a proper name; and we may infer, if we please, that Potiphar had read Sandford and Merton, and was greatly delighted with that excellent work. The language, however, in which the objects that supply the initials are to be named, is not English, but Coptic; but the results, we shall see, are precisely the same. Let us assume that the figure of a bird denotes A; since the engraving is not executed with the exquisite accuracy of a Bewick, it may be an albatross, a buzzard, a crow, a duck, an eagle—any bird, in short, in the Coptic vocabulary, and any letter in the alphabet; and so with the tree, which stands for B: it may be an apple, a beech, a cedar, or any arborescent vegetable whatever: and, as if this were not loose enough, each letter has several visible objects, each of which may be made to run the gauntlet of the alphabet. The number of figures contained in the scroll, we should have imagined, would control the length of the word, and indicate the number of the letters; but they are relieved from that slight responsibility thus: since every allowance ought to be made for a scribe who writes upon granite, ΠΤΟΛΜ. will stand for Πτολεμαιος; or, if there be a redundancy of objects, the superfluous letters are disposed of as symbolical, and are classed with the goose and globe, or the goose and grid-iron, and some other favourite emblems. Although there be figures enough to complete the name Πτολεμαιος, that monarch, if it be not his turn, may be desired to stand aside: any three may be chosen to spell Day, and the other seven may be explained symbolically to signify the author of Sandford and Merton, or any thing any body pleases. Such is the Phonetic system, and its results are such also as might have been expected. Dr Young, an ingenious and learned person, founding himself on certain notions entertained by Warburton, proceeded with singular zeal and activity to compass and imagine discoveries which we are not able to relate. We will only observe briefly, that any conjecture of that prelate may safely be presumed to be wrong; for although his energy, learning, and acuteness, were undoubtedly great, experience has shown, that from haste or some other cause his views are commonly erroneous. Dr Young, being in that vein, of course went on from discovery to discovery, being guided by that warm fancy which usually attends real talent; and, as is ever the case on such occasions, every person who took the pains to investigate the matter found precisely what he was looking for and most desired: no one was ever disappointed. MM. Champollion-Figéac, Sylvestre de Sacy, D'Akerblad, and many other foreigners, learned to read,—to run and read. The hieroglyphics were as legible when they rode by the obelisks as the names over our shops. Our own countrymen ran a bright career of glory. Mr W. J. Bankes, Mr Salt, and others saw immediately strong confirmations. Even Mr George Grey, a very estimable young gentleman, who took a little trip to Egypt in the season, according to the fashion, crept into the great pyramid and out again, saw every thing, bought a charming pair of mummies, a cock and a hen, cut them open, and found, without knowing it, the "ring of Polycrates," as Dr Young says, and perhaps also that of Hans Carvel. He found a Greek translation, it is said, of a manuscript, which had recently been brought from Egypt to Paris. The original was in the Enchorial character, and the translation showed that it was a sale of land. It was, moreover, duly registered and probably stamped; but that we are not told. That a landowner should go to bed with his title-deeds in his stomach, that the muniments of the deceased should be buried with him, ought to astonish us, even in an age of discovery. It shows, however, the perfection of the enchorial registration in Egypt, that the settlement was buried with the first tenant for life who died; and it will be a wholesome example to our law-commissioners, who are about to introduce registration in England, and an admonition to make the public title so complete, that all private securities may safely be dispensed with. The papyrus which Mr George Grey brought from Egypt refers, however, not to the hieroglyphics, but to the characters called enchorial, which are the second in order of the three inscriptions on the Rosetta stone. They seem to be alphabetic, although no one has been able hitherto to make out the alphabet. It is hard indeed to imagine, that there ever was any writing which was not alphabetic. Efforts have been made to interpret these also, but after turning over a few pages of the interpretation, the reader is disposed to say to the interpreter, "if you are permitted to read an inscription either backwards or forwards, to consider the letters as imperfectly formed, to select them from any alphabet that will suit your purpose, to turn them round or invert them, to supply, and amend, and reject at pleasure, to take any form of any word in any language you choose, and to make great allowances for barbarism, ignorance, foreign spelling, and so forth,—if you may do all these things, and cannot find your own name, your mother's, and mine, in any writing whatever, you certainly are not fit to decipher enchorial characters." The hieroglyphics which the accomplished Dr Young and his admiring disciples, whether foreign or domestic, were unable to read or to reconcile with their hypotheses, they boldly declared, after the usage of interpreters, to be spurious, and said that they had been negligently and unskilfully sculptured at Rome, in imitation of the Egyptian manner. They speak with as much confidence about a good and a bad style in hieroglyphic inscriptions, as if they were critics writing in the *Egyptian Review*, if we can fancy that such a periodical existed under the Pharaohs or Ptolemies, and deciding, in a summary manner and without appeal, on the literary merits of the new obelisks and pyramids as they appeared. So intolerant were they of the claims of what Dr Young in his first zeal termed "an exorbitant antiquity," that they condemned as forgeries some of the finest and most admired of the Egyptian monuments. But such aggressions upon the reverential feelings of mankind being likely to provoke retaliation, and to endanger the theory, they devised an ingenious expedient, and found, under the more modern scrolls, containing the names of Ptolemies or Roman emperors, the vestiges of more ancient scrolls comprehending those of older and native princes which had been erased to make way for the usurpers. Some ef these, it is said, have been deciphered. And since it has been the fashion to discover the

Alphabet.

names of the ancient kings of Egypt, many buildings have been restored to their original rank, and almost every scroll decided to stand in the place of one that had been obliterated. We would recommend some of the most sharp-sighted of these antiquaries to look well if there be not a third and older name under the second, that even "exorbitant antiquity" may once more be taken into favour. Mr Salt, in his *Essay on the Phonetic System of Hieroglyphics*, shows, that even in the symbolical department, which of course must be the most lax, it is necessary to humour the theory a good deal. This zealous convert speaks thus of Horapollo: "Having so often quoted this author, I may here state, that though I am convinced, for numerous reasons, that the first book and part of the second are written by a person perfectly acquainted with Egyptian hieroglyphics, yet so am I perfectly persuaded that the remainder is a vile interpolation, excepting perhaps the three or four last hieroglyphics, which seem to have been reserved from the original work, and placed at the end, more effectually to deceive the reader." This is very like choosing so much of a writer as will serve a favourite purpose, and rejecting the rest. It is unnecessary, however, to pursue this part of the subject farther. If we admit that the discovery of the phonetic system was very admirable; that it is demonstrated clearly, it may be mathematically; that the examples have been adduced with perfect candour and fairness; that it will afford much valuable illustration to the history of Egypt; and that it is madness, or even a crime, to doubt its truth and importance: if we concede all this, and more, it will not assist us in discovering the origin of the alphabet. The phonetic system is essentially alphabetic; the bird, and the tree, and the other figures within the scroll, are not hieroglyphics, but letters: they represent sounds. It is not a transition from hieroglyphics to letters: it is not a step in advance; but, if it be a step, it is assuredly a step backwards; for it is merely the substitution of clumsy and ambiguous letters for others that were simple and certain. The dog, the ass, and the yew-tree do not represent the author of Sandford and Merton symbolically or hieroglyphically. That ingenious person had not any of the properties peculiar to these objects. The three figures are an awkward manner of writing the three letters that compose his name, and any other object might be agreed upon to denote the same letters without reference to the initials, which could only have been chosen to assist the memory. A man, a woman, and a child would of course spell Day, if it were understood that a man was in the place of *d*, and the other figures of the other letters. Thus every one might compose at pleasure innumerable phonetic systems.

There is no foundation for the assertion of the president Goguet, and of other learned men, that the Egyptian hieroglyphics preceded the invention of alphabetic writing: whatever testimony exists is to the contrary. It is vain to argue that it is improbable any persons would use such cumbrous and inconvenient writing after they had experienced the advantages of a simple and convenient method; for there is abundant evidence, as the learned president admits, that it was practised long after they had become acquainted with the excellent alphabet of the Greeks. It is not easy to understand and to reconcile the passages in which the various sorts of writing that prevailed in Egypt are mentioned; the enchorial, the hieratic, the sacred, the demotic, the Ethiopic, &c. Our limits will not permit us to comment upon, or even to extract, the statements of Herodotus, Clemens Alexandrinus, Porphyry, Heliodorus, and others. The first author tells us that, unlike the Greeks, they wrote from the right to the left; and Clement and Porphyry affirm that the hieroglyphics were the invention of the priests, for the purpose of mystery and religious secrecy. Our physicians write their prescriptions in an uncouth character, and with barbarous abbreviations, not because they are unacquainted with the ordinary writing, but through quackery and for concealment; and for the same reasons the record in a court of law is made up in the form of a carpet, or the sail of a ship; and many similar devices, not unworthy of Tartars or Laplanders, are practised there, and in the composition of deeds, not through ignorance, but of design. If the hieroglyphics be in truth writing, and history seems to declare that they are, it is most probable that they are alphabetic; not only because we are told that they were invented when letters were in use, but because it is impossible to conceive any writing which is not such. Whether we shall ever obtain the alphabet, is very doubtful. It is easy to imagine many systems, but it is perhaps impossible to fix upon any. An animal or other object might represent a letter; and the representations might be varied according to fixed rules; or the parts of an animal might be the letters, and the animal itself would then be a word. There is no end of conjectures. It is not impossible, although the supposition has never been hazarded, that the priests wrote in initials only, like the Roman lawyers, who, partly for the sake of brevity, and partly and principally for concealment, entered their forms in that manner. A Roman notary would begin a will thus: T. I. T. L. W. A. T. &c. "This is the last will and testament," &c. Apuleius supplies a curious passage, which seems to imply that the sacred books were partly secured against profane readers by abbreviations. "Et injecta dextera senex comissimus ducit me protinus ad ipsas fores ædis amplissimæ; rituque solemni apertionis celebrato ministerio, ac matutino peracto sacrificio, de opertis adyti profert quosdam libros, literis ignorabilibus prænotatos: partim figuris cujuscemodi animalium, concepti sermonis compendiosa verba suggerentes; partim nodosis et in modum rotæ tortuosis, capreolatimque condensis apicibus, a curiosa profanorum lectione munita." (*Metamorph.* lib. 11.) We know not whence the Roman lawyers derived this kind of cipher or abbreviation, of which they made much use. It was a favourite practice likewise of the Rabbins to compose memorial words of initials. We are told that the hieroglyphics were the invention of the priests, and were connected with religion: it is probable therefore that they contain rituals, perhaps in an abbreviated form. The frequent repetitions of the same characters, and the perpetual recurrence of the same sets of characters, favour this supposition. The frequent repetitions of the services of the church of Rome furnished cause of complaint at the Reformation. In the liturgies of the Greek church they are far more remarkable. If we open any book of Greek offices, we shall find such directions as, "here make 60 kyries, then 30 doxas, then 30 χαιρες, and then 60 more kyries." The tedious ceremonies are infinitely protracted by such wholesale orders. The ancient Egyptians surpassed all people, even the Hindoos, in their addiction to religious exercises. We may read copious details of the prodigious exertions of the early Egyptian monks, who brought, with the common zeal of converts, the peculiar sentiments and habits of their nation, amongst whom all was prayer and rite, every thing was sacred, the whole land swarmed with gods. If we could translate a hieroglyphic inscription, we should probably find that it comprehended the rites to be observed in consecrating a punt. It would direct the faithful waterman to find the day and hour for the ceremony by certain rules, and to prepare himself and his boat for so many days in such a manner. At the proper hour, having made all previous preparations, he would be enjoined to turn his face to the north, and to say such and such and such prayers so many times, making certain gesticulations; and then to turn to the south, and to say the same, and this, that, and another, ten times as often, with the same gestures and some others. It is easy to imagine that the shortest epitome of the formula, although the boat was not to be used for fishing, or in a part of the Nile where crocodiles abounded, would cover the walls of a building as large as Westminster Hall; for if such folly be once permitted to begin, it is perfectly impossible to assign a reason why it should ever terminate. If such be the treasures which are locked up in the sacred characters, as it is most likely they are, we need not repine if we are never permitted to find the key; for it is plain that an authentic and faithful report of the precise words which have been uttered in all the masses that have been said for the repose of the souls of the departed, would be neither an amusing nor an instructive, although a very voluminous, pile of writing.

We have shown, we trust, that no assistance can be derived from the hieroglyphics towards discovering the origin of the alphabet. We will next examine, more briefly it is true than we would, the nature of the Chinese characters, which it is pretended afford much light, and indeed are an infallible guide to the invention of the alphabet. Let us suppose that the tradition as to the sound of the Greek letters, and all that has been written on the subject, were lost, but that we retained all the other materials for learning Greek which we still possess: if it were deemed expedient to study that divine language, we might still acquire it with pain and difficulty, as we learn the Chinese; and considering the word αλλος as a symbol, we should call it *another;* πολυς, βους, βιος, and ποταμος, would be regarded as pictures, and remembered as such; and, without reference to their original sound, would be named *many*, an *ox*, *life*, and a *river.* In copying these and other words, not as sounds composed of simple elements, but as drawings of objects, they would doubtless be much disfigured in the course of ages; it would even be desirable to vary their forms designedly, and to make them as grotesque and striking as possible, to assist the memory, which would surely deserve the aid of the compassionate. They would, moreover, be divided into classes, according to some clumsy calculation of the number of strokes by which they are formed, like the Chinese characters, that they might be arranged in dictionaries. Some mythic story of the invention of the Greek symbols would be current in Europe, as similar fables are received in China. The ingenious persons who occupy themselves in finding reasons to account for every thing just as it exists, or is supposed to exist, and lavish their admiration upon it, would indulge in raptures at contemplating the living, moving pictures which these symbols present. Not Cuyp himself, they would declare, could paint such a spirited ox as is sketched out by the image βους; and if the sign ποταμος were drawn large and black, so that the memory might seize on it through the eye and hold it fast, it would be refreshing, they would swear, on a sultry day to sit beside it and gaze on it; for no stream would be so lovely as that gentle Greek river,

Qui fluit illimis, nitidis argenteus undis.

It is no light matter to learn Greek now; what would it be under the circumstances we have supposed! When mankind were at last quite weary of admiring the Greek symbols, and of weeping over myriads of schoolboys who had been fairly flogged to death, some great man would at last arise, who, considering that all written language must of necessity be alphabetic, although the alphabet may have been lost in some cases amidst national convulsions, would proceed patiently to analyze the characters, not as a logician to seek for genera and species, nor as an artist to look for exquisite touches of art, but simply as a grammarian, to make out the letters. He would carefully dissect a character into parts, and assign arbitrarily to each part its sound, taking due care to make those parts or letters vowels which occur in words in such a manner as to render it necessary or convenient so to consider them for the purpose of articulation. He might, for example, call αλλος *uttak*, and πολυς *gatek:* the harmony of the language would be deteriorated or improved by the change, according to the taste of the age. But when the supposed symbols were once more restored to an alphabetic form, although entirely different sounds might have been substituted for the ancient, it would not be more difficult to acquire the language, than if the original alphabet had never been lost. "The Chinese characters, taken in general, are, as every body knows, images and symbols, designed to represent directly material objects, by an imitation more or less exact, and other objects by metaphors more or less ingenious. They are consequently entirely unconnected with pronunciation, and do not stand for any sounds. As it is necessary, however, that books should be read aloud, they attach by convention to each character a simple or complex syllable, which brings to the mind, in the spoken language, the same idea as the character in writing; but nothing in the latter denotes the sound or the syllable, and it is very possible to understand the one without knowing the other, and *vice versa.*" We quote these words from the excellent work of M. Abel Remusat, entitled *Recherches sur les Langues Tartares.* M. Freret, who tells the strange tale in his sensible reflections on the Chinese writing, in the sixth volume of the *Memoirs of the Academy of Inscriptions*, makes this lively remark—"*On diroit que cette écriture auroit été inventée pour des muets, qui ignorent l'usage de la parole;*" and we may add, that when we believe that the whole population of China are dumb, then will it seem worthy of belief, which is utterly incredible, that any kind of writing was ever devised that was not alphabetic. A person who gives from a Greek book, without naming the words in the original tongue, a literal translation in English, is like the man who reads aloud Chinese writing in the spoken language of China. He renders one language by another, and of two languages it is possible to know the one and not the other. Some understand English who are ignorant of Greek, and *vice versa.* "It was necessary sometimes," M. Abel Remusat continues, "for the Chinese to represent in writing the proper names of persons and of places, and of new objects and ideas. When their knowledge extended, they found that it was impossible to invent figures sufficiently exact, or to compose symbols sufficiently characteristic, to denote, in such a manner that they should be recognised, different natural objects,—quadrupeds, birds, fishes, trees, &c. Many expedients occurred, and were successively employed. They might take a symbol which was already known, and make it the sign of an individual. All proper names in China are characters of this sort. Most commonly there is nothing in these characters to mark this kind of alteration. Sometimes, however, they add to the symbol which has been thus stripped of its original meaning, the sign of the mouth, to show the change it has undergone." The sign of the mouth is precisely equivalent to the use of the capital letter, which with us marks a proper name, and shows that Mead signifies, not a liquor, but a physician, and Rose a man, and not a flower. Why one man should ever have been called Mead and another Rose, is as much a mystery as any thing in Chinese literature, although the question has not yet provoked an elaborate disquisition concerning the first Mead or the origin of Roses. "The second method is of so much consequence in Chinese writing, that from the most ancient times it has been accounted one of the six rules for forming characters. It consists in taking, as in the former case, a simple or complex symbol, and adding another, which denotes that it signifies a tree, a bird, &c. Almost all the names of natural objects are thus represented by two characters, one of which represents the genus, and the other the species." There is nothing peculiar in this method—it is common to all languages. We make compound words by the union of two simple, as tea-pot, coffee-pot; the latter word denoting the genus pot, and the former, or rather the two together, the species. These and similar contrivances, therefore, do not prove that there was a transition or gradual passage from symbolic to alphabetic writing. It is urged that tradesmen and ignorant persons in China frequently use those signs indifferently which have the same names but a different signification, for all the several purposes of the various characters; but this is not a step. In like manner, a boy has been known, in endeavouring to translate "thou shalt till" into Latin, to have found in his dictionary "till, *donec*," and to have written down "*donecabis*." If a foreigner arrives in China, and it is necessary to give him a name in writing, they usually assign to him some new combination of characters, which has no reference to the sound of his name. It is asserted, however, that they sometimes seek to express by their characters the sound of his name. If it be Har-ri-son, for instance, they take the three characters the names of which most resemble in sound the three syllables of the proper name. This would certainly be syllabic writing; but there is no satisfactory proof that it was ever devised by the Chinese themselves. It would occur very naturally to a foreigner who was familiar with alphabetic writing, and knew something of the language of the country. The spoken language of China consists entirely of monosyllables; consequently the necessity for such an expedient could never arise, except in conjunction with foreigners who are used to the alphabet. They could have no idea of a syllable, as distinct from and forming part of a word; and the name Harrison would not be to their ears one word of three syllables, but three separate words, each a monosyllable. We do not wonder if the Chinese have picked up from strangers a little instruction in reading; we are rather astonished that, in consequence of their addiction to old customs, they have not learned more. It has been said that the Japanese have adopted an alphabet of syllables of this kind, consisting of as many of the Chinese characters as are necessary to furnish it. We must withhold our assent to the existence of syllabic alphabets, until we have actually examined one that is not manifestly composed of letters. We read also that some nations of Tartars use an alphabet constructed of Chinese characters, either entire or mutilated. If we were to select 26 of these characters, we might of course write our own language in the same cipher; and the only consequence would be, that we should adopt very incommodious letters. Musical sounds, numbers, the signs of the Zodiac, and a few other matters of peculiar simplicity, are marked by arbitrary symbols, which have no reference to sound, and are understood by many nations. These examples, however, do not prove that it is possible to contrive a universal character, or to invent such a language, as the written Chinese is alleged to be. It would no doubt be a work of considerable difficulty, but not insuperable, to analyze the Chinese characters, and to reduce them to an alphabetic form. It would probably be necessary to assign several figures to the same letter—but this is common in other languages—and other expedients might be needed; but the result would facilitate immensely the acquisition of a language rich in a prodigious number of finely printed books. Hyde and others maintained that the language of the Manchou Tartars, in which there exist translations of most of the Chinese books, was, like the written language of China, symbolic; yet by the labours of MM. Amyot and Langlés it has been dissected into very comfortable and legible alphabetic letters. The spoken language of China is a vulgar, barbarous, and most imperfect jargon, that has never been reduced into writing, and has essentially no more connection with the written language than the Welsh or the Basque. If we must concede, contrary to reason and probability, that the Chinese characters contain a symbolic writing which is not alphabetic, they do not afford any assistance towards tracing the invention of the alphabet; for there is no proof that the Chinese, by their own means, and without foreign aid, have advanced a single step.

The uses of the alphabet are sweet and marvellous, and its origin, like the signification of the Egyptian hieroglyphics, undiscovered; but its structure is usually imperfect. It is commonly at once deficient and redundant, and the arrangement immethodical. In our own language, for example, although we have the sounds of the long and short vowels, we have only one character for each vowel; and it is left doubtful which sound is intended, or it is pointed out by the addition of other letters. In ben the *e* is short; in bean, been, bene, it is long, and the syllable might be spelled thus, bēn. The Greeks have a distinct character for the long and the short *e*, and two for *o* likewise; but their alphabet is as deficient as our own with respect to the other three vowels. If the Romans had used ten signs for vowels instead of five, all that difficult department of grammar which teaches the quantity of syllables would have been superseded by a simple and mechanical contrivance. Our alphabet is said to be redundant, because the one sound of *c* is expressed by *k*, and the other by *s*. It is true that *ch* is a peculiar sound, differing from that of *sh*, as cherry differs from sherry: it is true, however, that it might be represented by *kh*, if our orthographers had thought fit to ordain it. *F* is said to be redundant, because we might spell fig, phig: for we write philosopher, whilst the Italians use *filosofo*; and so with some other letters. As the Greek is pronounced in England, the $\chi$ is superfluous for the purposes of speech, and its place might always be supplied by $\kappa$. It distinguishes nevertheless many words to the eye, and is useful in etymology, on account of which, letters that would be redundant if they were to be tried by the verdict of the ear alone, have been retained in many alphabets. If the number of our own letters be too small, the deficiency is not very great. Those who affirm that there is the largest amount of simple sounds in our language, would not extend it beyond 32 or 33 characters, and their opponents would cut it down to about half the number: 26, therefore, is a tolerably fair mean between these extremes.

The lovers of method complain grievously that the arrangement of the letters is most unphilosophical. There is no reason, they truly affirm, why *b* should succeed to *a*, or *c* to *b* in the Latin and English, or *g* in the Greek and Hebrew alphabets. The vowels, they maintain, ought to walk first, and to be marshalled precisely according to the aperture that each demands from the mouth to give it due utterance; and the consonants ought to be arranged with reference to the organ to which they are chiefly indebted,—the lips, the teeth, the tongue, the throat. If we were about to compose an alphabet for the first time, such precision might be permitted; but this change, like most others, would be attended with many inconveniences. The next generation, for example, could not use our dictionaries and encyclopædias; and as the letters are sorted on the next page of the primer, although not in the alphabet itself, the advantage would be very trifling. An extreme and rigid regularity does not suit mankind; men love anomalies, exceptions, and varieties. In some languages, as in the Italian, and very probably, if we can judge of the pronunciation of the ancient Romans, in the Latin, each letter performs its office with great constancy and uniformity, and indicates the sound according to a few simple and well-observed rules; in others, as in some of the Celtic tongues, the only use of letters seems to be to mislead, and to show what is not the true pronunciation. The English orthography torments foreigners, and presents difficulties that appear at first to be insuperable: by perseverance, however, they find the clue to the labyrinth, and acknowledge that the maze is not always without a plan. The mode of spelling that was observed in the middle ages, especially in English and French, was to admit into words every letter that could possibly claim a shadow of right to be there. It resembles the style of law proceedings, the grand canon of composition and construction therein being, so that all is there that ought to be, it matters little how much is there that ought not: the excess may help, but cannot hurt, and may be rejected as surplusage. The French, after their peculiar manner, by means of the Roman letters, have cooked up strange kickshaws of words; their pronunciation, however, whimsical as it is, being practically, and especially amongst those who speak soberly and moderately, less absurd than the extraordinary persons who compose grammars of that language would have us believe.

The forms of letters in different systems are of course very various. It is curious to contrast the complicated characters of the Gothic, or of German text, or of some languages that are less generally known, with more simple alphabets, especially with those used in modern systems of short-hand. These extremely simple letters, however, are not so favourable to rapidity in reading as in writing: plainness and distinctness, a certain form that fills the eye, giving to each its proper individuality, are essential to give facility to the reader's office. If there were no other books but manuscripts, it would certainly be of great importance that such characters only should be used as the transcriber could execute with the utmost celerity: but as copies are now multiplied by printing, it matters little whether the letters are simple or complex; for although it may be more difficult to make the punches, and more troublesome to cast the types, these considerations cannot greatly influence the price of books. The manner of arranging letters and words is also various. The Chinese, and a few other people, dispose the words in perpendicular lines, one word below another; but most nations conform to the general practice of placing them in horizontal rows: and the world is nearly equally divided on the question, whether it be expedient to begin to write at the right or the left side of the page. The people of the East usually adopt the former, and those of the West the latter method. There are some exceptions, however: the Sanscrit is written, like the English, from the left to the right; and the Etruscans seem to have committed a similar error in longitude, for they proceeded, like the Arabs, from the right towards the left. The one arrangement is quite as convenient as the other. Persons who are prejudiced in favour of every thing to which they have been accustomed, have imagined reasons in support of the superiority of our method: daily practice convinces us that it is very excellent; but we must acknowledge, notwithstanding, that the best writers are to be found amongst the people who write from the right hand to the left. The Chinese, it is said, in their peculiar way, attain to great skill and excellence.

There is one kind of arrangement that was anciently in use among the Greeks, which is very remarkable: the letters proceed from the left to the right, and back again from the right to the left, or *vice versa*, alternately, like the course of an ox in ploughing, whence it has received the name βουστροφηδον. We can imagine that a person writing running-hand very rapidly might be tempted to adopt this alternate path for the sake of dispatch—although such perhaps would not be the result—in order to save the time that is wasted in carrying the hand back from the end of one line to the beginning of the next; but this could not be the motive that suggested its use in the inscriptions that are now in existence. It was probably esteemed sacred from its connection with ploughing, which was always a holy thing. A treaty written thus was more likely therefore to be observed. If a bill of exchange had a better chance of being accepted or paid were it sped like the plough, the sacred arrangement would no doubt be adopted by the drawers of these instruments.

The inconveniences of a diversity of characters have induced some speculative persons to endeavour to devise a universal character, and even to remedy the curse of Babel by a universal language. The great Leibnitz employed himself much, it is said, on these speculations, but without success. John Wilkins, bishop of Chester, a less able man, composed *An Essay towards a Real Character and an Universal Language*, which was printed by the Royal Society in 1668. Whoever will open this thick folio, will not be surprised that the husband of Oliver Cromwell's sister had but few disciples, or, whatever learning and ingenuity the book may display, that it has long been forgotten. It has rarely happened that men of distinguished ability have sought to introduce a severe uniformity into any science. Speculators who propose to furnish characters that will faithfully represent all the sounds of all the letters of all languages, only show that they have not accurate ears: sounds are infinite, and cannot be thus portrayed. Men have vainly discoursed also concerning a natural language: there is no language natural to man. It is not natural to call a horse a horse, or by any other name; but it is perfectly natural, for it is the universal practice, to call that animal by some name or other which is understood by those with whom we communicate. If there were a universal character to represent words, and it were generally received, so that the character for a horse should be read by an Englishman *horse*, by a Frenchman *cheval*, by a Spaniard *caballo*, and by a German *pferd*, as has been recommended, it would avail little. The syntax and construction of languages are so various, that although the characters might be understood, and every word intelligible by itself, the sense of a whole passage that had been written by a German would be utterly unintelligible to a Frenchman.

The Chinese is said to be a language of which the structure is remarkably easy and simple. As a proof that it is not enough to know the meaning of the words, but that it is necessary to be familiar with the collocation, in order to comprehend the sense of the author, let us take an example at hazard from the grammar of M. Abel Remusat. The following is a literal translation: "*Sicut amat sicut scit agit eam amat eam eam qui eam qui qui non qui non.*" Could Bishop Wilkins himself detect the meaning which lurks in these few and very plain words? They are rendered thus, having been re-arranged according to the rules of a system which is far more artificial, but with which, through habit, we are conversant: "*Celui qui la connoit* (*la vertu*) *ne vaut pas celui qui l'aime; celui qui l'aime ne vaut pas celui qui la pratique.*" If we are unable to interpret a short and easy sentence in an inartificial language, with the forms of which we are unacquainted, is it not certain, that if one of the long and rhetorical periods of Demosthenes, to say nothing of more obscure writers, were transcribed in the universal character, it would be as incomprehensible as a Babylonian brick covered with arrow-headed characters, to a person familiar with the universal writing, but who had not mastered the majestic but abstruse idiom of the Greek tongue? Nor is there a natural collocation of words. All collocation is artificial; and that to which the reader is most accustomed seems to him to be the most natural. He who speaks of the natural order of a sentence, and recommends that it should be observed in his projects for grammatical uniformity, commits the same error as the sailor who condemned the Spaniards with many oaths, as a most unnatural race, for calling a hat *sombrero*, and not, like men, by its natural name, a hat.

Having spoken as largely as our limits will permit of the alphabet in general, we will next call the attention of our readers to a few particular alphabets, not perhaps with so much minuteness as some might desire, nor certainly to all that are worthy of attention. The Greek alphabet is by far the most important to literature, not only because the most precious remains of antiquity have been preserved by its means, but because it is the parent of the Latin, which has been adopted by, and prevails amongst, the most civilized nations of the world. Plate XIX., which is the first of the three plates connected with this subject, is entirely devoted to elucidate its origin and history. The plate has been taken, except that part on the right hand which is headed "Greek," from Astle's work on the *Origin and Progress of Writing*, and was compiled from authorities which we regret that it would greatly exceed our limits to enumerate. It would be easy to extract the passages which would explain it; but as the book is generally accessible, we will content ourselves by referring to it; and as that admirable treasure of alphabetic lore, the *Nouveau Traité de Diplomatique* (6 tom. 4to, Paris, 1750–65), whence Astle has chiefly derived his authorities and the forms of the letters, may easily be consulted, we will not avail ourselves of the assistance it would afford. Joseph Scaliger was the first who endeavoured to show systematically, and with elaborate learning, the derivation of the Greek letters from the Phœnician. He has had many followers and imitators. A cursory inspection of the numerous specimens of Phœnician letters which this plate affords will prove, that if their forms are sometimes like those of the ancient Greek characters, they are often very dissimilar, at least if we may suppose that we have obtained from coins and inscriptions the true characters of the Phœnicians; and if the powers of the letters were the same as in the Hebrew, as the order appears to have been, there was a great dissimilarity in sound also. That portion of the plate which is headed "Greek" is taken from a plate inscribed *Variæ Alphabeti Græci per ætatis ordinem formæ*, published in the *Pœcilographia Græca* of Hodgkin, and in vol. ix. of the *Classical Journal.* The first column on the left consists of the ordinary letters, of which the number is increased to 27 by the insertion of the Fαυ επισημον, which marks the number 6, after E, of σανπι, 900, and of κοππα, 90, after Π. The second column is headed "Cadmi A. C. 1500," and is taken from Morton. The next column, standing immediately below "Greek," gives the various forms of the Sigean inscription, as published by Chishull, and is headed "Sigeum, circa 600 A. C." The third column is inscribed "Simonidis, A. C. 500," and is also from Morton. The remainder of the letters are of the date 450, A. C., and are given on the authority of Wachter, from W. Massey's *Essay on the Origin and Progress of Letters.* Mr Hodgkin has published in the same work a large and valuable collection of abbreviations and connections. The fac-similes of the Herculanean papyri present the Greek characters that were in ordinary use at the time when they were written. M. d'Agincourt, in his valuable *Histoire de l'Art par les Monumens*, has given many curious examples of Greek manuscripts of the middle ages, extracted from the unpublished treasures of the Vatican library; and Mr Rose has collected, with much care and accuracy, the various forms of letters from inscriptions at Athens and in Attica. It would be easy to multiply references to other volumes. Although the philologist may not accept all Mr Payne Knight's conclusions, as they are presented in his well-known *Analysis of the Greek Alphabet*, he cannot refuse him credit for much learning and ingenuity, for novelty sometimes amounting to paradox, and an energy often approaching to anger. The two learned dissertations of M. l'abbé Renaudot, in the second volume of the *Memoirs of the Academy of Inscriptions*, are well known. It is impossible not to remark, that, whenever a new inscription is discovered, archæologists instantly fly to it, and for a time, commonly until something else is turned up, endeavour to solve every phenomenon by means of it. This fickleness is undoubtedly suspicious, and resembles the conduct of men who are ill at ease in their theories. The letters which we find on coins and marbles of the earliest periods are only of certain peculiar forms; but it would be a rash deduction to infer, therefore, that they did not use letters of a different shape for other purposes. These have remained, because the materials on which they were impressed or engraven were durable; and the cursive writing, which probably existed and was inscribed on perishable substances, and for temporary purposes, has been lost. If all lettered monuments of the 19th century had disappeared except our money, the inference would be most erroneous, that the inhabitants of Great Britain knew no other characters save the Roman capitals, which are alone to be found on the sovereign; and will seem ridiculous to all who are aware that the bank-note that circulates with it presents, in evidence of its mercantile origin, specimens of every kind of hand which an ambitious schoolmaster, anxious to display his penmanship, could devise.

On the Greek alphabet, as on many others, the question arises, What is properly to be considered a letter? If we accept the ordinary definition, that it is a mark for a certain known sound, it is plain that *h* is entitled to the honourable appellation. The Romans include it in the alphabet, and, except perhaps in prosody, grant to it all its rights.

By most of the nations of the west it is duly recognised, and by the orientals it is usually had in great honour. The Greeks, however, have attenuated it into a spirit, and translated it, as such, out of the alphabet, and elevated it above the heads of its fellows. The practice of sending letters aloft, that were supposed to have a turn for climbing, exists indeed in many other languages. The two dots or lines, for instance, that sometimes hang over the vowels in the German, are the remains of *e*: thus *pökel* was formerly written *poekel*; and some grammarians have recommended that the old orthography should be resumed. It is unnecessary to multiply examples from other tongues. This letter was anciently marked by the sign H, as in the Latin and our own language. When that sign was applied to denote the η, it was cut in two, and one half was suspended in the air to mark the *spiritus asper*, the rough breathing, or the *h*, which, according to the definition, is a letter; the other half was hung up in the same manner for a very peculiar purpose, not to designate any letter, not as the mark of any known sound, but, under the name of the *spiritus lenis*, it signified the absence of a letter—it became a negative sign in grammatical algebra. Since the *spiritus lenis* merely imports the absence of the *spiritus asper*, or *h*, if a sign be used to show the absence of one letter, there ought equally to be a sign to denote that of every other letter in the alphabet; and on this principle there ought to be as many negative as positive signs. If it be supposed that the reader who sees the word *all* cannot understand that the word does not begin with *h*, and is not *hall*, unless a spirit tell him so, and a mark be prefixed to signify that the word *all* does not begin with *h*, he must need the like assistance to enable him to comprehend that every other letter also is wanting. He ought to be told that the word *all* does not begin with *b*, *c*, *d*, &c. and that it is not *ball*, nor *call*, nor *pall*, nor *tall*. Since the initial is not more intelligible than the remainder of the word, every other letter of every word ought on the same principle to be preceded by the negative signs of all the letters, to show that it is nothing more than itself. To such absurdities must we be reduced, if we abandon the plain rule, that the absence of a letter alone is sufficient to show that it is wanting. We should wonder the more that a people so intelligent as the Greeks should have fallen into such an error, if, as far as we know, Lanzi had not been the first to notice it. His *reductio ad absurdum* of the *spiritus lenis* has not hitherto received the attention which its acuteness merits. In Arabic, the mark *gesma*, unless we look upon it as representing the hyphen, is also a negative sign, importing, however, a more extensive negation. It has been conjectured that the Greek accentual marks were contrived to assist persons in reading aloud, before the practice of leaving a space at the end of each word was adopted. They certainly would be extremely useful in this respect, and they afford great help in perusing a manuscript written continuously. For this purpose the spirits are more useful than the accents; for they show that the vowels over which they are placed are initials,—ignorance whereof is a fertile source of ambiguity; and for this purpose the *spiritus lenis* is as necessary as the aspirate. The latter is a letter, and an orthographical mark besides; the former is only a mark that the Ε begins another word, as in the example ΚΑΙἘΓΩ, which is equivalent to ΚΑΙ ΕΓΩ, the sign ⊣ being equal to the space between the two words. It was afterwards usual to place a period after each word, as a spirit general affecting equally vowels and consonants, thus, ΚΑΙ.ΕΓΩ.ΛΕΓΩ; and this expedient is applicable to all words: and many manuscripts that were written continuously have received the convenient addition at a time long subsequent to the date of the writing. If we consider the *spiritus lenis* in this point of view, the inventors of it will be exculpated from the absurdity of which Lanzi sought to convict them, and it will attach to those grammarians only who retained the mark after the practice of leaving a space at the end of every word became prevalent. We must esteem the Greek accents and spirits, especially if we acquiesce in this theory of their invention, as venerable relics of antiquity—as contrivances which have been superseded. On this account, and from habit, it is difficult for a scholar to consent to abandon them, or to rest satisfied with a work, however well printed it may be in other respects, in which they are omitted.

Orthographical expedients to facilitate reading are numerous and ingenious, as spaces, punctuation, capitals for proper names and at the beginning of sentences, the apostrophe, and many others. It would be an interesting pursuit to trace their origin and history. Much attention has always been paid to reading and writing by the Christians, the Jews, the Mahometans, and, in short, by all nations whose religion is comprehended in ancient writings. Among the Greeks and Romans, little of their worship had been reduced into writing, nor did they profess to be in possession of a code of divine laws, like the Koran and similar volumes that are studied, transcribed, and venerated, by the orientals. The reverence that Alexander the Great displayed for the poems of Homer, remarkable as it appeared to his contemporaries, was but a faint shadow of the homage and adoration that the people of the East lavish on their sacred volumes. The treatment which the Sibylline books received at Rome was perhaps in some respects similar; but they were not publicly read; the grand object, indeed, of those in whose custody they were placed being, although they were not wanting in veneration for the prophetic volumes, to conceal, and not to publish, their mysterious contents. We cheerfully acknowledge that the religion of Greece and Rome, as a political institution, had many important advantages; but it is not to be denied that it was less favourable to the diffusion of reading and writing than Christianity and some of the religions of the East. The translations of the Scriptures have preserved for the philologer many curious fragments of languages, of which there are no other remains. In pagan Rome, as in Greece, public recitation and reading aloud were practised to a great extent; but these exercises were always performed by persons of some learning, and of considerable experience, who were comparatively few in number. When the Christians increased, public readers were greatly augmented: it became necessary to read the Scriptures, homilies, and other pious compositions, not only to learned men in cities, but to the poor and ignorant in the most obscure villages of the most remote provinces; and this office was commonly performed by men of extremely moderate attainments. It became expedient, therefore, to devise every contrivance that could facilitate the task of reading in public. The Biblical critic knows, that we owe to this cause many orthographical advantages, which are now commonly enjoyed, although the source of them is not generally understood. We are unable, however, to pursue this part of the subject at present; nor can we find leisure to trace our ordinary running-hand. It may be followed step by step from the Greek cursive, in such works as the *Palæographia Græca, sive de Ortu et Progressu Literarum Græcarum*, of Bern. de Montfaucon; in the curious publication of the Abate Marini, the principal librarian of the Vatican, entitled *I Pa-*

*piri Diplomatici raccolti ed illustrati;* in the specimens of D'Agincourt, and in similar publications. The Arabic alphabet, which, especially in the hands of the Persians, seems expressly designed to favour rapid writers, has six unconnectible letters; and when the Greek characters are written in running-hand, there are several letters which may not be joined, some with those that precede, others with those that follow. In our cursive every letter in every word may be united; but as it was first adapted to the Latin language, the school-boy who has written even a theme in that tongue must have remarked that the letters unite more easily and pleasantly than in English.

The second plate (No. XX.) presents a comparative table of hieroglyphic and alphabetic characters. We cannot dwell upon this very singular assemblage of signs and symbols, or point out in detail the absurdity of the theories which would deduce alphabetic writing from the Egyptian hieroglyphics; but it will manifest itself most strikingly and plainly, and without prejudice, to an intelligent person who will examine attentively this table, which has been arranged expressly for the purpose of presenting an untenable and unfounded hypothesis in the least unfavourable light. The first column on the left, headed "Chaldaic Letters," contains an alphabet which is so important in the history of literature, that we must not pass it over without some notice. The Chaldaic or Hebrew alphabet consists of 22 consonants, of which the forms are given on the extreme left of the comparative table, and their powers on the extreme right, and of 14 vowel points, making a total of 36 letters, if we may reckon the points, which are held to be less ancient than the consonants, and are often omitted in manuscripts and printed books, as letters. There are, besides, in a great number, accentual and other marks, designed to facilitate reading, and sometimes perhaps chanting or singing. Of some of these, however, the use is not at present understood; our business is with the 22 consonants only, and with their forms. The third letter, *g*, is called Gimel, which signifies the camel. *Camelus suo nomine Syriaco in Latium venit,* as Varro elegantly writes. There can be no doubt about the derivation of the animal's name, but the letter is as much like any other creature as a camel. Pe, the 17th letter, is called the mouth: it resembles the nose or the eyes equally. And the letter that immediately precedes it, as its name implies, is thought to be a picture of the eye; but it is as faithful a representation of any other feature, or even of the whole face. The ingenuity of the engraver could not humour the appearance of the teeth so as to make it remind us, as it ought, of the last letter but one—Shin. A very learned Rabbi, from whom we formerly received some instruction in Hebrew, gravely affirmed that the letter Pe, the mouth, is the true image of that organ; and that if it had not been the Sabbath, he would have written it, and shown, moreover, that there is a piece of pudding in it. Being offered a dry pen, that he might point it out in a book, he refused to do even that act. Such a severe observance of the day of rest appeared very surprising to persons unacquainted with the strict literal interpretation that prevails in the East. He consented indeed to explain by words that the piece of pudding is that mark which is inserted in the 17th letter, Pe, and serves to distinguish it from the 11th letter, Caph. The learned Jew, however, did not regard consistency in his explanation, nor do these ingenious people in general; for Caph is the palm of the hand; and by placing a piece of pudding in it, although it would probably be more welcome to the mouth, it would not be made to resemble it in form. Jod, which immediately precedes Caph, is the hand also; and these letters are equally unlike the hand and each other. We will not speak longer, however, of this miserable nonsense: the immense load of absurdity would soon become intolerable, if, in passing through several languages, we were to pick up in each some new extravagance. It is true that the names of the greater part, if not all, of the Hebrew letters, signify visible objects; but it does not follow that the letter ever resembled in form the object of which it bears the name. Nouns are used in the second intention without regard to shape; neither the horse for drying clothes, nor the dogs on which wood is burned, nor the cock of a barrel, nor a crow-bar, will remind us of any of the animals that lend them titles; nor do we ever see a boot-tree or a saddle-tree flourishing, like real trees, with leaves, flowers, and fruit. If we were to teach that our letter B derives its form and name from the insect, and that our alphabet, if considered in the same manner, would furnish a key to the Egyptian hieroglyphics, and would explain the origin of writing, we should not trifle more egregiously than certain expositors of the Hebrew characters.

Our third and last plate (No. XXI.) comprehends specimens of some remarkable alphabets. We will treat them in the order in which they stand. In the Syriac, the number and order of the letters are the same as in the Hebrew, and their names and powers are nearly the same also. The row of characters on the right is that square writing which is called Estrangelo. The letters in the next row are commonly termed Chaldee. Many of them resemble the former, and some are different. The open letters are the same as the first row, except that they are formed with greater regularity, and are more square. The remaining four columns consist of the ordinary Syriac letters, varying more or less in form from the Estranghelo, and arranged from the right to the left in order, as initial, medial, final, and solitary letters. Of these alphabets, the Estranghelo is the most ancient and solemn. Some maintain that the Hebrew Scriptures were originally written in this hand. It corresponds in its origin and use with the Roman capitals, which we esteem older than the small letters, and now use only for titles, inscriptions, and the like. The second column, or Chaldee, is called also the reformed Syriac, being a medium between the Estranghelo and the ordinary Syriac. Vowel points are added to these letters; but it is acknowledged that the use of them, in this language at least, is entirely modern. The Illyrian and Servian alphabets are evidently derived from the Greek: *Græco fonte cadunt;* we cannot add, however, *parce detorta:* the order of the letters is the same, many being inserted. The two rows of letters on the left, which are usually very like the Greek originals, are the Servian, and are commonly called the alphabet of St Cyril, being ascribed to that saint. The other two rows of letters, which are, as it were, double, and frequently of an extraordinary form, are the Illyrian, or Dalmatian, and are named the alphabet of St Jerome. We are apt to wonder why the good father should have taken so much trouble, if he was indeed the inventor, to disfigure the elements of speech. The appearance of the Illyrian, when we see an entire passage in this character, is still more strange: it is impossible indeed to judge of its effect from a mere table of letters. We regret, therefore, that our space will not suffer us to give a specimen of this whimsical and unusual writing. The Russian alphabets, both ancient and modern, are formed from the Greek by additions and alterations, the order of the letters being nearly the same. The Ethiopic alphabet, which occupies the middle of the plate, is extremely interesting, because it is said to be a great and important step in the history of writing; and it is expressly referred to by the very learned President Goguet, as a specimen of a syllabic alphabet: "rectius syllabarium quam alphabetum." Syllabic writing, if it ever existed, would not be a step from hieroglyphic to alphabetic writing: it would be a kind of alphabetic writing, in which the alphabet would be very numerous, and the sounds expressed by each letter complex; but it would have no connection with hieroglyphics; the pretended link would be united to the chain at one end, but not at the other. If we suppose *prosterner*, the word chosen by Goguet, to be represented by three letters only, each of which is a syllable, as πσν, the π, which stands for *pro*, would mark a complex sound, but it would not be in any respect hieroglyphic. It would not denote a sensible object or an idea, and so of the other two syllabic letters σ and ν, and of all the rest. The conjecture would appear probable in itself, that syllabic characters are compounded of other and less complex forms; nor is the aspect of the alphabets that are put forth as belonging to this class so simple as to exclude the supposition. It is easy in the Ethiopic to trace the vowel which is added with tolerable uniformity to the simple letter. There are a few anomalies, no doubt, as in the grammatical arrangements of all languages. The first column on the left, next to the name, shows the simple letter. It is not combined with the vowel *a*, as it would seem at first sight; for that union is effected in the fourth or middle column. A moment's inspection of this alphabet and table of syllables will satisfy any one that it is composed of 26 consonants—we must use the word in an eastern sense—combined with six vowels, precisely like the tables ba, be, bi, bo, bu, by, &c., in our spelling-books; and that it does not in any respect resemble the case which is put by Goguet, of the word *prosterner* being spelled by three letters. As the Sanscrit alphabet is not shown on our plates, we will not analyze it to prove that it is not to be considered as syllabic. The Persian is as much entitled to that appellation, because the junction of the letters being often difficult, they write, for the assistance of learners, books full of syllables. It is not by steps built of such materials as these that we can hope to ascend to the origin of that most wonderful invention, the alphabet. The Ethiopic is derived from the Arabic: it is a dead language, like the Latin, and it is called the language of study, or the language of books: the Abyssinian, or Amharic, so called from Amhar, the principal province of Abyssinia, and termed the royal language, has taken its place as a living speech; and seven letters have been added to the 26 of the Ethiopic alphabet, which we have given. These two languages may be studied in the grammars of Job Ludolphus, who tells us that they are of difficult acquisition, and declares the words to be exceedingly unutterable—"maxime esse ineffabilia." The aspect of the characters, when arranged in words and sentences, is uncouth and unsightly: they somewhat resemble the Tironian notes, which, although their appearance is unpromising, were written, as we are informed by positive testimony, with great rapidity. Contractions, abbreviations, and connections, far from indicating that writing is in an imperfect condition, evince that penmanship is far advanced.

The Armenian alphabet consists of 38 letters. They have several other kinds of writing. We have given that which is called the round hand, and is used in printed books. Like ourselves, they write from the left to the right. The appearance of their printed books is neat and agreeable. The leaning of the letters was perhaps learned from the Italic, which was chiefly used by the printers of Venice. The greatest benefactors to their literature and typography have been the congregation of Armenian monks, who resided at Methone in the Peloponnesus, and afterwards removed to Venice. This language possesses a few original works, but is chiefly rich in translations from the writings of St Chrysostom and other Greek fathers, which have improved and refined it. Those who are curious on the subject may consult the dissertation of Schröder, *De Antiquitate et Fatis Linguæ Armenaicæ;* and the historian of a nation, to whom it is said we owe the apricot, and who have always been renowned for skill in the ancient, delightful, and honourable art of gardening, Moses Chorenensis. The Iberian or Georgian letters, as expressed in types, are commonly somewhat lighter than our engraved alphabet of 36 letters. The Georgians write also from the left, and have several kinds of writing. The plate represents the ordinary hand. The Coptic language derives its name from Coptos, a city of Upper Egypt, where it was chiefly spoken. It is said to be a mixture of Greek with the ancient language of Egypt, Ethiopic, and the old Persian. The alphabet, which is borrowed from the Greek, superseded the use of the older letters in Egypt, as the characters introduced by Cadmus possibly took the place of those that were used by the Greeks before his time. The names, figures, and order of the letters, are the same as in Greek. Eight letters were added to express sounds unknown to the Greeks. Seven of these follow the omega; psi is put out of its place, being the last letter; and ϛ, under the name So, is duly inserted after the epsilon. This tongue has attracted some little attention, in consequence of the phonetic system, of which we have spoken. A full and handsome grammar was published at Rome in 1778, by the Society *de propaganda Fide.* The examples are given in Arabic, as well as Coptic. The Gothic alphabet of the patriarch Ulphilas, which is the last of our specimens, was formed in part from the Latin, and in part from the Greek: the letters are arranged in the order of the former language. We know not whether certain theorists will consider the double letters at the end as syllabic characters. The Runic alphabet is interesting from its connection with Scandinavian antiquities. It is nearly identical with the Icelandic: the letters are copied from the Greek and Roman, being a little varied for the sake of notching them more conveniently on sticks or staves; but the order of the sixteen letters is very different from both these alphabets. There are many specimens in Hickes's *Thesaurus.* These letters have afforded much scope for controversy. Those who are most favourable to the antiquity of the Runic inscriptions assign to them nearly 2000 years. Olaus Rudbechius teaches that the Greeks used these letters before the time of Cadmus. Those who are least so say that they are not older than the third century of our era.

The best kind of Anglo-Saxon writing was very elegant; the small round characters that we see in charters are neat and extremely legible. Domesday book is written in a hand less perfect, but somewhat similar. After the Norman conquest writing deteriorated in England, and became quaint, affected, and illegible. In proportion as a nation is civilized or barbarous, the pronunciation of its language, it has been maintained, varies from the orthography. In the Celtic languages the variation is prodigious; in our own tongue it is very considerable; in the Anglo-Saxon, so far as we are able to judge, it was much less. That language was assiduously cultivated before the conquest, especially in poetry; many poems were composed, and in extremely difficult and complicated metres. After that event French became the language of the aristocracy; and the Saxon or English was long neglected, and was spoken only by the vulgar, for a long period, during which the foundations of our present orthography were laid.

The Irish claim "an exorbitant antiquity" for their tree alphabet, in which the order of the letters is peculiar, and the name of each of them is borrowed from some tree. B, under the name Beith, which signifies a birch-tree, is the first of them: it is fit that the tree of knowledge should lead the band. This alphabet is commonly allowed to be a modern fabrication: a few antiquaries, however, are ready to maintain that it is many centuries older than the creation. In most languages words are pronounced in a manner somewhat different from that in which they are written; but in the Irish the aberration of the sound from the spelling is so great, that the only use of letters seems to be, to show how words are not pronounced by omitting all that are really wanted, and inserting all but the right. As straight lines placed in different positions will form most of the letters of the Roman alphabet, so the various arrangement of lines, shaped like wedges or the heads of arrows, would make a sufficient variety of characters not altogether dissimilar to the Roman. Two of them inclining towards each other at the bottom would be V, one wedge at right angles to another might represent L, and three might be so placed as to designate either F or H. It is not necessary to pursue the subject farther. The structure of the arrow-headed, cuneiform, or ancient Persian alphabet, must be already sufficiently intelligible. Inscriptions in this character, which perhaps was also esteemed sacred, closely resemble the Runic Ogham, represented in General Vallancey's *Irish Grammar.*

The twenty-five instructive and excellent plates in the second volume of the Collection of Plates, published with the French *Encyclopédie*, contain many curious specimens of alphabets. They are taken, however, almost entirely and without acknowledgement, after the manner of the French literati, from the valuable publications of the Society *de propaganda Fide* at Rome. M. du Marsais, the writer of the article on the alphabet in that *Encyclopédie*, evinces a passionate desire to regenerate the world—such was the taste of the age—and strenuously recommends a new alphabet: had it been adopted, according to his advice, we should undoubtedly be using the old one at the present day. The numerous publications of the Society we have mentioned well deserve attention; and many curious alphabets are given in Niebuhr's *Travels*, and in other works that we need not enumerate. We have spoken already of the advancement which the arts of reading and writing have received from religion: we will mention a very remarkable and important alphabet, which derived its origin and its general diffusion from the same source. The Arabic letters are said to be the invention of the unfortunate Vizier Moclah, who flourished at the beginning of the 10th century, and lost at different times, for political offences, his right hand, which had thrice copied the Koran, his left hand, and his tongue; cruel privations for a man of letters and an elegant penman. The Cuphic, a most grave and goodly character, appears to stand in the same venerable relation of paternity to the Arabic, as the Estranghelo to the vulgar Syriac. In the *Arabian Nights*, that faithful mirror of eastern manners, we find that the second Calender, who was a king's son, after describing his critical knowledge of the Koran, and of the commentaries on "that blessed book," boasts of his excellent penmanship thus: "But one thing, which I highly admired and succeeded in to admiration, was to form the characters of our Arabian language, wherein I surpassed all the writing-masters of our kingdom that had acquired the greatest reputation." The Arabic character, especially as it has been modified by the Persians, who have added to it much elegance, with some affectation, is not only favourable to the most daring flights of the pen, but in an eminent degree also to rapid execution. Wherever the Koran penetrated it was received, and it superseded the older and more tedious modes of writing. This alphabet consists of twenty-eight or twenty-nine letters, for it is a question whether *Lam-alif* is to be accounted a letter; but it has as much right to the title as ψ, and some others in the Greek alphabet, and it can plead a proverb in its favour, "from alif to lam-alif" being exactly equivalent to "from alpha to omega." For twenty-eight or twenty-nine letters there are only seventeen primary figures, and these perhaps may be reduced to fifteen; and the letters of which the figures are similar are distinguished by the number and position of certain dots, which are called diacritical or distinctive points. It is precisely as if a numeral were added, as a co-efficient, to a letter in order to change its power entirely (we refer to this alphabet without a plate, as being generally known): thus, 1b is b, but 2b perhaps is j, 3b is n, 4b is t, and 5b is th; again, 1f is f, but 2f is k, and so with the rest. It is impossible to conceive a more clumsy device, or one more fruitful in mistakes, especially as they are distinguished, not by numerals, but by dots, which are easily omitted or misapplied. The Persians have added four more letters, by means of additional dots, without introducing a new figure. They content themselves, nevertheless, with a smaller number than the Arabs, and the same as the Greeks, for the purposes of their own tongue; never using eight of the letters except in words adopted from the Arabic. Thus, with the Romans k, y, and z, held offices in the foreign department only. The Persians vary the character in many hands, some of which are very beautiful, others very legible, and others very rapid. The Indians, when they write in the Arabic character, increase the number by three more letters, which they distinguish by additional points. The order of the Arabic letters has been changed; for their numerical value is the same as that of the twenty-two equivalent letters in the Hebrew, the six letters that have been added differ in their points only, and not in figure. It is a remarkable difference, that in the languages of the East, at least in that family which is called Semitic, the vowels are not expressed, but only the consonants. On the contrary, in all the languages of the West, the vowels and consonants enter equally into the composition of the writing. Besides the twenty-eight or twenty-nine letters, eleven other marks are used in the Arabic. In the Semitic family the vowels are not of the essence of the word, the radical meaning resides entirely in the consonants, and so is it also in the Teutonic tongues. In our own we have, for example, *sang*, *sing*, *song*, and *sung*, and innumerable other instances. Whatever may have been, therefore, the parent of the Greek, it is impossible to agree with Colonel Vans Kennedy, who maintains in his late work *On the Origin of Languages*, that the Teutonic tongues are the offspring of the Sanscrit, in which the vowels are radicals.

It has been conjectured with some ingenuity, but without foundation, that the Arabic characters in which the vowels are not expressed were invented for the common use of several dialects, in which the consonants alone were determined in an invariable manner, and the pronunciation of the vowels varied. They have certainly been applied thus, but they were invented to facilitate those who transcribed the pure Arabic of the Koran, as the Hebrew letters were used without points to copy the Jewish law. Abbreviations and simple characters, that are of easy formation, are not merely advantageous to the reporter, but are useful also to the man of letters, for instantly catching the warm thought as it issues from the imagination; and perhaps also as a cipher, that the rash surmise, the first hasty impression, may not be exposed to the rude gaze of those who, never being original themselves, never give birth to errors, and accordingly are intolerant of them in others. Short-hand, therefore, independently of its ingenuity, is so useful, that it deserves notice in an essay on the alphabet; but we refer to it only to illustrate the Arabic. The use of an extremely simple character, which is very cursive, and joins easily, and of many contractions, and the total omission, in languages like our own, where they are not radical, of all the vowels, are the means by which the short-hand writer attains to expedition. These are the wings on which his pen flies; they are the characteristics also of the Arabic alphabet. Let us suppose that all Great Britain was smitten with an immense love of writing—printing being still unknown—and that it was deemed the chief good to copy as much as possible; that for this purpose all men learned short-hand, and, finding that it increased their powers, and the passion continuing, laid aside all the ordinary hands, so that they were forgotten. Such was the origin of the Arabic writing. When the short-hand writer would make his writing more legible, he adds the more important vowels by dots, and by various diacritical marks resolves ambiguities and clears up difficulties. If it were necessary to explain it to children and to strangers, and to interpret the abbreviations of distant times—and it would be were stenography universal—many orthographical signs would be required, whereby men would in truth return to the course which they had formerly quitted. Such was the origin of the vowel points and their adjuncts.

When we reflect that we have the very words of Socrates, as he spoke them, unless Plato and Xenophon have deceived us, we cannot wonder, since the power of letters is really so great, that men have sometimes attributed to them a little more influence than they possess. Hence originated the belief in magical spells, and charms, and characters; and certain mysterious properties were assigned to writing, not only amongst the Pagans, but by many of the Christians. It is somewhat remarkable that it has always been the practice from the earliest times, and it still prevails in Catholic countries, for the bishop, when he consecrates a church (the order of this ancient and venerable rite may be read in the *Pontificale*), to inscribe twice on the pavement, in the form of a cross, all the letters of the Roman alphabet. History assigns the highest antiquity to the most precious art of alphabetic writing. The author of the book of Job was familiar with it. Moses speaks of it constantly in the Pentateuch, and he acquired his human learning in Egypt, where it was necessarily well known at that time. The better opinion seems to be, that although Cadmus, the contemporary of Joshua, introduced an alphabet into Greece, which was accepted there, it was only taken in exchange for that which had been previously in use. Josephus, it is true, with his usual desire to exalt his own nation and its laws at the expense of the Gentiles, asserts, without hesitation, that letters were unknown in Greece even in the time of Homer, and to Homer himself; and some of the fathers of the church, who piously but unfairly endeavoured to degrade the learning of the Greeks, accepted the assertion as well founded. The startling paradox of the Jew, whose nationality has been less doubted than his veracity, has been maintained, at different periods, with much ingenuity: it is capable, however, of an easy refutation. The more diligently we inquire, the more ample and unequivocal shall we find the testimony of history to be in favour of the antiquity of alphabetic writing, and also, as reason alone teaches us, that no other ever existed.

The Egyptian hieroglyphics, the Chinese characters, and the supposed syllabic alphabets, have been examined, and they do not afford, as is commonly asserted, any clue to lead us to the invention of the alphabet. Since we are unable, either in history or even in imagination, to trace the origin of the alphabet, we must ascribe it, with the Rabbins, who are prepared with authenticated copies of the characters they used, and of those of Seth, Enoch, and Noah, to the first man, Adam; or we must say with Pliny, "ex quo apparet æternus literarum usus;" or we must admit that it was not a human, but a divine invention, and that the artist who made men, Prometheus, says truly,

Εξευρον αυτοις γραμματων τε συνθεσεις. (T. J. H.)



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ALPHÆUS, or Cleophas, father of James the Less, and husband of Mary the sister of our Lord's mother; for which reason James is called "the Lord's brother." It would seem that Alphæus was his Greek, and Cleophas, or rather Clopas, his Hebrew, or Syriac name. Compare John xix. 25, with Luke xxiv. 10, and Matt. x. 3.

ALPHERY, Mikipher, or Nikephor, a clergyman of the English church, was descended from a branch of the imperial line of Russia. That country being distracted by intestine commotions in the latter end of the sixteenth century, he and his two brothers were sent over to England, and recommended to the care of Mr Joseph Bidell, a Russia merchant. Mr Bidell, when they were of age fit for the university, sent them to Oxford, where, during the prevalence of the small pox, two of the brothers died of that disease. The surviving brother entered into holy orders, and in the year 1618 was presented to the rectory of Wooley in Huntingdonshire, a living rated under L.10 in the king's books. Here he did his duty with great cheerfulness and alacrity; and although he was twice invited back to his native country by some who would have ventured their utmost to have set him on the throne of his ancestors, he chose rather to remain with his flock, and to serve God in the humble station of a parish priest. Yet in 1643 he underwent the severest trials from the rage of the fanatics, who, not satisfied with depriving him of his living, insulted him in the most barbarous manner. Having left Huntingdonshire, he went to Hammersmith, where he resided till the Restoration put him in possession of his living again. Being upwards of 80 years of age, and very infirm, he retired to his eldest son's house at Hammersmith, where soon after he died, much honoured and respected, and affording a remarkable instance of the vicissitudes of the world.

ALPHEUS, the chief river of Peloponnesus, now called *Alfeo*, *Rofeo*, or *Ryfo*. Its sources are in the mountains of Arcadia, in the east of Megalopolis. Being fed by a great number of small streams it becomes navigable, and traversing Elis, empties itself into the Ionian sea. In mythology, the Alpheus, or rather the river god of the same name, acts a very prominent part, especially as the lover of the nymph Arethusa.

ALPHONSE, two small rocky islands in the Indian Ocean.

ALPHONSIN, in *Surgery*, an instrument for extracting bullets out of gunshot wounds. This instrument derives its name from the inventor, Alphonso Ferri, a physician of Naples. It consists of three branches, which are closed by a ring. When closed and introduced into the wound, the operator draws back the ring towards the handle, upon which the branches opening take hold of the ball; and then the ring is pushed from the haft, by which means the branches grasp the ball firmly; and so it is extracted from the wound.

ALPHONSO, Alfonso, or Alonzo. This name, so famous in the annals of the Spanish Peninsula, has been borne by no fewer than two-and-twenty of its sovereigns, viz., by eleven of Leon and Castile, five of Leon, and six of Portugal.—(*La Coronica General de España, by Morales; Catalogo Real y Genealogico de España, by Rod. Mendez Silva; History of Spain, by Mariana.*)

1st. *Leon and Castile.*—Alphonso I., surnamed the *Catholic*, was the son of Pedro, Duke of Biscay, and a lineal descendant, it is said, of King Recaredo. On the death of Favila the son of Pelayo, in 739, Alonzo, who had married Ormisinda, the daughter of the latter, was proclaimed king of Asturias. He conducted in person a war against the Moors, which lasted almost throughout his reign; extended his territories by the conquest of many important places; and united to his crown the kingdom of Leon. He was a prince of an excellent understanding, equally skilled in the arts of peace and of war, and fortunate in all his undertakings. He died at Cangas in 757, at the age of 74; and was succeeded by his son Fruela, who founded the city of Oviedo in Asturias.

Alphonso II., surnamed the *Chaste*, son of King Fruela who was assassinated in 768, was but a child at his father's death. He was invested with regal authority by King Silon in 774; on whose demise in 783 he became sole monarch. He was afterwards dethroned by his uncle Mauregatus, assisted by the Moors, and retired into Biscay, where he had numerous friends. Mauregatus reigned five years, and was succeeded by Bermudo, who, two years afterwards, took Alonzo as his partner in the throne. Alonzo engaged in war against the Moors, and obtained a great victory over them at Ledas. Bermudo reigned only six and a half years. Alonzo, taking advantage of the dissensions among the Moors, captured the city of Lisbon. After this event, a great rebellion among his subjects obliged Alonzo to fly into Galicia; but with the assistance of Theudius, he was soon re-instated in his dominions. Charlemagne was invited into Spain by Alonzo; and it was in this reign that the famous battle of Roncesvalles was fought. The city of Oviedo was greatly adorned by Alonzo, who was the first sovereign who made it the capital of the kingdom. Here he died in 843, aged 85, having reigned 52½ years. Some historians have erroneously ascribed his surname of *Chaste* to his having refused to concede the tribute of a hundred virgins to the Moors: but this story is fabulous, that epithet having been derived from his observing an absolute continence towards the queen, his wife, in fulfilment of a vow. He left his throne to Don Ramiro, the son of King Bermudo.

Alphonso III., the *Great*, was 18 years of age on the death of his father Ordoño, in 862. In the first year of his reign the title of King of Galicia was usurped by Fruela, son of King Bermudo, and Alonzo retired to Alava, which was part of his own dominions: but the tyranny of Fruela soon after occasioned his assassination, and Alonzo returned to Asturias. Shortly afterwards, his four brothers, jealous at his elevation, conspired against his life; but they were seized, deprived of their eyes, and cast into prison. Alonzo then commenced those wars against the Moors by which he acquired the epithet of *Great*. He built Sublancia, and Cea, near Leon; also the cities of Porto, Viseo, Chaves, Oca, and Zamora; besides taking from the Moors Coimbra, Simancas, Dueñas, and all the territory of Campos. But fresh conspiracies arrested his victorious career. The malcontents, at the head of whom was his own son Don Garcia, charged him with overtaxing the people for the support of his wars. Alonzo then attacked Don Garcia, and having vanquished him, cast him into prison. Ximena the queen, who was of the blood royal of France, espoused the cause of the insurgents; and Hernandez earl of Castile, the father-in-law of Garcia, united with her other two sons for the deliverance of Don Garcia. The people adopted their cause, and a war ensued which lasted two years; when the king, despairing of any other means to restore peace, abdicated the throne, A.D. 910. But Alonzo could not relinquish the sword with the sceptre. In the true spirit of the age, he undertook, as the lieutenant of his son, an expedition against the Moors, and acquired fresh laurels in this campaign. In the same year, 911, he died at Zambra, after a reign of 48 years, and having added to his dominions a part of Portugal and of Old Castile. He is the reputed author of *Annals of Spain*, which embrace that period from the time of Wamba, towards the end of the seventh century, to that of Ordoño. Alonzo was tall and of a pleasing countenance, affable, and gentle, and exceedingly liberal to the poor.

Alphonso IV., called the *Monk*, King of Leon, began to reign in 924. On the death of his wife, about six years afterwards, he resigned the crown to his brother Don Ramiro, and retired into a cloister: but soon growing weary of the monastic life, he made an attempt to resume the sceptre. Upon this, King Ramiro besieged him in Leon; and having taken him captive, he put out his eyes, and threw him into a dungeon, where he ended his days.

Alphonso V. succeeded his father King Bermudo in 999, being then but five years of age. Gonsalez earl of Galicia, and his wife, were appointed by the late king to be the guardians of his minority; and, on arriving at manhood, he espoused their daughter Donna Elvira. Alonzo made war on the Moors, and lost his life at the siege of Viseo, A.D. 1028. He rebuilt, at his own cost, the city of Leon, which had been ruined by the Moors. During this reign the Moorish kingdom was subdivided into several small principalities. Alonzo was succeeded by his only son, Don Bermudo.

Alphonso VI., surnamed the *Valiant*, was the son of Fernando the Great, king of Castile and Leon. On the death of his father in 1065, the kingdom was divided among his three sons. Sancho, the eldest, received as his portion Castille; to Alonzo was given the kingdom of Leon, the territory of Campos, part of Asturias, and some towns in Galicia; and Garcia, the youngest brother, received a part of Galicia and of Portugal. Peace was not long maintained between the three brothers. Sancho made war on Alonzo, and defeated him in a bloody battle at Piantaca. Alonzo recruited his army, and defeated Sancho on the banks of the river Carrion; but an attack being made on his camp during the night, Alonzo was taken captive, and compelled to abdicate, A.D. 1071. Escaping from the monastery where he was confined, he found refuge with Almenon the Moorish king of Toledo, who lodged him in a superb palace, gave him a retinue of Christians, and assigned him a pension. Sancho took possession of Leon, and advanced into Galicia against Garcia, whose kingdom was in an uproar. The two brothers met at Santarem, where the Galicians were defeated with great slaughter, and Garcia himself captured and thrown into prison. Sancho being assassinated in 1073, Alonzo was re-instated in his dominions, after he had made a solemn declaration that he was guiltless of his brother's death. This solemn oath was administered to him by the famous Roderigo Diaz de Bivar, commonly called the Cid, whose exploits have rendered his name illustrious in the annals of chivalry. Don Garcia, on receiving his freedom, was making efforts to re-instate himself on his throne; when Alonzo, under the pretext of assisting him, obtained possession of his person, and immured him in a dungeon, where he died ten years after. He then turned his arms against the Moors, and committed great ravages in their territories, taking much spoil. No less treacherous than he had proved himself unnatural, Alonzo, after feigning some scruples of conscience, devastated the territories of Hiaya Aldirbil king of Toledo, whose father had befriended him in his adversity; and, assisted by many strangers, he invested his capital, which, after a siege of five years, A.D. 1085, was taken from the Saracens, in whose possession it had been for about 370 years. Alonzo prosecuted the war against the Moors, taking many of their towns; and being sovereign of a great part of Spain, and king of Aragon, he now assumed the imperial title. This prince was married six times. His third wife was Zayda, the daughter of Ben-Abed the Moorish king of Seville. Alonzo having invited the Almoravides from Africa to assist his father-in-law in his project of reducing all Mahometan Spain under his sway, the Almoravide king sent over a large force under the command of Hali Ben-Axa: but that chief soon finding occasion of quarrel with the Moorish king, a battle ensued in which Ben-Abed perished, and Hali took possession of his kingdom, A.D. 1091. The other Moorish princes were quickly subdued or submitted to him; and Alonzo had the mortification to see such of them as were tributary to himself throw off their allegiance, at the same time that he lost those towns which he had received as the portion of Zayda. The army he sent to oppose the victorious Moors was routed near Rhoda; and another mighty force which he gathered for that purpose was defeated at Caçalla near Badajoz with great slaughter. Many strangers now flocked to his assistance from all parts, especially from France under Raymond of Bourgogne and Raymond of Toulouse, upon which the Moors prudently retired without coming to an engagement.

In the year 1093 appeared Peter the Hermit preaching the first crusade for the recovery of Jerusalem from the Saracens. About this time the king married his three daughters; of whom Teresa, illegitimate, was given to Henry of Lorraine, with the title of Earl of Portugal, which he held as a fief of the crown of Castile. This was the origin of the kingdom of Portugal, which title was afterwards assumed, and continued in the line of this prince above 400 years. Alonzo died at Toledo in 1109, after a reign of 43 years, aged seventy-nine. It is worthy of notice, that in 1077, when Gregory VII. declared in a bull that Spain had anciently been tributary to the Holy See, Alonzo consented to pay a tribute, which was abolished by his successors.

Alphonso VII. The same as Alonzo I. of Aragon.

Alphonso VIII. (*Raymond.*) This prince, born in 1106, was proclaimed king by the states of Galicia met at Compostella; and his mother Uraca, on account of his youth, was associated with him in the government. The contentions that arose from this arrangement were only terminated by the death of Uraca in 1126: after which, Alonzo strove to repress the internal dissensions of his kingdom, and by salutary laws to ameliorate the condition of the country. He then made war on the Moors; and, elated with success, he assembled the cortes at Leon, and was solemnly crowned emperor of Spain. He married Eleanor the daughter of Henry II. of England, a princess of great personal attractions. Her jointure consisted of a part of Castile, Burgos, Medina del Campo, with many other towns, and half of all that should be taken from the Moors. Another expedition which Alonzo undertook against the Moors in Africa, was signalised by the brilliant victory of Jaen in 1157: but in returning homewards he died, in the fifty-first year of his age, and 31st of his reign. This prince is distinguished in history for his rigid observance of the rights and privileges of his subjects. His daughter Constance was married to Louis VII. *le Jeune*, king of France; which was the first alliance by marriage between those two crowns. After the example of his predecessors, Alonzo divided the kingdom between his two sons. In 1156 he instituted the order of Saint Julian, which afterwards became so celebrated under the name of Alcantara. See Alcantara.

Alphonso IX., *the Noble*, son of Sancho II., was only three years of age on the death of his father in 1158. His minority was disturbed by the contention of two powerful houses for the regency: but when he had attained the age of fifteen he was proclaimed by the cortes assembled at Burgos, and commenced his reign by making war on those Christian kings of Spain who had leagued together to dispossess him of his heritage. After repulsing them, he turned his arms against the Moors; and at Alarcos, in 1195, sustained one of the most disastrous defeats recorded in the annals of Spain. This disaster encouraged the kings of Leon and Navarre to renew their hostilities. About this time occurred a tragical event illustrative of the fierce spirit of the age. A young Jewess, whose beauty had enthralled the king, was accused as the author of all the public calamities; and the nobles, undaunted by the presence of their sovereign, plunged their daggers into her bosom before his eyes. This outrage aroused Alonzo from inactivity, and he soon repaired the defeat at Alarcos by the splendid victory of Tolosa. He died soon after, in 1214. This prince was an encourager of literature, and founded the university of Palencia, the first in Christian Spain.

It ought to be observed that the kingdoms of Castile and Leon were at this time separate: the prince of whom we shall presently speak reigned over the first; and over the latter reigned another Alonzo, also the ninth of the name. He waged war successfully against the Moors, and was the founder of the celebrated university of Salamanca. He died in 1230, having reigned 42 years.

Alphonso X., surnamed *El Sabio*, the *Wise* or the *Learned*, succeeded his father Fernando the *Good*, king of Castile, in the year 1252. He obtained the appellation of *wise*, not for his political knowledge as a king, but for his scientific and literary accomplishments. In consequence of the general opinion of his princely qualities, and his uncommon generosity, he ascended the throne with universal approbation. The ill-concerted projects of his ambition, however, disturbed the prosperity of his reign. Pretending a better right than Henry III. of England to the territory of Gascony, he directed his first attempt towards its acquisition. The arms of England, however, proved too formidable; and he was compelled to renounce his claim, on condition that Henry's son, afterwards King Edward I., should marry his sister Eleonora. At an expense which drained his treasures, and obliged him to debase his coin, he prepared for an expedition against the Moors in Barbary; but his maternal right to the duchy of Suabia, which he was called to defend, diverted him from it. Thus he formed a connection with the German princes, and became a competitor, with Richard Earl of Cornwall, for the imperial crown, a contest in which they both expended immense sums of money. The claims of several of the princes of the blood gave exercise to his military talents, and he was successful both in opposing and defeating them. He formed the romantic design of visiting Italy in the year 1268; but the states firmly remonstrating, he was obliged to relinquish it. But although he abandoned the design, it produced such discontents among the common people, and conspiracy among the nobles, that it required considerable exertion before the king could allay the ferment. Alonzo being still desirous to ascend the imperial throne, made another attempt after the death of Richard Earl of Cornwall, and even after Rodolph of Hapsburg was actually elected emperor of Germany; and for that purpose took a journey to Beaucaire, to obtain an interview with the pope, in order to prevent him from confirming the election. The Moors, ever ready to draw the sword against him, took this opportunity of entering his dominions for the purpose of ravaging them. This ambitious journey, undertaken at so vast an expense, and productive of so much confusion in his kingdom, proved unsuccessful; for the pope would not realise his claim, or alter the former election. But his excessive ambition was soon punished by domestic calamity; for his eldest son died in this interval, and his second son Don Sanchez, having obtained great reputation in opposing the infidels, to the prejudice of his brother's children, laid claim to the crown. This claim was admitted by the states of the kingdom; but Philip king of France, supporting the cause of the children, whose mother was his sister Blanche of France, involved Alonzo in a war; which occasioned the retreat of his own queen Yolande or Violante to the court of her father, the king of Aragon. While thus harassed with dissensions, he proclaimed war against France, and by the authority of the pope renewed the war with the Moors, which proved so unfortunate, that he reluctantly concluded a truce with them, and engaged in a contest with the king of Granada.

These various measures exhausted his treasure; taxes were multiplied, and the affairs of the kingdom were in such confusion, that he was under the disagreeable necessity of calling an assembly of the states, which was held at Seville in the year 1281, where, on the king's proposal, the states consented to give a currency to copper money. In consequence of the intrigues of Don Sanchez his son, another assembly of the states was held at Valladolid, A.D. 1282, which deprived Alonzo of the regal dignity, and appointed Sanchez regent. Reduced to almost insurmountable difficulties, Alonzo solemnly cursed and disinherited his son, and by his last will, in the year 1283, confirmed the act of exclusion, and appointed for the succession the infants de la Cerda, and, upon the failure of their heirs, the kings of France; and at the same time supplicated the assistance of the king of Marocco against the power of his son. At the commencement of the next year, when Alonzo received information from Salamanca that Sanchez was dangerously ill, his heart relented. He pardoned his son, revoked his curses, and then died, on the 4th of April 1284, in the eighty-first year of his age. His remains were interred in the cathedral of Seville; and he left behind him the character of a learned man, but a weak king. Alonzo has been charged with irreligion and impiety, chiefly on account of a well-known but differently interpreted saying of his, that "if he had been of God's privy council when he created the world, he could have advised him better."

To this prince science is indebted for the set of astronomical observations known as the *Alphonsine Tables*, which were drawn up under his auspices by certain Jews of Toledo. In the palace of Segovia a chamber is still shown as the observatory of Alonzo. He was also distinguished as a poet and a legislator. In the Escurial is preserved a curious manuscript containing some hymns of his composition; and he was the principal compiler of that code of laws which is still extant under the title of *Las Siete Partidas*.

ALPHONSO XI., the *Avenger*. This prince was an infant when he succeeded his father Ferdinand IV. in 1312. During his long minority the kingdom was cruelly distracted by intestine warfare. Assuming the reins of government in his fifteenth year, he strove to repress the turbulent spirit of the nobility, and to put down that system of brigandage to which it had given rise. His inflexible severity towards all such offenders procured for him the title of the Avenger. As commander of the allied armies of Catholic Spain, on the 29th Oct. 1340 he gained a complete victory over the kings of Marocco and Granada, who had besieged Tarifa. The slaughter was immense, and the booty so rich that the value of gold is said to have fallen one sixteenth. In 1342 Alonzo laid siege to Algeziras, where cannons were employed for the first time in Europe by the Moors in defence of their walls. This siege had lasted two years, when the Moors capitulated on condition of a truce between the two nations for ten years: but the king of Castile broke his word a few years after by besieging Gibraltar, where he died of the plague on the 26th March 1350, aged 40. He was the father of Pedro the Cruel, who succeeded him. From this reign dates the institution of *regidors* or jurats, to whom was committed the administration of the communes; and these *regidors* became the exclusive electors of the cortes, in which the people ceased to have a voice.

2d. *Aragon.*—ALPHONSO I., surnamed the *Fighter*, king of Navarre and Aragon, was the second son of Don Sancho Ramirez, and succeeded his brother Pedro I. in 1104. At that period Aragon was exhausted by the interminable wars which its successive sovereigns had waged against the Moors. The power of the Almoravides, which the exertions of the Cid were unable to check, menaced all Christian Spain; and the only prince that still was able to oppose them was the aged Alonzo VI., king of Leon. It was in this juncture of affairs that Alonzo I. by many years of peace had gathered strength to pursue that headlong career which afterwards caused him to be surnamed the *Fighter*. Very shortly after his marriage with Uraca the daughter of Alonzo VI. of Leon, some misunderstanding alienated his affections from that princess. The haughty Castilian nobles, indignant at her treatment, rescued her from the fortress where she was confined, and bore her away in triumph. In the meantime Alonzo was occupied with his schemes of aggrandizement. The capture of Tudela from the Arabs was the prelude to his invasion of the kingdom of Saragoza in 1110. In dissolving his marriage with Uraca, he attempted to retain the greater part of her dowry; but she had a powerful friend in her brother-in-law Henry Count of Portugal, whose army already menaced Navarre. This obliged him eventually to renounce all pretensions to the states of Leon and Castile, and to recognise, as king of Galicia, Alonzo Raymond the son of Uraca, A.D. 1113. His marriage was dissolved by a council of Castilian bishops, and their decision was ratified by the pope. At this period commenced the struggle between the Aragonese and Almoravides. The army of the governor of Granada was cut to pieces near Saragoza, and Alonzo obtained another victory over a large army sent by Ali of Marocco under the command of his ablest generals to avenge Ben Mezdeli. In this short campaign Alonzo displayed extraordinary ability. No longer concealing his designs upon Saragoza, he obliged Amad Dola to surrender that city, from which point he commenced his attempts to subdue the kingdom (A.D. 1118). This hard-earned acquisition was the means of involving him in interminable troubles. In 1120 his territories were menaced by a large force sent against him by Ali; but engaging the enemy near Daroca, he left 20,000 Almoravides dead on the field. This victory placed Daroca and Calatayud in his power. Three years afterwards, while the king of Marocco was fully occupied at home by the rise of a dangerous sect of Almoravides (see ABDUL-MUMEN and ALMOHADES), Alonzo seized the opportunity to invade the territory of Valencia. The brilliant victory he obtained at Alcaraz seemed to open up the way for the conquest of all eastern Spain. In 1125 he undertook a new expedition against Granada. The spoil taken from the Andalucians was dearly bought by the Christians; but it was not upon Alonzo that the Moors made their reprisals. They invaded Estremadura, and defeated the Castilians near Badajoz. The king of Aragon, so far from rendering his neighbours any assistance, determined to take advantage of the critical position of Alonzo Raymond, as well as of the troubles which the death of Uraca had occasioned in several parts of his dominions. But, when on the point of battle with the king of Leon upon his own territory, Alonzo agreed to an accommodation, and resolved to turn his arms in another direction. He imagined the time was arrived for achieving with ease the conquest of Saragoza. Two cities, Mequinenza and Fraga, still held out. He reduced the first, and put the garrison to the sword on account of their devotion to the Almoravides. He then laid siege to Fraga; where, during a sally from the town, he received a mortal wound. Alonzo had been victorious in 29 battles, and his arms had never received a check until this day, when he beheld, whilst dying, the utter destruction of his followers. The camp of the Christians with its rich spoils indemnified the Moors for the losses they had sustained at his hand. His ancient rival, Alonzo Raymond, hastened to avenge his defeat, and to succour the remnant of his army.

Alphonso II. began to reign in 1162, and was almost constantly at war with Raymond V. Count of Toulouse. He was a patron of the troubadours, and wrote some poems in the Provençal language. He died in 1196.

Alphonso III. ascended the throne in 1285. His short reign was remarkable for the establishment of the most liberal political constitution of that age, the *justiza* being invested with the right of citing the king himself to appear before the cortes, and with the power of deposing him if he infringed the privileges of the subject. Alonzo vainly endeavoured to avoid taking the oaths of adherence to the articles to which his predecessors had subscribed, by absenting himself from the solemn ceremony of coronation; but the nobles obliged him to appear according to custom. Under this reign also were united the cortes of Valencia, Catalonia, and Aragon, which each sovereign on his elevation engaged by oath never to disunite. Alonzo died in 1291, aged 26.

Alphonso IV. ascended the throne in 1327. Almost the whole of his reign, which lasted ten years, was occupied in war with the Genoese.

Alphonso V., the *Magnanimous*, commenced his reign in 1416. He was the son of Fernando the *Just*, of Castile, whom the Aragonese had chosen for their king. Alonzo was one of the greatest princes of the fifteenth century. The first act of his reign was to destroy a list containing the names of those who had conspired against him. But the free nature of the constitution, which was almost republican, imposed restraints little in accordance with Alonzo's ardent aspirations after fame, and he resolved to seek a wider sphere of action. Accordingly he left his kingdom, and during a reign of forty-three years scarcely revisited it, unless momentarily, or when urgent affairs demanded his presence. The shores of the Mediterranean were to be witnesses of his exploits, where the possession of the Balearic Isles, Sardinia and Sicily, gave him dominion. His first expedition was directed against Corsica, then in possession of the Genoese. Thence sailing to Naples, he offered to make John II. his heir if he would assist him against Louis of Anjou. Being recalled to Spain by an attack made by the Castilians upon his hereditary states, he left his brother Don Pedro at Naples; and coasting the Adriatic, he suddenly descended on Provençe, and captured Marseilles, which pertained to the Duke of Anjou, his competitor for the kingdom of the two Sicilies. Alonzo, ever generous in war, preserved the city from pillage; and refusing a present that was offered him in acknowledgment of his forbearance, contented himself with carrying away the body of a canonized bishop. After restoring peace at home, he directed his arms anew against Naples, where his cause appeared to be compromised. In 1435, Queen Joanna being dead, he besieged Gaeta; but when he had reduced that place, Philippo Maria Visconti, Duke of Milan, appeared with a fleet before the town, and after a bloody engagement, took Alonzo prisoner, with a great number of his followers. The high character which Alonzo bore induced the conqueror to treat him honourably: he made him his ally, and without ransom restored him to liberty, with all his suite. Immediately on recovering his freedom, Alonzo made his third attempt on the kingdom of Naples. After an obstinate resistance the city was taken by assault, in 1442, and Alonzo entered it in triumph. The states were convoked, and he was solemnly proclaimed; his elevation being sanctioned by Pope Eugenius IV., who had promised to René that honour. Alonzo fixed his residence at Naples, where he died on the 27th June 1458, at the age of sixty-four, while preparing for a new war against several of the Italian princes. Possessed of many noble qualities, he united humanity with valour; but his amorous disposition sometimes inclined him to abuse his authority. He was a lover and patron of literature, and delighted in Cæsar's Commentaries, a copy of which he always carried about with him. His secretary, Antonio de Palermo, has left a life of this prince.

3d. *Portugal.*—Alphonso I., *Enriquez*, son of Henri of Bourgogne, Count of Portugal, and Teresa of Castile, was born in 1094. The Count Henry dying when Alonzo was but three years old, he was placed under the tutelage of his mother; and when he came to age, he was obliged to wrest from her by force that power which her vices and incapacity had rendered disastrous to the state. Being proclaimed Count of Portugal in 1128, he defeated a body of troops which his mother had armed against him, and made her his prisoner. He also vanquished the Castilians who came to support his enemies, and freed Portugal from dependence on the crown of Leon. Then turning his arms against the Moors, on the 26th July 1139 he obtained the famous victory of Ourique, which gave him a crown. Not satisfied, however, with being proclaimed king by his army on the field of battle, he assembled the cortes of the kingdom in 1145 at Lamego, where he received the crown from the hands of the archbishop of Braganza. Holding a naked sword in his hand, he said—"I have delivered you with this sword from the power of the Moors: I have conquered your enemies: you have made me your king. Let us at once establish laws for maintaining order, justice, and peace, in this realm." The constitution of the kingdom was accordingly voted by the deputies, and the freedom of Portugal was proclaimed as follows:—"You are asked if you wish that the king should pay tribute to Castile, and appear before the states of this kingdom as a vassal." Upon which a shout was raised,—"We are free, and our king shall be free also." Such was the result of the famous assembly at Lamego, and the foundation of the Portuguese monarchy. Alonzo continued to signalise himself by his exploits against the Moors, from whom he wrested Lisbon in 1147, after a siege in which both parties displayed the most heroic valour. He next engaged in the war that had broken out among the kings of Spain. Being disabled during an engagement by a fall from his horse which fractured his leg, he was made prisoner by the soldiers of the king of Leon, who obliged him to give up as his ransom almost all the conquests he had made in Galicia. Alonzo was then eighty years old;

but he had still sufficient energy to relieve his son Sancho who was besieged in Santarem by the Moors. This was his last exploit. He died in 1185, at the age of ninety-one, having reigned seventy-three years. Alonzo was of gigantic stature, even seven feet in height according to some authors. His victories and his laws, his Christian life and chivalry, as well as the numerous religious houses he established, are claims on the admiration and the gratitude of the Portuguese, among whom, accordingly, he has long been regarded as a saint.

Alphonso II., the *Fat*, born in 1185, succeeded his father, Sancho I., in 1211. He endeavoured to repress the ambition of the clergy, and to apply a portion of their enormous revenues to purposes of national utility. Having been excommunicated by the pope, he was anxiously negotiating for absolution when death overtook him in 1223, in the 39th year of his age, and 12th of his reign. He framed a code of laws in which it was enacted that capital punishment should not be inflicted until the expiry of twenty days after condemnation.

Alphonso III., son of the preceding, succeeded his brother Sancho II. in 1248. He, like his father, was frequently embroiled with the ecclesiastics. He died in 1279.

Alphonso IV., in 1325 succeeded his father Dionisio the *Liberal*, whose death he had hastened by his intrigues and rebellions; and his persecution of Alonzo Sancho proved him to be no less unnatural as a brother. To an immoderate love of the chase he sacrificed his duties as a king; and on one occasion, while expatiating on his favourite sport before the council, he was plainly told by the indignant ministers of the wrong he was inflicting on the nation, and that, if he did not amend his life, they would depose him. Alonzo was filled with rage; but suddenly recovering himself, he confessed that their announcement had opened his eyes, and that in future they should find him a very different king. Hostilities with the Castilians and with the Moors occupied many years of his reign: but one bloody act, of which the mass of Camöens has perpetuated the memory, has fixed an indelible stain on his character. The murder of Iñez de Castro, who was secretly espoused to his son Don Pedro, recals the sad history of that young prince, and the troubles in which it involved the kingdom. Alonzo was scarcely reconciled to Don Pedro when he died, in the 77th year of his age, A.D. 1376.

Alphonso V., *Africano*, king of Portugal, was the son of Duarte I., whom he succeeded in 1438, being then but six years old. In 1471 he landed in Africa with a fleet of 300 sail and 30,000 men, and there acquired by his conquests the title of *Africano*. During this expedition he heard of an ancient tradition that, at Fez, was jealously preserved a sword which should become the spoil of a Christian prince; and supposing that its accomplishment was reserved for himself, he instituted the chivalrous order of The Sword. In returning to Portugal in 1475, his ambition led him into Castile, where two princesses were disputing the succession to Henry IV. Supported by a powerful party, Alonzo caused himself to be proclaimed king of Castile and Leon. Being defeated at Toro by Ferdinand of Aragon, the husband of Isabella of Castile, he applied for assistance to Louis XI. of France; but finding himself deceived by Louis, he became disgusted with the regal state, and forwarded his abdication to his son. A few days after he appeared in Portugal, and was constrained by his son, Juan II., to resume the sceptre, which he continued to wield for two years longer; after which he fell into a deep melancholy, and retired into a monastery at Cintra, where he died of the plague in 1481, aged 49. He was a brave prince, and ruled equitably; and he was the first king of Portugal who possessed a private library.



Alphonso VI. was the son of that Duke of Braganza who succeeded to the crown as the representative of the ancient dynasty of Portugal. He succeeded his father in 1656; and in 1667 was compelled to abdicate the throne, of which his vices had rendered him unworthy.

ALPHONSUS *a Sancta Maria*, or Alfonso *de Cartagena*, a celebrated Spanish historian, was born in 1396, and died in 1496. He succeeded his father as Bishop of Burgos. He was the author of several works, the principal of which is a History of Spain from the earliest times down to the year 1496, printed at Granada in 1545, fol.

ALPINI, Prospero, in Latin Prosper Alpinus, a celebrated physician and botanist, was born at Marostica, in the republic of Venice, in November 1553. In his early years his inclination led him to the profession of arms, and he served some time in the Milanese. By the encouragement and persuasion of his father, who was a physician, he retired from the army, and devoted his attention to literature. To prosecute his studies with more advantage, he went to the university of Padua, where he was soon after elected deputy to the rector, and syndic to the students. He continued his medical studies with zeal and success; and after having acquired the necessary qualifications, he was admitted to the degree of doctor of physic in 1578. Soon after this he left the university, and settled as a physician in Campo San Pietro, a small town in the Paduan territory, at the invitation of its citizens.

In the course of his studies he had paid particular attention to plants, and had become an enthusiast in botanical science; but the sphere of his present practice was too limited to afford him much opportunity of prosecuting his favourite study. He wished particularly to extend his knowledge of exotic plants; and considered that the only means of attaining this was to study their economy and habits in their native soil. To gratify this laudable curiosity an opportunity soon presented itself. George Emo, the consul for the Venetian republic in Egypt, appointed Alpini his physician. They sailed from Venice in September 1580, and, after experiencing a tedious and dangerous voyage, arrived at Grand Cairo in the following year. Alpini spent three years in Egypt, and, by his industry and assiduity, greatly improved his botanical knowledge, having travelled along the banks of the Nile, visited every place, and consulted every person from whom he expected any new information. From a practice in the management of date-trees, which he observed in this country, Alpini seems to have deduced the doctrine of the sexual difference of plants, which was adopted as the foundation of the celebrated system of Linnæus. He says, that "the female date-trees, or palms, do not bear fruit unless the branches of the male and female plants are mixed together; or, as is generally done, unless the dust found in the male sheath, or male flowers, is sprinkled over the female flowers."

When Alpini returned to Venice in 1586, he was appointed physician to Andrea Doria, prince of Melfi; and during his residence at Genoa, he was esteemed the first physician of his age. The Venetians were unwilling that the Genoese state should number among its citizens a person of such distinguished merit and reputation; and in the year 1593 he was recalled to fill the botanical chair in the university of Padua, with a salary of 200 florins, which was afterwards augmented to 750. He discharged the duties of his professorship for many years with great reputation, till his declining health interrupted his labours. He died in 1617, in the 64th year of his age, and was succeeded as botanical professor by one of his sons. Alpini wrote the following works in Latin:—1. De Medicina Ægyptiorum libri iv. Venice, 1591, 4to; 2. De Plantis Ægypti liber, Venice, 1592, 4to; 3. De Balsamo Dialogus, Venice, 1592. 4to;

Alpiste || Alps. 4. De Præsagienda Vita et Morte Ægrotantium libri vii. Venice, 1601, 4to; 5. De Medicina Methodica libri xiii. Padua, 1611, folio; 6. De Rhapontico Disputatio, Padua, 1612, 4to. Of all these works there have been various editions given to the world; and, besides these, two posthumous treatises were published by his son: 1. De Plantis Exoticis libri ii. Venice, 1627, 4to; 2. Historiæ Naturalis Egypti libri iv. Lugd. Bat. 1635, 4to. Several other works of Alpini remain in manuscript.

ALPISTE, or Alpia, a sort of seed used to feed birds with, especially when they are to be nourished for breeding. The alpiste seed is of an oval figure, of a pale yellow, inclining to an isabel colour, bright and glossy. It is an article of the corn-chandlers and seedmen's trade.

ALPS. On taking a general view of the continent of Europe, we can distinguish two great mountain masses, from which proceed the various chains of mountain groups that characterize it. The first of these is the mountain mass of *St Gothard*, in Switzerland, between the sources of the Rhine, the Rhone, the Etch, and the Aar: the second is the *Wolchonsky-wald*, in Russia, between the Wolga and the sources of the Don, Dnieper, and Dwina.

The mountains connected with St Gothard are the Alps, which in their full extent reach from long. 4° 20′ to 19° E. from Paris, and from lat. 44° to 47° N. The central point of the Alps is in Switzerland, the numerous branches of it extending through Savoy, France, Italy, Germany, Croatia, and Sclavonia. They are bounded on the south-west by the Rhone, in southern France; on the north-east by the Danube, in Hungary; on the south and south-east by the Mediterranean Sea, and the rivers Kulpa and Sau; on the north and north-west by the Danube, in Germany; by the Rhine on the northern boundary of Switzerland; and by the Doubs in the Jura. Hence it appears that this great high land passes through France, Savoy, Switzerland, Italy, Germany, Croatia, and Sclavonia. The southern part of the chain in Croatia, in long. 35°, does not reach its extremity, but continues onwards to the left bank of the Sau and Danube, fully ten degrees of longitude farther.

Origin of the name. In the Celtic language, the word *alb*, *alp* according to some authors, signifies *white*. As the highest peaks of this Alpine land are perpetually covered with snow, they were by the ancient inhabitants named Alps; by the Greeks Αλπεις, who, however, knew only the Maritime Alps; by the Romans Alpes, and by modern writers Alps.[1]

History. The Romans, although they knew well that the Gauls under Bellovesus (620 years before Christ) made an irruption into Upper Italy across the Alps, were entirely ignorant of the route he followed. It was not until Hannibal had crossed the Alps (300 years after Bellovesus) that the Romans thought of examining this grand barrier. Polybius described the Alpine country traversed by the military host under Hannibal, fifty years after that remarkable event; and Cincius Alimentus heard Hannibal himself detail his passage of the Alps. Livy, and other writers, both Latin and Greek, also speak of the Alps. Fifty-two years after Hannibal's irruption into Italy (in the year of Rome 587, before Christ 178), the Romans, under the consuls Claudius and Marcellus, conquered the Cisalpine Gauls, who inhabited the country between the Po and the Alps; and seven years afterwards, under Fulvius Nobilis, they for the first time crossed the Alps to Nice and Antibes, in order to aid the Marsilians against the Ligurians. For one hundred and fifty years from this period, the Romans frequently traversed this chain, partly with the view of subjugating the various tribes inhabiting it, and partly in extending their conquests into Spain, Gaul, and Germany After the death of Cæsar, the whole Alpine population threw off the Roman yoke. The emperor Augustus sent against them (in the year of Rome 747, before Christ 18) his legions, under Drusus, Tiberius, Terentius Varro, and Lucius Silus. This long-continued warfare terminated in the conquest of forty-six Alpine tribes or nations, whose names were inscribed on the celebrated triumphal arch of Augustus, erected near Nice. From this period until the fifth century after Christ, the Romans continued in complete possession of the north and south sides of the Alps.

During the long domination of the Romans, the Alps received the following names, which are still retained by geographers, viz. Maritime, Cottian, Grecian, Pennine, Leopontine, Rhætian, Noric, Carnic, Julian, and Dinarian.

### DIVISIONS OF THE ALPS.

Divisions of the Alps. 1. *Maritime Alps* (Alpes Maritimæ).—These extend from the coast of the Mediterranean Sea, between Oneglia and Toulon, across the Cols Ardente and Tende, to Mont Viso (Vesulus), separating Piedmont from Provence and the Mediterranean Sea.

2. *Cottian Alps* (Alpes Cottiæ) extend from Mont Viso by Mont Genevre to Mont Cenis, a distance of twenty-five leagues, thus separating Piedmont from Dauphiny. It is in this range that we first meet with heights analogous to those of the central chains of the Alps. The Po and the Durance rivers have their sources here. The name is derived from Cottius, who, in the time of Cæsar and Augustus, had his chief place of residence at Seguvium, the present Susa, and ruled as king or chief of this part of the Alps.

3. *Graian or Grey Alps* (Alpes Graiæ) extend from Mont Cenis, across the Iseran and the Little St Bernard, to the Col de Bonhomme, separating Piedmont from Savoy. They were named Grey Alps from their grey colour, owing to the partial cover of snow. The Little St Bernard is considered as the Alpis Graia of the ancients.

4. *Pennine Alps* (Alpes Penninæ), also named by Cæsar Alpes Summæ, extend from the Bonhomme across Mont Blanc, the Great St Bernard, Combon, onwards to Mont Cervin and Mont Rosa, separating Piedmont from Savoy and the Lower Vallais. The Celts named every high mountain a Ben or Penn; hence the loftiest summits and the most exalted of their deities were named Penn. In the time of the Romans, in one of the valleys, a temple was built, and a statue erected in it, to one of their gods, named Penn, by the Romans Deus Penninus, and afterwards Jupiter Penninus. Hence these Alps were named Alpes Penninæ. In this part of the great Alpine range there occur Mont Blanc, the highest mountain in Europe, and Mont Rosa, the next in elevation to that monarch of European mountains.

5. *Lepontine Alps*, also named Alps of Switzerland, or Aulæ. They extend from Mont Rosa on both sides of the Rhone, or valley of the Vallais, across St Gothard, the Moschelhorn, and Bernardino in the Grisons, thus separating Lombardy from Switzerland. The distance from St Gothard to Bernardino is 15 leagues. They were named Lepontine after a people, the Lepontii, who formerly inhabited the confines of Rhætia, Helvetia, and Italy.

[1] Some authors derive Alp from *alb*, a verdant height.

Alps.

6. *Rhætian Alps* (Alpes Rhæticæ) extend from Bernardino through the whole of the Grisons and the Tyrol, to the Dreiherrn peak, on the borders of Saltzburg and Carinthia, and more southerly to Mont Pelegrino; thus separating Lombardy and a great part of the Venetian terra firma from Northern Rhætia and Germany.

7. *Noric Alps* (Alpes Noricæ) extend from the Dreiherrn peak through the whole of Carinthia, on the left bank of the Drau, through Saltzburg, Austria, and Styria, to the Oedenburg plain in Hungary. They have their name from the Roman town Noricum.

8. *Carnic Alps* (Alpes Carniæ) extend from Pelegrino, between the rivers Drau and Sau, to Terglou, at the source of the Sau.

9. *Julian Alps* (Alpes Juliæ) extend from Terglou, between the right bank of the Sau, the Kulpa, and the Adriatic Sea, to the rock Kleck, near Zenk in Dalmatia; thus separating the Friaul from Idria, and in general the whole of Upper Italy from Carinthia, Carniola, Croatia, and Servia. The present Civita di Friuli occupies the site where formerly stood the Forum Julii, which gave name to this division of the Alps.

10. *Dinarian Alps*, so named from Mount Dinaria, which has an elevation of 6046 feet, extend from Kleck to Sophia, ranging along the right bank of the Sau and Danube, and join the Hæmus or Balkan, on the Black Sea.

Direction of the Alps. The general direction of the Alps, exeluding the Maritime Alps, which range nearly from south to north, is from west-south-west to east-north-east. Direction of valleys. The most considerable valleys, those named *longitudinal*, run parallel with the direction of the chain; and others, named *transverse*, run from south and south-east to north and north-west, or from north and north-west to south and south-east.

Great acclivities of the Alps. The great crest of the Alps, the *water-shed* (divortia aquarum) of this vast high land has declining from it two acclivities, one towards the north, the other towards the south. The north acclivity declines towards the ocean, the North Sea, and the Baltic; the south acclivity towards the Mediterranean and Adriatic Seas. The northern acclivity has a gentle inclination, and is much more extensive than the southern, which is comparatively abrupt and steep. From the nature of these two acclivities or inclined plains, we naturally expect to find the principal and most numerous secondary chains on the northern, and this is actually the case. Mont St Gothard, in some degree the central point of the whole chain, is distant in a straight line from the Mediterranean about 52 leagues, from the Adriatic 75 leagues, from the ocean 175 leagues, from the North Sea 168 leagues, from the Baltic 185 leagues.

Heights of mountains.

HEIGHTS OF THE MORE REMARKABLE MOUNTAINS IN THE ALPS.

I. *Maritime Alps.*

| | English Feet. | |
|---|---|---|
| 1. Col de Tende | 5,818 | |
| 2. Mont Venteux | 7,235 | |

II. *Cottian Alps.*

| | | |
|---|---|---|
| 3. Mont Viso | 13,828 | Zach. |
| 4. Mont Genevre | 11,788 | |
| 5. Mont Cenis | 11,460 | |

III. *Graian Alps.*

| | English Feet. | |
|---|---|---|
| 6. Mont Iseran | 13,278 | Welden. |
| 7. Summit of the Little St Bernard | 9,594 | |
| 8. Col de Bonhomme | 8,027 | |

IV. *Pennine Alps.*

| | | |
|---|---|---|
| 9. Mont Blanc | 15,781 | |

Mont Blanc is the highest mountain in Europe. The Elbruz in the Caucasus, which is 16,411 feet, cannot be reckoned a European mountain. Notwithstanding its vast height, Mont Blanc is much inferior in elevation to some mountains in the New World and in Asia; for, according to late measurements, there are in Upper Peru mountains 25,250 feet above the sea; and in the Himalaya ridge summits soaring to a height of 26,000 feet.

| | | |
|---|---|---|
| 10. Great St Bernard | 11,011 | |
| 11. Mont Cervin | 14,784 | |
| 12. Mont Rosa | 15,540 | Welden. |

Mont Rosa is the next in elevation to Mont Blanc, and therefore the second highest mountain in Europe. By some it is stated to be even higher than Mont Blanc, but we do not know the authority for this statement.

| | | |
|---|---|---|
| 13. Col de Geant | 11,275 | |
| 14. L'Alle Blanche | 14,775 | |
| 15. Breithorn | 12,800 | |

V. *Lepontine Alps—Group of St Gothard.*

| | | |
|---|---|---|
| 16. Petchiroa (one of the summits) | 10,529 | Welden. |
| 17. Fienda, another summit | 10,180 | |
| 18. Furca | 14,040 | |
| 19. Piz Pisoc | 12,792 | |
| 20. Pettina | 9,153 | |
| 21. Finsteraarhorn | 14,116 | |
| 22. Schreckhorn | 13,397 | |
| 23. Jungfrau or Virgin | 13,720 | |
| 24. Diablerets | 10,732 | |
| 25. The Simplon[1] | 6,590 | |
| 26. Ruffi or Rossberg | 5,154 | |
| 27. Rigi | 6,050 | |

VI. *Rhætian Alps—Great Rhætian Chain.*

Grisons and Tyrol.

| | | |
|---|---|---|
| 28. Muschel Horn | 10,948 | |
| 29. Bernhardino | 10,187 | |
| 30. Orteles | 12,859 | Welden. |
| 31. Greiner | 9,380 | |
| 32. Brenner | 6,463 | |

*Northern Rhætian Chain.*

Chain between Tyrol and Bavaria.

| | | |
|---|---|---|
| 33. Watzmann | 9,655 | |
| 34. Breithorn | 7,772 | |

VII. *Noric Alps.*

| | | |
|---|---|---|
| 35. The Great Glockner | 13,713 | |
| 36. Hohenwart | 11,076 | |
| 37. Hahe-varr | 11,334 | |

VIII. *Carnic and Julian Alps.*

| | | |
|---|---|---|
| 38. Kleck | 6,692 | |
| 39. Terglou | 9,096 | |

[1] There is a great road over the Simplon. It was improved by the Emperor Napoleon at an expense of nine millions of francs. It runs along the Savoy side of the lake of Geneva, and connects the ridge of the Jura with the Alps. At St Maurice it falls in with the road that traverses the Swiss margin of the lake, passes up the Vallais beyond Sion, and conducts the traveller to the lake Maggiore and Milan. See SIMPLON.

Alps.

*Heights of Passes across the Alps.*

| | | English Feet. |
|---|---|---|
| 1. | Pass of Mont Cenis | 6,773 |
| 2. | Pass of the Little St Bernard | 7,194 |
| 3. | Pass of the Great St Bernard | 7,966 |
| 4. | Pass of the Cervin | 10,100 |
| 5. | Pass of St Gothard | 6,800 |
| 6. | Pass of Gemmi | 7,378 |
| 7. | Pass of Airolo | 7,192 |
| 8. | Pass of the Splugen | 6,310 |
| 9. | Pass of Mont Julien | 7,280 |

*Heights of Lakes in the Alps.*

| | | |
|---|---|---|
| 1. | Lake of Mont Cenis | 6,280 |
| 2. | Lake of the Dead, on the Grimsel | 7,067 |
| 3. | Lake Refen, in the Tyrol | 6,151 |
| 4. | Lake Zegern, Tyrol | 2,480 |
| 5. | Lake Lugano | 936 |
| 6. | Lake Como | 636 |
| 7. | Lake of Geneva | 1,207 |
| 8. | Lake of Neufchatel | 1,370 |

*Heights of Sources of Rivers in the Alps.*

| | | |
|---|---|---|
| 1. | Sources of the Rhone | 5,748 |
| 2. | Sources of the Reuss | 7,088 |
| 3. | Sources of the Tagliamento | 4,412 |

*Elevated Habitations in the Alps.*

| | |
|---|---|
| Priory of Chamouni | 3,354 |
| Convent of St Gothard | 6,796 |
| Hospital of the Grand St Bernard (highest habitation in Europe) | 7,966 |
| Hospital of the Grimsel | 6,003 |

Snow line. The cold of the atmosphere continually increases with the elevation; and at a certain height, depending on climate or latitude, perpetual frost prevails. Where the earth's surface attains this height, it is, with the exception of mural precipices, continually covered with snow. The snow increases from season to season; for though it may melt slowly from the heat of the ground on which it rests, yet it suffers little loss externally in the way of melting, except what the air carries off by evaporation. If in the neighbourhood of Edinburgh we had mountains 6000 feet high, their summits would be always covered with snow, and consequently we should here have perpetual snow within a few hours' walk. But in Great Britain none of the mountains reach to the snow line of the latitude,—an arrangement very different from what prevails in the Alps, where whole ranges are covered with eternal snow. When mountains are covered with perpetual snow, its lower limit, or the snow line, descends in winter and rises again in summer; so that in the Alps in winter the snow line reaches the low country, while in summer it ascends, and in the autumn, when the heat is greatest, it attains its maximum of height.

Glaciers. The lower edge of the snow line differs much from that above it, and might more properly be called the *ice line;* because the snow, owing to the influence of rain, the heat of the sun, and the heat of the earth, is there partially melted every summer, and frozen again in the winter, forming an icy boundary. This ice is named *glacier ice,* or simply *glacier.* Above this zone, the region of the glaciers, the snow is seldom moistened by rain or softened by the rays of the sun. These glaciers or vast accumulations of ice have received particular names in different parts of the Alps. Those in Dauphiny and Savoy are named *glacier;* in Switzerland, *gletcher;* in the Grisons, *wader;* in the Tyrol, *ferner;* in Salzburg and Carinthia, *käs;* and by the Italians who inhabit the Alps, *vedretto.* They fill all the upper, and principally the transverse valleys, from Dauphiny to the frontier of Salzburg; few of them are less than three miles, many 18 or 20 miles in length, from one to two miles broad, and from 100 to 600 feet thick. They frequently run into each other, and thus surround the peaks on all sides, in such a manner that they appear rising like islands through a sea of ice. Where the glaciers are largest, they send down great arms or branches into the cultivated country, and into the fruitful valleys, 3000 feet above the sea. The chain of Mont Blanc affords a striking example of these descending arms; for there are twenty-five glaciers, descending from it into the valleys of Chamouni, Entreves, and Bionnay. The glaciers are frequently traversed by rents, often of great width and depth; so that when hid by a thin covering of snow or ice they become extremely dangerous to travellers. It is therefore proper to have experienced guides when visiting the dreary and desolate scenes where they occur. The unfortunate Mr Escher, mentioned by M. de Luc, was cautioned by his guide not to separate from his companions when they arrived at the glacier. Hurried on, however, by that indescribable sensation which people sometimes experience when they reach lofty summits, and observing at the top of the glacier, a little distance before him, two chamois hunters, who were resting themselves, he hastened to join them; but he disappeared in a moment, and was precipitated to the bottom of a frightful fissure. He met with an instantaneous death, which was caused by the compression of his body in the narrow part of the rent. Bodies of those destroyed in fissures are sometimes brought to light by the glacier streams. Other adventurers have been even less fortunate than Escher; for there are instances in the melancholy records of these dreary regions, of bodies having been found uninjured, lying on projecting ledges in the fissures, and even sometimes suspended in narrow parts of these horribly dark gulfs: thus showing that the wretched sufferers had had a slow and awful death. All around the lower edges of the glaciers there are vast heaps of stones; these are partly masses which have fallen from the mountains on their surface, or which have been thrown from under the glacier in its progress downwards. The collection of earth and stones is termed by the inhabitants of Switzerland, *moraine.* Moraine.

The glaciers are not stationary, but occasionally move downward, and with a motion more or less quick. The movement of the glacier sometimes takes place unexpectedly; as was experienced by the priest of the Grindenwald, who, along with a chamois hunter, felt the glacier over which they were travelling moving under them. The travellers were resting themselves, and had lighted their pipes, when suddenly a frightful noise resembling thunder was heard. Every thing around them began to move; their fowling-pieces, which they had laid on the ice, moved about. Masses of rock, which a few moments before lay quietly on the surface of the glacier, bounded about in all directions; fissures closed with a loud noise, like that of cannon, and forced the water contained in them several fathoms upwards. New rents, from 10 to 12 feet, burst open with indescribably disagreeable noises. The whole mass of the glacier moved forward several yards: a dreadful convulsion appeared approaching; but in a few seconds all was still again, and the dead silence was interrupted only by the call of the marmot. The total number of glaciers in the whole range of the Alps may be between 500 and 600, which together form an icy sea of enormous extent. Number of glaciers.

Avalanches. These are masses of snow separated from the general snowy cover, which in their course downwards carry-

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ing along with them fragments of rock, and branches and trunks of trees, rapidly increase in size, and sometimes, before reaching the bottom of the valleys, have accumulated to an enormous magnitude. They destroy houses and villages, break down whole forests, and sometimes even interrupt the course of rivers. Those who are unfortunately enveloped in these avalanches have little chance of escape. In 1478 sixty soldiers in the district of St Gothard were destroyed by an avalanche. One hundred men were enveloped in an avalanche in the Great St Bernard, in the year 1500. In 1595 the course of the Rhine was so much interrupted by the fall of a great avalanche across it, that the water rose and drowned many men and cattle. In 1624 three hundred soldiers were enveloped in an avalanche in Italian Switzerland, but the greater number were dug out alive. Many other details of a similar description are to be found in the records of modern travellers.

The snows and glaciers of the Alps already described are the never-failing sources of water for the great rivers which rise from them, as the Rhine, Po, Danube, and Rhone.

Population of the Alps.

The inhabitants, as is well known, are in many respects highly interesting, more especially those inhabiting the more remote and magnificent districts. The population of the whole range may be between 6,000,000 and 7,000,000. Of these, from 1,000,000 to 2,000,000 belong to the Celto-Gallic stem, from 800,000 to 900,000 to the Italian, about 1,000,000 to the Sclavonian, and nearly 5,000,000 to the German states. Among these there may be at least 1,500,000 who lead a pastoral life, and who occupy themselves exclusively with Alpine economy and the rearing of cattle.

Distribution of vegetables.

In the Alps the upper limit of vegetation ascends above the snow line; for we observe plants growing on mountains situated above that line, but which are so steep that snow will not lie on their sides. Thus, an androsacea and a silene were found growing at a height of 10,156 feet, on the mountains around Mont Blanc. At an elevation of 11,041 feet, on the same group of mountains, there were found, growing and in a healthy state, a cardamine, a draba, a gentian, and other plants that do not fear the glacier zone. At elevations between 8188 and 7537 feet, where the snow and glaciers cease, we find growing, not upon rock, but on a fertile soil watered by the snow-water, dwarf willows in the midst of Alpine herbaceous plants. This region presents here and there islands or patches of snow, in places screened from the sun's rays. In the bare patches of ground among these islands, excellent clover grows, which, however, can only be reached by traversing these snowy patches. Lower down we reach that Alpine region so celebrated for the magnificent pasturages it contains; and still lower, between 7537 and 4914 feet, new plants make their appearance; viz., the rhododendron ferrugineum, the rhododendron hirsutum, and ericæa or heaths. We find the alder at 6394 feet; and here we enter into the region of trees. The *pinus mughus* appears at 5553 feet; the *pinus picea*, or pitch pine, at 4780; the birch at 4780 and 4473; the yew at 4473. The region of great trees does not ascend higher than 4338 feet; beech stops here. Oaks do not pass beyond 3510 feet. At this height the *cerealia* cannot be advantageously cultivated. The cherry ranges upwards as high as 3195 feet; walnut tree and chesnut to 2556. The vine is planted as high as 1782. The olive is cultivated at the foot of the Alps, and on the coast of Italy; and there also we find the orange, the citron, and other fruit-trees. Local circumstances occasion changes in the limits of these vegetables: barley, oats, and wheat range to 4473, and even to 5751 feet.

Distribution of animals.

The animal world exhibits similar distributions with the vegetable. Thus, the ibex and the chamois occur among the most elevated summits, amidst snow and ice; but of these two quadrupeds, the chamois in general occupies a lower situation than the ibex. Lower down we meet with the marmot and the white hare, the bear and the mole; still nearer the low country, wolves, foxes, the lynx and the wild cat.

Among the feathered creation the feathered vulture or lammergeyer is the species which is observed at the greatest heights, being seen soaring above very lofty snow-covered pinnacles. The ptarmigan wanders along the edge of the snowline; the heath-cock frequents pine forests; the grey partridge and other birds occur in still lower regions. Various aquatic birds frequent the lakes and rivers, and have also their appropriate distribution. The distribution of fishes is also interesting, as they occur at different heights, whether in lakes or rivers. Where the water is abundantly supplied from the glaciers, fishes do not thrive, and are rarely to be found. Insects, too, as we shall partially explain in our article on the geography of the animal world, are met with in the Alps, from spots amidst the snows of the loftiest peaks to the deepest valleys, increasing in number, variety, and beauty, as we approach the lower country. Even the testaceous molluscæ, and creatures lower in the animal scale, exhibit on the great acclivities of the Alps a similar mode of distribution.

Geological composition.

In this vast high land there are examples of all the different rock formations of which the crust of the earth is composed, from the deepest-seated primitive rock to the most superficial and newest alluvial deposite. The higher and also many of the deeper ranges and valleys are composed of *primitive rocks*, viz. granite, gneiss, mica slate, clay slate, limestone, trap, porphyry, syenite, serpentine, and quartz rock. Resting upon these, and frequently at a great height, rocks of the *transition* class appear, as grey wacke, clay slate, quartz rock, granite, gneiss, mica slate, limestone, syenite, trap and serpentine. The *secondary rocks*, or those of the third class, although frequently occurring at a great height, yet more generally occupy lower situations than the primitive and transition rocks. The following secondary deposites are enumerated by authors as occurring in the Alps. We enumerate them in their order of deposition, beginning with the first or oldest.

1. First secondary sandstone, or coal formation.
2. First secondary limestone, or magnesian limestone.
3. Second secondary sandstone, or new red sandstone.
4. Second secondary limestone, or shell limestone.
5. Third secondary sandstone, or keuper sandstone and marl.
6. Third secondary limestone, or Jura, and Lias, and Oolite limestones.
7. Fourth secondary sandstone, or green and iron sand, and quader-sandstone formation.
8. Fourth secondary limestone, the chalk deposite of geologists.

Resting upon these secondary deposites, we find in many parts vast accumulations of strata of newer rocks belonging to the fourth or *tertiary class.* These tertiary deposites consist of sand, sandstone, and conglomerate; of clays, marls, and coals, and of various limestones; all more or less abounding in fossil organic remains. The bottoms of the valleys, even their sides to a considerable height, are more or less covered with clays, sands, rolled masses, &c., belonging to the *diluvium* of authors. And we find in every situation, from the lofty peak to the bottom of the deep valley, spread over the other deposites already enumerated, a more or less deep cover of that alluvial de-

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tritus which is daily forming, and which consists of broken masses more or less angular, gravel, sand, clay, loam-clay, shell-marl, peat, &c. The common vegetable soil rests upon this alluvium, in beds varying in thickness from a few inches to several feet.

These secondary and tertiary rocks are variously intermingled with trap and old volcanic rocks, and the diluvial and alluvial deposites with newer igneous or volcanic rocks.

Fossil organic remains.

No fossil organic remains occur in the primitive rocks; few appear in those of the transition class; whereas in the various members of the secondary and tertiary classes fossil plants and animals are abundant, and so disposed as to assist in characterizing the different deposites or formations. The diluvial and alluvial deposites also abound in fossil organic remains; but for details we refer to the article GEOLOGY.

Minerals and ores.

Varieties of almost every species of the European simple minerals are met with in the Alps or their connecting chains; and in the long range of this high land we find gold, and many different and valuable ores of silver, lead, copper, iron, bismuth, nickel, cobalt, zinc, manganese, mercury, antimony, arsenic, molybdena, uranium, titanium, and tungsten. These occur in veins, beds, imbedded masses, or are disseminated in rocks of various descriptions, particularly those of the primitive and transition classes.

Most remarkable mountains.

The loftiest and most interesting mountains are Mont Blanc, Mont Rosa, the Jungfrau, the Great Glockner, and the Ortler. The ascent to the summits of these colossal masses exhibits all those varied displays of scenery, of climate, and of distribution of animal, vegetable, and mineral production which so much excite the curiosity of the traveller and the naturalist. The ascent to the summit of the Great Glockner and the Ortler Spitze is described by Schultes and other travellers; that of Mont Rosa by Saussure, but more particularly by Von Welden, in his account of that mountain; and that of the Jungfrau by Agassiz and Forbes. Mont Blanc being more in the track of travellers, has excited greater attention than any of the other great Alpine mountains. To reach the summit of the highest mountain in Europe has always been an object of desire with adventurous travellers; hence repeated attempts have been made to reach the top of Mont Blanc. Some of these have been successful, others have been the contrary. The first attempt to reach the summit was made in the year 1762, by Pierre Simon of Chamouny, who endeavoured to accomplish it by the Glacier du Buissons, and again from the French side; but failed in both. Another unsuccessful attempt was made by some villagers in 1773; and again in 1783 by M. Bourrit of Geneva. Bourrit made a second attempt in 1784, which was also unsuccessful. In 1785 M. de Saussure, M. Bourrit, and M. Bourrit junior, with fifteen guides, left Bionassy in the beginning of September, and ascended the glacier of the same name. They slept near the base of the Arguille du Gouté, and next day climbed to the summit of it; but the snow was so soft that they could proceed no farther. They returned to the place where they had slept the night before, and next day descended into the valley. In June 1786 six Chamouny guides next attempted it, but gave it up through fatigue and fear: they were alarmed by the black appearance of the sky. Jacques Balma, as they were returning, strayed from the party, and lost his way among the hills and blocks of ice on the glacier, and was unable to regain his party. He remained all night in some hole or cave which he found in the ice. Next morning he wandered about, and discovered a route by which he thought he could reach the summit, and then returned to Chamouny with a determination to keep it a secret. Dr Paccard, a native of Chamouny, had some suspicion that Balma knew an accessible track leading to the summit, and tried in vain to get this information from him; but they agreed at last to go together and make the attempt. Therefore, on the 7th of August 1786, they left the Priory, and slept on the summit of the mountain of La Cote. Thence they started next morning at four o'clock; and after surmounting many difficulties, they attained the summit at half-past six in the evening. They left it at seven, and about midnight arrived at the spot where they had slept the night before; and at eight o'clock on the morning of the 9th returned to Chamouny. M. de Saussure having heard of the success of this journey, hastened to the valley, and, with seventeen guides, immediately attempted to follow the route of Jacques Balma; but from the bad state of the weather he did not succeed. In July 1787 Saussure sent Balma to reconnoitre the glacier, who reported that it was not in a fit state; but on the 1st of August this illustrious philosopher and indefatigable traveller left Chamouny at seven A. M., with a servant and eighteen guides. At two o'clock they arrived on the summit of the mountain of La Cote. Next day they crossed the glacier, and halted on the second plateau at four. Here they passed the night, and next day gained the summit at eleven in the forenoon. They remained on it for nearly four hours, leaving it at about three o'clock, and descended to about 1100 yards below the summit, slept there, and next day reached the Priory. M. Bourrit set out on the enterprise on the day of their return, but bad weather drove him back. On the 9th August of the same year, Colonel Beaufoy, with ten guides, attained the summit, having left Chamouny the day before, and returned to it on the 10th. He was enabled to ascertain that the latitude of the summit of Mont Blanc is 45° 49′ 59″ N. At twelve o'clock the mercury in the thermometer stood at 38° in the shade. At the same hour, in Chamouny, and in the shade, it stood at 78°. In 1788 M. Bourrit, his son, Mr Woodley, and Mr Camper, set out together; but when at a great height, a severe storm separated the party, of whom Mr Woodley was the only one who reached the summit, which was on the 5th of August. He and his guides suffered severely. M. Bourrit never attempted the ascent again. In 1791 four Englishmen made an unsuccessful attempt to reach the summit. On the 10th of August 1802 a native of Lausanne and a German, with seven guides, reached the summit. They remained on it twenty minutes, and then descended part of the way, performing the remainder and arriving at Chamouny on the 11th, having taken three days to accomplish it. On the 10th of September 1812 M. Rodalz of Hamburg got to the summit. On the 4th of August 1818 a Russian gentleman reached the summit. On 12th July 1819 Dr Van Ranselaer and Mr Howard, Americans, ascended the mountain and reached the summit; and on the 13th of August of the same year Captain Undrell, R. N. made a successful attempt. On the 19th August 1820 Dr Hamel, a Moscovite, with three gentlemen and twelve guides, ascended to the great plateau. In climbing from it up the side of Mont Blanc, an avalanche swept away the whole party. Some of them extricated themselves; but three guides were driven into a crevice and perished. On the 22d August 1822 Mr Clissold, who has published an account of his journey, reached the summit. On the 4th September 1823 Mr Jackson arrived on the summit and descended the same day to Chamouny, being, it is understood, the first who ever accomplished this arduous task in so short a time, having been absent only thirty-six hours and a half from Chamouny; but he remained on the summit only three or four minutes. On the 26th August 1825 Dr E. Clarke and Captain M. Sherwill made the ascent, employing three days in the expedition. On the 25th July 1827, M. C. Fellowes and M. H. Hawes gained the summit, having discovered a new route. Their journey occupied nearly three days. On the 9th of August the summit was attained by Mr Auldjo of Cambridge, who has published a highly interesting account of his journey. He says, "My ascent to the Grand Mulet was on the 8th, and thence to the summit on the following day, pursuing the route discovered in July. I remained on the summit one hour, and descended to Chamouni the same day, being absent thirty-seven hours." There have, therefore, been fourteen successful ascents, says Mr Auldjo; and, not including guides, eighteen persons have gained this great height. The majority of these are Englishmen, ten being their number. Of the rest, two are Americans, two Swiss, one Russian, one German, and one Savoyard. Some years ago a party of guides made the ascent for pleasure, and Maria de Mont Blanc, a high-spirited girl, accompanied them, being the only female who has ever reached the summit. Napoleon also ordered a party of guides to ascend, and plant a cross on the summit, which was done; but it was blown down in a day or two afterwards.

Among the more recent successful ascents, may be noticed that of Dr Martin Barry and his party in 1834, that of Mr Albert Smith and his companion in 1851, and that of Messrs Browne and Goodall in June 1852.

The most interesting accounts of the Alps are contained in the following works:—Saussure, *Voyages dans les Alpes*, 4 vols. 4to; 2. Ebel. *über den Bau der Erde in dem Alpin-Gebirge*, 2 vols. 1808; 3. Schultes, *Reisê durch Salzburg*, &c., 4 vols. 1804; 4. *Alpina*, 4 vols. 1806–9. Agassiz, *Etudes sur les Glaciers, et Recherches sur les Glaciers, I. II.* Forbes's *Travels in the Alps*. (R. J.)

ALPS, besides its proper signification, by which it denotes a certain chain of mountains which separate Italy from France and Germany, is frequently used as an appellative to denote any mountains of extraordinary height or extensive range. In this sense, Ausonius and others called the Pyrenean Mountains *Alps*, and Gellius the Spanish Alps, *Alpini Hispani*. Hence also we say, the *British Alps*, meaning the Grampians, &c., the *Asiatic Alps*, meaning the Altaic chain, &c.; the *American Alps*, meaning the Andes, &c.

*ALPS, HIGHER, Department of.* This department is bounded on the north by the department of Isere and Savoy, on the east by Piedmont, on the south by the department of the Lower Alps, and on the west by that of the Drome and part of that of Isere. The soil consists of enormous mountains and narrow valleys. Two-thirds of the surface are useless for agricultural purposes. The north wind, which generally prevails, renders the climate cold; and the snow remains in some of the valleys eight months of the year. The principal river is the Durance, which is extremely rapid, and commits great ravages by its inundations. The extent of this department is 2161 square miles. It is divided into three arrondissements, twenty-four cantons, and 189 communes, having in 1851 a population of 132,038. It returns two members to the chamber of deputies. Gap is the capital town of the department, with a population of 7726.

*ALPS, LOWER, Department of*, in France. This department is bounded on the north by the department of the Upper Alps, on the east by Piedmont, on the south by the department of the Var and the north-east extremity of that of the Bouches-du-Rhone, and on the west by the departments of Vaucluse and the Drome. It presents a succession of high rugged mountains, with vast forests and numerous low rich valleys. Its extent is equal to 2666½ square miles. It is divided into five arrondissements, thirty cantons, and 256 communes, having in 1851 a population of 152,070. The chief town is Digne, with 4119 inhabitants. This department returned two members to the chamber of deputies.



ALPTEGHIN, the founder of the Ghuznevite dynasty, and grandfather of the celebrated Mahmoud of Ghuzni. He was originally a slave in the service of Ahmed-ibn-Ismail, the second sultan of the race of Saman; and having obtained his liberty, rose gradually till he was made governor of Khorassan. He finally revolted, and made himself independent at Ghuzni. He died A.D. 775.

ALPUJARRAS, or ALPUXARAS, a mountainous district in the province of Granada, in the south of Spain, to which the Moors of the capital were banished after the destruction of their kingdom under Ferdinand and Isabella. It is a range parallel to the Sierra Nevada, but separated from it by the Rio Grande, which runs to the Mediterranean by Motril. Its slope there extends about 17 leagues in breadth from Almeria to Motril, and its highest ridge is about 13 from the sea. The mountains are composed of a clay-slate highly favourable to the culture of the vine, and produce the wine called Pedro-Ximenes, so highly prized in Spain. The declivity of this range is very rapid to the north, but on the south the descent towards the Mediterranean Sea is very gradual, and the inclined planes are highly prolific. The highest part of the range is the Sierra de Gador, which has an elevation of 6550 feet, and is covered with snow eight months of the year; but it is below the line of perpetual snow, which in that latitude is upwards of 9500 feet above the sea.

ALQUIERE, a measure used at Lisbon for dry goods, sixty of which equal a moye, or 23·03 English bushels.

ALREDUS, ALURED, or ALUREDUS, of Beverley, one of the most ancient English historians, was born at Beverley, in Yorkshire. He wrote in the reign of Henry I.; but no circumstance of his life is known with any degree of certainty. It is generally believed that he was educated at Cambridge, and that he afterwards became one of the canons and treasurer of St John's at Beverley; and we learn from a note of Bishop Tanner's, that for the sake of improvement he travelled through France and Italy, and at Rome became domestic chaplain to Cardinal Othoboni. He died in the year 1128 or 1129, leaving behind him the following works: —1. The Annals of Alured of Beverley, published at Oxford in 1716, by Mr Hearne, from a manuscript which belonged to Thomas Rawlinson, Esq. It contains an abridgment of our history from Brutus to Henry I., written in Latin, and with great accuracy, elegance, and perspicuity. 2. Libertates Ecclesiæ S. Johannis de Beverlac, &c., a manuscript in the Cottonian library. It is a collection of records relative to the church of Beverley, translated from the Saxon language.

ALRESFORD, a market-town in the middle division of the county of Hants, 7 miles from Winchester and 58 from London. It consists of two parishes, having been in past ages a place of more consideration than of late years, as the river Itchen, on the banks of which it is built, has long ceased to be navigable. Pop. in 1851, 2141.

ALSACE, before the Revolution, a province of France, bounded on the east by the Rhine, on the south by Switzerland, on the west by Lorraine, and on the north by the palatinate of the Rhine. It was formerly a part of Germany, but was given to France by the treaties of Munster and Ryswick. It is one of the most fruitful provinces in Europe, abounding in corn, wine, wood, flax, tobacco, pulse, fruits, &c. The mountains which divide it from Lorraine are very high, and generally covered with fir, beech, oak, and hornbeam. Those on the side of Switzerland are lower, and furnished with all sorts of wood, as well for fuel as for building. The country itself is diversified with rising hills and fertile vales, besides large forests; but that between the rivers Ill, Hart, and the Rhine, as far as Strasburg, is inferior to the rest, on account of the frequent overflowing of the Rhine. In High Alsace there are mines of silver, copper, and lead. There are iron works in several parts of Alsace, and particularly at Betford. At Sulzmatt, near Munster, in High Alsace, there is a mineral spring, which is in great reputation for the cure of palsy and gravel, and as a general tonic. The original inhabitants of Alsace are honest and good-natured, but wedded to their own manners and customs. The fruitfulness of their country renders them indolent and inactive; for the Swiss make their hay and reap their corn, as well as manage the vintage of High Alsace. The common language is the German, but the upper classes in the towns speak French; and even in the country they speak French well enough to be understood. By the late division of France, this province forms two departments, viz., those of the Upper and Lower Rhine; the capital of the former being Colmar, and that of the latter Strasburg.

ALSEN, an island of Denmark, situated in the Little Belt, between Sleswick and Funen, 100 miles west of Copenhagen. It extends in length six leagues, and about two in breadth. The soil is fertile, producing abundance of fruit and variety of grain, with large crops of anise, a carminative much used in seasoning food, and mixing with the bread, over all the Danish dominions. Long. 9. 55. E. Lat. 55. 12. N. Pop. 22,000. Sonderborg its capital has 3100.

ALSFELD, the capital of the bailiwick of the same name in Hesse Darmstadt. It stands on the river Schwalm, and has 3800 inhabitants, chiefly engaged in making coarse woollen cloth.

ALSHASH, the name of a province and of a very beautiful city in Bokhara, supposed to be the same with that which is now called Tashkend, the capital of the eastern part of Turkistan, possessed by the Kassats. It is situated on the river Sihon, now Sirr, and had a well-watered garden for every house; but was ruined by Jenghis Khan, who took the city, and caused a great number of its inhabitants to be massacred. Lat. 43. N.

ALSHEDA, a parish in the province of Jönköping, in Sweden, where a gold mine was discovered in 1738.

ALSIRAT, in the *Mahometan Theology*, a bridge laid over the middle of hell, finer than a hair, and sharper than the edge of a sword, over which people are to pass, after their trial on the day of judgment. To add to the difficulty of the passage, Mahomet affirms that the Alsirat is beset with briars and thorns; which, however, will be no impediment to the good, who shall fly over it like the wind; whereas the wicked shall soon miss their footing and tumble headlong into hell, which is gaping beneath to receive them.

ALSIUM, an ancient city on the coast of Etruria, about 25 miles north-west of Rome. It was much resorted to by the wealthy Romans, and Pompey had a villa here. Its site is now occupied by the modern village of Palo.

ALSOP, Anthony, an English divine and poet, was educated at Westminster School, and from thence elected to Christ Church, Oxford, where he took the degree of M.A. in March 1696, and of B.D. in December 1706. On his coming to the university, he was very soon distinguished by Dean Aldrich, and published *Fabularum Æsopicarum Delectus*, Oxon. 1698, 8vo, with a poetical dedication to Lord Viscount Scudamore, and a preface in which he took part against Dr Bentley in the famous dispute with Mr Boyle. His death, which happened on the 10th June 1726, was occasioned by his falling into a ditch that passed his garden door. A quarto volume was published in 1752, under the title of *Antonii Alsopi, Ædis Christi olim Alumni, Odarum libri duo*. Four English poems of his are in Dodsley's *Collection*, one in Pearche's, several in the early volumes of the *Gentleman's Magazine*, and some in *The Student*. Alsop is respectfully mentioned by the facetious Dr King as having enriched the commonwealth of learning by Translations of Fables from Greek, Hebrew, and Arabic; and not less detractingly by Bentley, under the name of "Tony Alsop, a late editor of the Æsopean Fables."



Alsop, *Vincent*, an English nonconformist divine, was born in Northamptonshire, and educated at St John's College, Cambridge, where he took the degree of master of arts. When he received deacon's orders, he went to Rutlandshire, and settled at Oakham, where he was an assistant to the master of the free school. He was settled at Wilby, in the county of Northampton, whence he was ejected in 1662 for nonconformity. After this he ventured to preach sometimes at Oakham, and at Wellingborough, where he lived, and was once six months in prison for praying by a sick person. After the revolution, Mr Alsop gave public testimonies of his attachment to government; yet upon all occasions he spoke very respectfully of King James, and retained a very high sense of his clemency in sparing his only son when attainted of treason. The remainder of his life he spent in the exercise of his ministry, preaching once every Lord's day; besides which he had a Thursday lecture, and was one of the lecturers at Pinners Hall. On grave subjects he wrote with a becoming seriousness; but where wit might properly be shown, he displayed it to great advantage. He lived to a great age, and, preserving his spirits to the last, died in May 1703.

ALSTAHAUG, a small town of Norway, in the island of Alster, and province of Nordland. It is the seat of the bishop of Nordland and Finmark.

ALSTED, Johann Heinrich, a German Protestant divine, and one of the most indefatigable and voluminous writers of the seventeenth century. He was some time professor of philosophy and divinity at Herborn, in the county of Nassau. From thence he went into Transylvania, to be professor at Weissenberg, where he continued till his death, in 1638. His *Encyclopædia*, the most considerable of the earlier works of that class, was long held in very high estimation. It was published in 1630, in two large folio volumes. His *Thesaurus Chronologicus* has gone through several editions. He also wrote *Triumphus Biblicus*, to show that the principles of all arts and sciences are to be found in the Scriptures. He was a Millenarian, and published, in 1627, a treatise *De Mille Annis*, in which he asserted that the reign of the saints on earth was to begin in 1694.

ALSTON, Charles, M.D., a botanical and medical writer, was born in the west of Scotland in the year 1683. He began his studies at the university of Glasgow; and on the death of his father, the Duchess of Hamilton, to whom he was related, took him under her patronage, and thus afforded him an opportunity of pursuing the bent of his inclination for the study of physic. About the age of 33, along with his friend and companion the celebrated Alexander Monro, he went to Leyden, and studied three years under Boerhaave. On their return to their native country, they, in conjunction with Rutherford, Sinclair, and Plummer, undertook departments in the college of Edinburgh, and by their abilities and industry laid the foundation of that school of physic. The branches of botany and materia medica were long the favourite studies of his life; consequently he undertook that department, and continued to lecture on them with increasing reputation until his death, which happened in November 1760, at the age of 77 years. His talents, which appear to have been naturally great, were improved and strengthened by his great assiduity and industry, and employed successfully in the service of science.

In the year 1753, his dissertation on the sexes of plants, in which he combats the doctrine of Linnæus, was published in the first volume of the *Edinburgh Physical and Literary Essays.* In the fifth volume of the *Edinburgh Medical Essays*, there is a short paper of his on the efficacy of the powder of tin to destroy or expel worms from the bowels. Dr Alston also engaged in a chemical controversy respecting quicklime with Dr Whytt. But the most valuable of all his works are his lectures on the *Materia Medica*, which were published in the year 1770, in two volumes 4to.

ALSTON-MOOR. See ALDSTON-MOOR.

ALT, in *Music*. See MUSIC.

ALT, or ALUT, a branch of the Danube, rising in Transylvania, east of the Carpathians, through which it descends, about 18 miles S.S.E. of Hermanstadt, and falls into the Danube, opposite to Nicopolis, after a course of about 250 miles.

ALTAI. This name has been erroneously extended by geographers to several chains of mountains stretching through the northern parts of Asia, and supposed to form an unbroken chain from the vicinity of the Aral Sea to that of Ochotsk: but in fact no such continuous chain exists; and the true Altai is a group of mountains, certainly of great magnitude, that form the southern boundary of the extensive plains of Siberia. This group extends through 2½ degrees of latitude between 50. and 52. 30. N., and through 21. of longitude, or about 700 geographical miles from west to east, from the junction of the small river Ouba with the Irtysh, near the rich mines of Schlangenberg, to mount Goubi, south of the Baikal. The name *Altai-Alen*, in the Mongolian, signifies "Golden mountains;" and in the curious Chinese geography of the last century, translated by Klaproth in 1831, these mountains are named *Kin-Tchan*, which has the same meaning in Chinese. No doubt they are so named, by both nations, from their remarkable auriferous deposits. The mountains east of the Baikal, which have been confounded with the Altai, are several independent systems of mountains, generally running south-west and north-east, nearly at right angles to the true Altai.

The eastern branch of the Altai is distinguished by the names Mountains of Sayane, Tangnou, and Malakha. The Russians confine the designation of Altai to that portion of the group which projects from the west end of the central chain, like an enormous promontory, into the vast plains of the province of Tomsk, and which contains the loftiest summits of the Altai group. This portion has been improperly divided by western geographers into Great and Little Altai, from an obscure passage in Aboulghassi's *General History of the Tartars*, published at Leyden in 1726. What are now considered as the true Altai by the Russian geographers, are named *Altai-Kolyvan*, the group passing northward between the rivers Irtysh and Jeniseï. It is divided into five parallel chains by deep valleys. The general appearance of these mountains is grand and imposing. They rise beyond the limit of perpetual snow, and some of these towering summits are alpine *needles*, or terminate in abrupt, truncated cones, soaring far above extensive fields of snow. The inaccessible snowy summit of Katunia towers to 12,900 feet; and the fine peak of Bieloukha rises to 10,900 feet above the ocean. Many of the peaks extending to the west of Bielay, and north of Katunia, have an elevation from 7500 to 8500 feet. A glacier, exactly similar to those of Switzerland, and terminated by large ancient *moraines*, descends from the south flank of Bieloukha (the white mountain) to the river Katunia. The next in altitude to Bieloukha are the peaks of Alailon and Irbislon, about 40 leagues farther east, near the sources of the Karugom river. The glaciers of the Altai seldom reach farther down than 8000 feet above the sea.



The basis of the Altai is granite, and other rocks usually denominated primary, which are mingled with diorite porphyries and greenstone. The unstratified rocks are covered by gneiss and mica slate; while the flanks of the mountains present graywacke slate, covered by secondary limestone rocks which the English geologists describe as belonging to the Silurian and Devonian systems.

The rarity of petrifactions in the limestone of the Altai is remarkable; but in one place Humboldt found encrinites in a compact sedimentary rock. He considers the limestone of the Altai in many places as belonging to the carboniferous strata. Mica slate is the principal rock, sometimes passing into chloride slate; granite is not so abundant, and gneiss is rather scarce. The porphyries and diorite often occur in beds. Rose found that the diorites are mixtures of amphibole and albite.

From the south and west slopes of the Altai Kolyvan, immense mineral wealth has been extracted, between the years 1736 and 1845. It was in this chain that in 1725 Niksten Demidof established his copper-works, which have given the name of *Kolyvanskoi* to the whole country; but the scarcity of fuel, and the demand for it since the discovery of the rich auriferous silver, have caused the removal of the copper furnaces to the confluence of the Barnaoulka and the Obi.

The Altai yields gold, silver, copper, and iron in great quantity. All, except the first, occur in the Devonian system of rocks, especially in the vicinity of veins of greenstone or beds of porphyritic rocks. The gold chiefly occurs in alluvial deposits near the plains. It is in the same deposit that the bones of the mammoth (*Elephas Primigenus*) and rhinoceros are found. The quantity of fossil elephant's tusks is so enormous, as to make *ivory mining* an important branch of industry in those countries. The diorite porphyries and granites of the Altai furnish materials for extensive manufactures of superb vases and other ornamental articles. The quantity of malachite found in the copper-mines afford the finest specimens of that beautiful material, and furnished those magnificent ornaments that formed such conspicuous objects in the Great London Exhibition of 1851. The Kolyvan branch of the Altai is better known to Europeans than the rest of the group: but it is believed that other parts of the chains would yield to explorers the same valuable products. (T. S. T.)

ALTAMURA, a city of the kingdom of Naples, in the province of Bari. It is the seat of a royal governor, and confers the title of prince on a noble family. It contains 16,500 inhabitants, a great part of whom are Greeks.

ALTAR, an artificial elevation for the purpose of offering sacrifices. The heathens at first made their altars only of turf; afterwards they were made of stone, of marble, of wood, and even of horn, as that of Apollo in Delos. Altars differed in figure as well as in materials: some were round, others square, and others triangular. All of them were turned towards the east, and stood lower than the statues of the gods; and they were generally adorned with sculpture, representing either the gods to whom they were erected, or their symbols. The height of altars also differed according to the different gods to whom they sacrificed. According to Servius, those altars set apart for the honour of the celestial gods, and gods of the higher class, were placed on some pretty tall pile of building, and for that reason were called *altaria*, from the words *alta* and *ara*, a high elevated altar. Those appointed for the terrestrial gods were laid on the surface of the earth, and called *aræ*. And, on the contrary, they dug into the earth, and opened a pit for those of the infernal gods, which they called βοθροι, λακκοι, *scrobiculi*. But this distinction is not everywhere observed: the best authors frequently use *ara* as a general word, under

Altar. which are included the altars of the celestial and infernal, as well as those of the terrestrial gods. The Greeks also distinguished two sorts of altars: that whereon they sacrificed to the gods was called βωμος, and was a real altar, different from the other whereon they sacrificed to the heroes, which was smaller, and called εσχαρα. Pollux makes this distinction of altars in his *Onomasticon:* he adds, however, that some poets used the word εσχαρα for the altar whereon sacrifice was offered to the gods. The Septuagint version does sometimes also use the word εσχαρα for a sort of little low altar, which may be expressed in Latin by *craticula*, being a hearth rather than an altar.

Before temples were in use, altars were erected sometimes in groves, sometimes in the highways, and sometimes on the tops of mountains; and it was a custom to engrave upon them the name, ensign, or character of the deity to whom they were consecrated.

In the great temples of ancient Rome, there were generally three altars. The first was placed in the sanctuary, at the foot of the statue of the divinity, upon which incense was burnt and libations offered; the second was before the gate of the temple, and upon it they sacrificed the victims; the third was a portable altar or table, upon which were placed the offering and the sacred vessels. Besides these uses of altars, the ancients swore upon them, and swore by them, in making alliances, confirming treaties of peace, and on other solemn occasions. Altars also served as places of refuge for all those who fled to them.

The first altar we read of in the Bible was that erected by Noah on leaving the ark. According to a Rabbinical legend, it was partly formed from the remains of one built by Adam on his expulsion from Paradise, and afterwards used by Cain and Abel, on the identical spot where Abraham prepared to offer up Isaac (Zohar, *In Gen.* fol. 51, 3, 4; Targum, Jonathan, Gen. viii. 20). After the giving of the law, the Israelites were commanded to make an altar of earth: they were also permitted to employ stones, but no iron tool was to be applied to them. This has been generally understood as an interdiction of sculpture, in order to guard against a violation of the second commandment. Altars were frequently built on high places (βωμοί); the word being used not only for the elevated spots, but for the sacrificial structures upon them. They were sometimes built on the roofs of houses: in 2 Kings xxiii. 12, we read of the altars that were on the top of the upper chamber of Ahaz. In the tabernacle, and afterwards in the temple, two altars were erected, one for sacrifices, the other for incense: the table for the shew-bread is also sometimes called an altar.

The altar of burnt-offering belonging to the tabernacle was a hollow square, 5 cubits in length and breadth, and 3 cubits in height: it was made of shittim-wood, and overlaid with plates of brass. In the middle there was a ledge or projection, *deambulacrum*, on which the priest stood while officiating: immediately below this, a brass grating was let down into the altar to support the fire, with four rings attached, through which poles were passed when the altar was removed. As the priests were forbidden to go up by steps to the altar (Exod. xx. 26), a slope of earth was probably made rising to a level with the *deambulacrum*. According to the Jewish tradition this was on the south side: on the east was 'the place of the ashes' (Lev. i. 16): and the laver of brass was probably near the western side, so that only the north and south sides were left.

The altar of burnt-offering in Solomon's temple was of much larger dimensions, "twenty cubits in length and breadth, and ten in height" (2 Chron. iv. 1), and was made entirely of brass.

Of the altar of burnt-offering in the second temple, the canonical Scriptures give us no information excepting that it was erected before the foundation of the temple was laid (Ezra iii. 3, 6) on the same place where it had formerly been built, (Joseph. *Antiq.* xi. 4, 1). From the Apocrypha, however, we may infer that it was made, not of brass, but of unhewn stone, for it is said, "They took whole stones (λίθους ὁλοκλήρους), according to the law, and built a new altar according to the former" (1 Macc. iv. 47). Altar.

The altar of burnt-offering erected by Herod is thus described by Josephus (*De Bell. Jud.* v. 5, 6): "Before this temple stood the altar, 15 cubits high, and equal both in length and breadth, each of which dimensions was 50 cubits. The figure it was built in was a square; it had corners like horns, and the passage up to it was by an insensible acclivity from the south. It was formed without any iron tool, nor did any iron tool so much as touch it at any time." A pipe was connected with the south-west horn, through which the blood of the victims was discharged by a subterraneous passage into the brook Kedron. Under the altar was a cavity to receive the drink-offerings, which was covered with a marble slab, and cleansed from time to time. On the north side of the altar several iron rings were fixed to fasten the victims. Lastly, a red line was drawn round the middle of the altar to distinguish between the blood that was to be sprinkled above and below it.

The second altar belonging to the Jewish worship was *the altar of incense*, called also the golden altar (Numb. iv. 11). It was placed between the table of shew-bread and the golden candlestick, in the most holy place.

This altar in the tabernacle was made of shittim-wood overlaid with gold plates, 1 cubit in length and breadth, and 2 cubits in height. It had horns of the same materials; and round the flat surface was a border of wrought gold, underneath which were the rings to receive "the staves made of shittim-wood, overlaid with gold to bear it withal," Exod. xxx. 1–5 Joseph. *Antiq.* iii. 6, 8.

The altar in Solomon's temple was similar, but made of cedar, overlaid with gold.

The altar in the second temple was taken away by Antiochus Epiphanes (1 Macc. i. 23), and restored by Judas Maccabæus (1 Macc. iv. 49). On the arch of Titus there appears no altar of incense; it is not mentioned in Heb. ix., nor by Joseph. *Antiq.* xiv. 4, 4. (*vide* Tholuck *On the Hebrews*, vol. ii. p. 8; *Biblical Cabinet*, vol. xxxix.) (Winer's *Realwörterbuch*, articles 'Altar,' 'Brandopfer altar,' 'Raucheraltar;' Bähr's *Symbolik des Mosaischen Cultus*, bd. 1. Heidelberg, 1837.)

The altar or table of shew-bread, which stood in the outer apartment of the tabernacle, was made of shittim-wood, covered with laminæ of gold, and was 2 cubits long, 1 broad, and 1½ high. The top of its leaf was surrounded by a rim of gold; the frame, immediately below the leaf, was surrounded by a piece of wood about 4 inches broad, around which was a similar border of gold; and lower down, attached to the legs, were four golden rings for the staves covered with gold by which it was carried. These rings were not found in the table afterwards made for the temple, nor in any of the sacred furniture where they had previously been, except in the ark of the covenant. Upon this table were placed twelve unleavened loaves (in allusion to the twelve tribes), which were changed every Sabbath-day, and sprinkled with frankincense (the *Sept.* adds salt). The bread was called the "bread of the presence," because it was set forth before Jehovah in his holy place. Wine was also placed before the table, in bowls, covered vessels, and cups, which were probably used in making libations. (Exod. xxv. xxxvii. xl., Lev. xxiv., Numb. iv.)

*Forms of Altars.*—The direction to the Israelites, at the time of their leaving Egypt, to construct their altars of unhewn stones or of earth, is doubtless to be understood as an injunction to follow the usage of their patriarchal ancestors; and not to adopt the customs which they had seen in Egypt, or might see in the land of Canaan. That the patriarchal altars were of unhewn stones or of earth, is confirmed by the circumstances under which they were erected, and by the fact that they are always described as being "built."

It may be observed that all the Oriental altars are square or oblong, whereas those of Greece and Rome are more usually round; and that, upon the whole, the Hebrew altars were in accordance with the general Oriental type. It has been supposed that some of those ancient monuments of unhewn stone usually called Druidical remains, were derived from the altars of primitive times: but the ablest archæologists are of opinion that these structures were seldom, if ever, used as altars, but were merely depositories of the dead; an opinion which is strengthened by the fact that human remains are usually found on excavating below them.—See Worsaäe's *Scandinavian Antiquities.*

Altar is also used among Christians for the communion-table. In the primitive church the altars were only of wood, it being frequently necessary to remove them from place to place; but the council of Paris in 509 decreed that no altar should be built but of stone. At first there was but one altar in each church, but the number soon increased; and from the writings of Gregory the Great, who lived in the sixth century, we learn that there were sometimes in the same church twelve or thirteen. In the cathedral of Magdeburg there are no less than forty-nine altars.

The altar is sometimes sustained on a single column, as in the subterraneous chapels of St Cecilia at Rome, &c.; and sometimes on four columns, as the altar of St Sebastian of Crypta Arenaria; but the customary form is a massive frame of stone-work sustaining the altar-table. These altars bear a resemblance to tombs: consequently we read in ecclesiastical history that the primitive Christians chiefly held their meetings at the tombs of the martyrs, and celebrated the mysteries of religion upon them; for which reason it is a standing rule to this day in the church of Rome, never to build an altar without inclosing the relics of some saint in it.

ALTAR-THANE, or Altarist, in old law-books, an appellation given to the priest or parson of a parish, to whom the profits arising from the altar or altarage belonged.

ALTDAMM, or Damm, a fortified city in the circle of Randow, government of Stettin, and Prussian province of Pomerania. It is built in a strong situation at the point where the river Plone discharges its waters into the Lake Damische; and contains 235 houses and 3000 inhabitants. Long. 14. 58. 47. E. Lat. 53. 24. N.

ALTDORF, a town of Bavaria on the Schwartzach, capital of the bailiwick of the same name, and about twelve miles E.S.E. of Nuremburg. It was formerly the seat of a university, now incorporated with that of Erlangen. It has several breweries and toy manufactories; and in its neighbourhood are coal-mines and charcoal works. Pop. 3000. Long. 11. 27. 13. E. Lat. 49. 23. 22. N.

Altdorf, a town on the Schmeidebach, in the bailiwick of Ettenheim, and circle of Upper Rhine, in the duchy of Baden. It has 1300 inhabitants, and a palace belonging to the family of Von Turkheim, with a good library and a botanical garden.

Altdorf, or *Altorf*, a town of Switzerland, capital of the canton of Uri, situated near the southern extremity of the lake of Lucerne, and at the northern end of the pass over Mount St Gothard. It has a handsome parish church, a town-house, two convents, and an old tower, which tradition marks as the place where Tell shot the apple from his son's head. Pop. 1800. Long. 8. 30. E. Lat. 46. 50. N.

ALTDORFER, Albert, a Bavarian painter and engraver, was born in 1488, and died in 1538. His few pictures show surprisingly minute and careful finish, in the ancient German manner, as is seen in his picture of the battle of Arbela, in the museum of Munich. His wood engravings are considered next in execution to those of Dürer, and his copperplates are well known, and very numerous.—See Bartsch. *Peintres-graveur.*

ALTEA, a town of Spain, on the bay of the same name, in the province of Alicante. It contains 5502 inhabitants, principally sailors and fishermen.

ALTELAND, a district in the province of Bremen, in the kingdom of Hanover, denominated a royal justiceship, *königliche Gerichte.* It is situated on the banks of the Elbe, and is divided into three portions by the small rivers Schwinge, Este, and Luhe, which cross it. The extent is 79 square miles, or 50,560 acres. The soil is peculiarly fertile. The inhabitants amount to 15,000, mostly living on separate farms, in prosperous circumstances. As a part of the ancient duchy of Bremen, the district possesses some peculiar privileges.



ALTENA. See Altona.

Altena, a circle in the government of Arnsberg and Prussian province of Westphalia. Its extent is 193 geographical square miles. The chief rivers are the Lenne, which receives the waters of the Nette and the Erse, and the Wipper, both of which run to the Rhine. The agriculture is bad, and in many parts can scarcely produce oats. It has some pasture land, and, besides, yields wood, game, iron, marble, and good stones for building. Its population, which amounts to 43,054, depends almost wholly on the several manufactures which are spread over the whole circle. These comprehend almost every species of iron goods, which, though clumsy in form, are very substantial, and find a ready sale.

Altena, a city, the chief of the circle of the same name, in Prussia. It contains 689 houses, and 4889 inhabitants, who trade in the several kinds of goods made in the vicinity. It is situated on the Lenne. Long. 7. 41. 23. E. Lat. 51. 15. 36. N.

ALTENBERG, a city, capital of the bailiwick of the same name in the circle of Dresden in Saxony. It contains 2042 inhabitants, who depend on the mines, the transit traffic with Bohemia, and the manufacture of bone lace.

ALTENBRUCH, a market-town on the Werne, in the district of Hadeln, in the kingdom of Hanover. It contains 378 houses and 2500 inhabitants; and has a small harbour, by means of which it carries on trade in corn, fruit, and cattle. It is in Long. 8. 51. 3. E. and Lat. 53. 50. 5. N.

ALTENBURG. See Saxe-Altenburg.

Altenburg, the chief town of the duchy of Saxe-Altenburg, near the river Pleisse, and about twenty-four miles south of Leipsic, with which it has been connected by railway since the end of 1842. The town, from its hilly position, is irregularly built, but its streets are wide, and ornamented with many large and beautiful buildings. Its ducal castle is a very ancient building, surrounded by picturesque scenery, with a beautiful garden, and an extensive library. Of its public buildings the most remarkable are the cathedral, and St Bartholomew's church, with its two steeples. It has several other churches, a gymnasium with a considerable library, a theatre, an infirmary, an obstetric institution, and several elementary schools and charitable institutions. The trade in grain is very considerable, as well as in cattle and in silk; and sealing wax, tobacco, woollen goods, and gloves, are among its manufactures. Pop. 15,300.

Altenburg, or Owar, a small but strong town of Hungary, with 3500 inhabitants. It is seated in a marsh, near the river Danube, and is surrounded by deep ditches. It is forty miles south-east of Vienna. Long. 17. 15. E. Lat. 47. 50. N.

Altenburg is also the name of several small towns and villages in Austria, Bavaria, Switzerland, &c.

ALTENKIRCHEN, a circle in the government of Coblentz, and the Prussian province of the Lower Rhine. Its extent is 208 square miles, or 133,120 acres. It contains two market-towns, 155 villages, and 37,857 inhabitants, of whom 18,114 are Roman Catholics, and 19,548 Lutherans. The Jews amount to 195. The whole of the circle is on the Westerwalde, and from its lofty position the soil is unproductive. Its mines of iron, lead, and copper, give the chief employment to the people, who are an industrious race; and the females spin much linen yarn. The circle is watered by the rivers Sieg, Niester, and Wiedbach, the banks of which afford pasturage to cattle. The whole district suffered severely from being the seat of war in 1796.

ALTERANTS, or *Alterative Medicines*, such as correct the bad qualities of the blood, and other humours, without occasioning any sensible evacuation.

ALTERN-BASE, in *Trigonometry*, a term used in contradistinction to the true base. Thus, in oblique triangles, the true base is either the sum of the sides, and then the *difference* of the sides is called the *altern-base*; or the true base is the difference of the sides, and the *sum* of the sides is called the *altern-base*.

ALTERNATE, in *Heraldry*, is said in respect of the situation of the quarters. Thus, the first and fourth quarters, and the second and third, are usually of the same nature, and are called *alternate quarters*.

ALTERNATION, in its primary sense, denotes a succession by turns.

Alternation is sometimes used to express the different changes or alterations of orders in any number of things proposed. This is also called *permutation*, &c., and is easily found by a continual multiplication of all the numbers, beginning at unity. Thus, if it be required to know how many changes or alternations can be rung on six bells, multiply the numbers 1, 2, 3, 4, 5, 6, continually into one another, and the last product gives the number of changes.

ALTERNATIVE is particularly used for the choice of two things proposed. In this sense we say, to take the *alternative* of two propositions.

ALTHEA, a genus of the natural order of Malvaceæ, of which the *A. officinalis*, or marsh mallow, and *A. rosea*, or hollyhock, are the best known.

ALTIN, a money of account in Muscovy, worth three *copecs*, 100 of which make a ruble, worth about 3s. 2½d. sterling.

Altin, a lake of Siberia, in the government of Tomsk, from whence issues the river Ob or Obi, in Long. 85. 55. E. Lat. 52. 0. N. This lake is called by the Russians *Teloskoi Osero*, from the Telessi, a Tartar nation who inhabit its borders, and who give it the name of *Altin-Kul*. By the Calmucks it is called *Altinnor*. It is 77 miles long and 52 broad, with a rocky bottom. The north part of it is sometimes frozen so hard as to be passable on foot, but the southern part is never covered with ice. The water in the Altin lake, as well as in the rivers which run through the adjacent places, only rises in the middle of summer, when the snows on the mountains are melted by the heat of the sun.

ALTING, Heinrich, a German divine, was born at Embden in 1583. His father was minister of the church of Embden, and early destined his son to the same profession. In the year 1602, after a grammatical course, he was sent to the university of Herborn. There he studied with so much assiduity and success, that he had the honour of being appointed tutor to the three young counts of Nassau, Solms, and Isenburg, who studied with the elector prince palatine, first at Sedan, and afterwards at Heidelberg. Alting was appointed preceptor to the prince in 1608, and was chosen to accompany the elector into England. There, among the number of celebrated men to whose acquaintance he was introduced, was Dr Abbot, archbishop of Canterbury. In 1613, returning to Heidelberg after the marriage of the elector with the princess of England, he was appointed professor of theology, and in 1616, director of the College of Wisdom. In 1618, along with Scultetus, he represented the university in the Synod of Dort.

In 1622 Count Tilly took the city of Heidelberg, and devoted it to plunder. In order to escape the fury of the soldiers, Alting endeavoured to pass by a back door into the chancellor's house, which was under guard; but as he was entering, the commanding officer said to him,—"With this battle-axe I have to-day killed ten men, and Alting, if I knew where to find him, should be the eleventh: who are you?" Alting, with singular presence of mind replied—"I am a teacher in the College of Wisdom." The officer took him under his protection; but the Jesuits unfortunately taking possession of the house next day, left the generous officer no time, at his departure, to take care of the teacher in the College of Wisdom. Alting evaded the hands of the Jesuits by hiding himself in a garret; and a cook of the electoral court, who happened to be employed by Count Tilly in the kitchen occupied by him in the chancellor's house, supplied him with food. In this perilous situation he remained till an opportunity offered of making his escape to Heilbron, whither his family had been previously conducted.

But Alting was now as much harassed by ecclesiastical intolerance as he had formerly been endangered by military hostility. With the permission of the duke of Wirtemberg, he retired for a few months to Schorndorf, after the desolation of the palatinate by the victorious forces of Count Tilly.

In 1623 Alting retired with his family to Embden, and afterwards followed to the Hague his late pupil, now king of Bohemia. Such was the unfeigned esteem of this prince for Alting that he still retained him as preceptor to his eldest son, and prevented him from accepting the charge of the church at Embden, and likewise of a professorship in the university of Franeker. In 1627, Alting, with some difficulty, obtained leave from his patron to remove to Groningen, where he was appointed to the chair of divinity; and there he continued to lecture with increasing reputation until his death, which took place in 1644. The ardent desire and repeated endeavours of several universities to appropriate to themselves the honour and benefit of his services, is the most unequivocal proof of the general esteem in which his character was held.

The states of Groningen refused to give their consent to his removal, when the university of Leyden solicited him to come and labour among them. But some time after, the prospect of extensive usefulness in re-establishing the university of Heidelberg, and restoring the churches of the palatinate, determined him to accept the office of professor of divinity and ecclesiastical senator, presented to him by Prince Lewis Philip. In the year 1634, amidst numerous hardships, to which the existing war exposed him, he set out for Heidelberg, and pursued his journey as far as Frankfort; when the battle of Norlingen, in which the imperialists were victorious, rendered his further progress impracticable. He therefore with great difficulty returned to Groningen.

Alting was a man of eminent talents, extensive learning, and amiable dispositions, and always more solicitous to serve the public than to benefit himself. He was averse to quarrels and disputes about trifles, although no friend to the innovations introduced at this period by the Socinians; and, adhering to what he considered the plain doctrine of Scripture, he was equally desirous to avoid fanatical scrupulosity and sophistical subtilty. The productions of his pen are, *Notæ in Decadem Problematum Jacobi Behm*, Heidelbergæ, 1618, Notes on a Decade of Jacob Boehmen's Problems; *Loci Communes*, Common Places; *Problemata*, Problems; *Explicatio Catecheseos Palatinæ*, Explanation of the Palatine Catechism; *Exegesis Augustanæ Confessionis*, &c., Amst. 1647, Exposition of the Augsburg Confession; *Methodus Theologiæ Didacticæ et Catecheticæ*, Amst. 1650, A Method of Didactic and Catechetic Theology. The *Medulla Historiæ Profanæ*, Marrow of Profane History, published under the name of Paræus, was written by Alting.

Alting, *Jacob*, son of the preceding, was born at Heidelberg, in 1618. After the usual course of grammatical studies he became a student, and soon after professor of divinity in the university of Groningen. The oriental languages were his favourite studies, and in 1638 he put himself under the tuition of a Jewish rabbi at Embden. Determining to take up his residence in England, he arrived there in 1640, and was admitted to clerical orders by Dr Prideaux, bishop of Worcester. By an offer of the Hebrew professorship in the university of Groningen, he was soon induced to alter his plan of life, and consequently returned to Germany in 1643. His active assiduity in the study of the languages, and his knowledge in other sciences, procured him universal esteem and great reputation as a scholar. About this time he received many academic honours; he was admitted doctor of philosophy, academic preacher, and at last professor of divinity in conjunction with a colleague, Samuel des Marets, with whom, as being an admirer and follower of the subtleties of the scholastics, Alting had a long and painful controversy, which was only terminated by a formal reconciliation when Marets was on his deathbed.

By the permission of the curators of the university, Des Marets appeared as public accuser of Alting, and produced a long list of erroneous propositions to the divines of Leyden, for their opinion. The divines pronounced Alting innocent of heresy, but imprudently fond of innovation; and they declared Des Marets deficient in modesty and candour. Such was the protection given to Alting, that whenever any of the order of ecclesiastics proposed any further measures against him, they were immediately rejected by the civil power.

Alting died of a fever in 1679. The fondness which he showed for rabbinical learning, gave birth to the general report that he was inclined to become a Jew. His opinions, which seem to have excited more general attention than they deserve, may be seen at large in his writings, which were collected a few years after his death, and published in five volumes folio, by his pupil, the well-known Balthasar Bekker.

ALTING, *Menso*, the elder, father of Heinrich Alting, a distinguished divine of the Reformed Church, was born in 1541, and died in 1612. He was president of the Consistory of the Calvinist church at Embden, and took a prominent part in the controversy with the Lutheran party. His grandson, of the same name, was a burgomaster of Groningen, and wrote a valuable geographical work entitled *Notitia Germaniæ Inferioris*, &c. He was born in 1636, and died in 1713.

ALTINUM, an ancient town of Venetia on the right bank of the Silis. Its site is occupied by the modern village of Altino.

ALTITUDE, *Accessible* and *Inaccessible*. See GEOMETRY.

*ALTITUDE of the Eye*, in *Perspective*, is a right line let fall from the eye, perpendicular to the geometrical plane.

ALTITUDE, in *Astronomy*, is the distance of a star or other point in the mundane sphere from the horizon. This altitude may be either *true* or *apparent*. If it be taken from the rational or real horizon, the altitude is said to be true or real; if from the apparent or sensible horizon, the altitude is apparent, or rather, the apparent altitude is such as it appears to our observation, and the true is that from which the refraction has been subtracted.

The true altitudes of the sun, fixed stars, and planets, differ but very little from their apparent altitudes, because of their great distance from the centre of the earth, and the smallness of the earth's semidiameter when compared therewith. But the difference between the true and apparent altitude of the moon is about 52°.

*ALTITUDE Instrument*, or *Equal Altitude Instrument*, is that used to observe a celestial object when it has the same altitude on the east and west sides of the meridian.



ALTKIRCH, an arrondissement in the department of the Upper Rhine, in France. The extent is 446 square miles, or 285,440 acres, and it contains seven cantons and 158 communes, with 149,874 inhabitants, in 1851. The chief city of the arrondissement is of the same name, and is situated on a hill whose base is washed by the river Ill, about two leagues from Mulhausen. It has 3371 inhabitants. Long. 7. 11. E. Lat. 47. 37. N.

ALTMUHL, a river of Bavaria which rises seven miles north-east of Rothenburg, and flows into the Danube between Ratisbon and Kehlheim, after a course of 150 miles. This river has lately been connected with the Regnitz by the Ludwigo Canal, by which means the rivers Rhine and Danube are now united.

ALTO *BASSO*, or *in ALTO et in BASSO*, in *Law*, signifies the absolute reference of all differences, small and great, high and low, to some arbitrator or disinterested person. The following are examples of the use of the phrase:—*Pateat universis per præsentes, quod Willielmus Tylar de Yetton, et Thomas Gower de Almestre, posuerunt se in* Alto *et in* Basso, *in arbitrio quatuor hominum;* viz., *de quadam querela pendente inter eos in curia. Nos et terram nostram* altè *et* bassè *ipsius domini Regis supposuimus voluntati.*

ALTO-FAGGOTTO, a wind instrument of music, resembling in form a small bassoon. It is played with a reed and mouthpiece similar to a clarinet, and produces a very fine tone.

*ALTO Relievo.* See RELIEVO and SCULPTURE.

*ALTO Ripieno.* See MUSIC.

ALTOMONTE, a very handsome town of Italy, in the kingdom of Naples, in Calabria Citerior, 15 miles north-west of Bisignano. Long. 16. 22. E. Lat. 39. 40. N.

ALTON, a market-town in the hundred of the same name in the county of Hants, 47 miles from London, and 16 from Winchester. It stands on the river Wey, and is a well-built place. Pop. in 1851, 2828.

ALTON, or ALVETON, a village in Staffordshire, five miles north of Uttoxeter. Here may be seen the ruins of a castle which is supposed by some to have been built before the Norman conquest; but Dr Plot is of opinion that it was erected by Theobald de Verdun in the beginning of the reign of Edward II.

ALTONA, or ALTENA, a city in the duchy of Holstein, a part of Germany, but included within the dominions of Denmark. It is situated on the banks of the Elbe, and only separated from Hamburg by a ditch between the suburbs of the two cities. It is on an ascent, very gradually rising from the water's edge, with streets well-built, overlooking each other. In 1847 it contained 32,200 inhabitants, of whom 2300 were Jews, who are here allowed the free exercise of their religion, and have two synagogues and a high rabbi. Altona is a free port, and carries on a very extensive shipping trade, and also engages in the herring and whale fisheries. The number of vessels that entered the harbour in 1845 was 5253. The ship-building is considerable, and there are manufactures of woollen, cotton, silk, tobacco, leather and glass; besides breweries, distilleries, and sugar-refineries. The town is well built, and contains a royal observatory, a town-house, six churches, an anatomical theatre, a gymnasium, a public library, and an orphan asylum, &c. Altona was raised from the insignificance of a fishing village on passing into the possession of the Danes in 1640, who erected it into a city in 1664. It was burnt to the ground in 1713 by the Swedes under General Stenbock. It is in Long. 9. 57. 15. E. and Lat. 53. 43. 30. N.

ALTORF. See ALTDORF.

ALTRANSTADT, a town in Saxony, famous for the treaty between Charles XII. king of Sweden and Augustus elector of Saxony, in 1706, wherein the latter resigned the kingdom of Poland.

ALTRINGHAM, or ALTRINCHAM, a township and market-town in the county of Chester, 180 miles from London. It is a neat and clean place. Its manufactures are chiefly cotton and worsted. There are many gardens in its neighbourhood which supply Manchester with vegetables. The Duke of Bridgewater's canal passes the town, and it is connected with Manchester by railway. Pop. in 1851, 4488.

ALTSOL, or ZWOLEN, an imperial free city on the Gran, where that river falls into the Zalathna, in the lower circle of the palatinate of Solor in Hungary. It has one church, and a castle that belonged to Prince Esterhazy. Pop. 2400. Long. 19. 12. 47. E. Lat. 48. 21. 50. N.

ALTSTRELITZ, or OLD STRELITZ, a town in the duchy of Mecklenburg-Strelitz in Germany. It has an old castle, several tanneries, and tobacco manufactories, and a great horse market. Population 3800, of whom about 600 are Jews. This town was founded about the year 1349, and is two miles to the south of New Strelitz.

ALUCEMAS, SAN AGUSTIN Y SAN CARLOS DE LAS, a small rocky island, with a garrison and criminal establishment, belonging to Spain, on the coast of Africa, between Capes Morro and Quilates in Marocco. Long. 4. 12. W. Lat. 35. 16. 30. N. It contains 28 houses, including the governor's residence, an hospital, and a church. It is supplied with the necessary articles of consumption from the neighbouring coast of Ceuta.

ALUDELS, in the older and more complicated chemical apparatus, were earthen pots without bottoms, inserted into each other, and used in sublimations.

ALUM, a compound salt employed by dyers and other artists in their different processes. It is soluble in water, has an astringent, acid, and sweetish taste; reddens vegetable blues, and crystallizes in regular octahedrons. When heated, it liquefies; and if the heat be continued, the water of crystallization is driven off, the salt frothes and swells, and at last a white matter remains, known by the name of *burnt alum.*

Its constituents are sulphuric acid, alumina, an alkali, and water. The alkali may be either *potash*, *soda*, or *ammonia.* Hence there are three distinct species of alum, depending upon the nature of the alkali which each contains. *Potash alum* (in which the alkali is potash) is the common alum of this country. In France both potash and ammoniacal alum are manufactured; while soda alum is met with native in different states, and probably in considerable quantity, in South America; for it is curious that, on that continent, soda almost uniformly replaces potash. Instead of nitrate of potash, which occurs in the old continent, there are great deposites of nitrate of soda in South America. It is likely that albite will be found replacing felspar in the granite of South America.

The progress made by chemists in the discovery of the constitution of alum was very slow. The species first investigated was potash alum. That it contained sulphuric acid as a constituent, was known even to the alchemists. Pott and Margraaf demonstrated that alumina was another constituent. Mr Pott, in his *Lithogeognosia*, showed that the earth of alum, or the precipitate obtained when an alkali is poured into a solution of alum, is quite different from lime and chalk, with which it had been confounded by Stahl. Margraaf went much farther. He not only showed that alumina is one of the constituents of alum, but that this earth possesses peculiar properties, is different from every other substance, and is one of the ingredients in common clay. (*Expériences faites sur la Terre a'Alun:* Margraaf's *Opusc.* ii. 111.) Margraaf showed likewise, by many experiments, that crystals of alum cannot be obtained by dissolving alumina in sulphuric acid, and evaporating the solutions. The crystals formed are always soft, and quite different in their appearance from alum crystals. But when a solution of potash or ammonia is dropt into this liquid, it immediately deposits perfect crystals of alum. (*Sur la Régénération de l'Alun:* Margraaf's *Opusc.* ii. 86.) He mentions likewise, that manufacturers of alum in general were unable to procure the salt without a similar addition, and that at first it had been customary to add a quantity of putrid urine, and that afterwards a solution of carbonate of potash was substituted in its place. But subsequent chemists do not seem to have paid much attention to these important observations of Margraaf: they still continued, without any rigid examination, to consider alum as a sulphate of alumina.

Bergman indeed had observed, that the addition of potash or ammonia made the alum crystallize, but that the same effect was not produced by the addition of soda or of lime. (*De Confectione Aluminis:* Bergman's *Opusc.* i. 225.) He had observed likewise, that sulphate of potash is frequently found in alum. He decomposed the solution of alum by means of ammonia, evaporated the filtered liquid to dryness, and exposed the residue to a red heat. A quantity of sulphate of potash often remained behind in the crucible. (*Ibid.* p. 326.) From these facts he drew the conclusion that sulphate of potash readily combines with sulphate of alumina. Yet it is obvious, from the whole of his dissertation, that he had no conception that alum is a double salt. He ascribed the difficulty of crystallization to the excess of sulphuric acid present. He thought that the only use of the potash was to saturate this excess; and advises manufacturers to substitute clay instead of potash, as a method which would not only saturate the excess of acid, but increase the quantity of alum. This very bad advice was not, we presume, followed by any alum-makers. If they had tried it, they would soon have been convinced of its injurious consequences. Instead of alum, they would have obtained an insoluble, tasteless powder, well known by the name of *alum saturated with its earth.*

After Klaproth had discovered the existence of potash as an ingredient in *leucite* and *lepidolite*, it occurred to Vauquelin, that it was probably an ingredient likewise in many other minerals. He recollected that alum crystals often make their appearance during the analysis of stony bodies; and, considering that alum cannot be obtained in crystals without the addition of potash, he began to suspect that this alkali constituted an essential ingredient in the salt. A set of experiments, undertaken on purpose to elucidate this important point, soon satisfied him that his conjecture was well founded. Accordingly, in the year 1797 he published a dissertation, demonstrating that alum is a double salt, composed of sulphuric acid, alumina, and potash. (*Annales de Chimie*, xxii. 258.) Soon after, Chaptal published the analysis of four different kinds of alum, namely, Roman alum, Levant alum, British alum, and alum manufactured by himself. This analysis led to the same result as that of Vauquelin. (*Ann. de Chim.* xxii. 280.)

Since that time alum has been admitted by chemists to be a triple salt; and various analyses of it have been made to determine its constituents. Vauquelin (*Ann. de Chim.* l. 167), Thenard and Roard (*ibid.* tom. lix. 72), Curaudau (*Journal de Physique*, lxvii. 1), and Berzelius (*Ann. de Chim.* lxxxii. 258), successively published the results of their experiments. These analyses gradually led to an accurate knowledge of the composition of this salt. The atomic weights of the constituents of alum are as follows:—

| | |
|---|---|
| Sulphuric acid | 5 |
| Alumina | 2·25 |
| Potash | 6 |
| Soda | 4 |
| Ammonia | 2·125 |
| Water | 1·125 |

Potash alum is a compound of

| | |
|---|---|
| 4 atoms sulphuric acid | = 20 |
| 1 atom potash | = 6 |
| 3 atoms alumina | = 6·75 |
| 25 atoms water | = 28·125 |
| Hence the integrant particle of it weighs | 60·875 |

Every atom of the sulphuric acid is combined with an atom of base; so that potash alum is a compound of sulphate of potash and sulphate of alumina, in the proportion of one atom of the former salt to three atoms of the latter. We may therefore state the constituents of potash alum as follows:—

| | |
|---|---|
| 3 atoms sulphate of alumina | = 21·75 |
| 1 atom sulphate of potash | = 11 |
| 25 atoms water | = 28·125 |
| | 60·875 |

Soda alum differs from potash alum in containing sulphate of soda instead of sulphate of potash. Its constituents are as follows:—

| | |
|---|---|
| 3 atoms sulphate of alumina | = 21·75 |
| 1 atom sulphate of soda | = 9 |
| 25 atoms water | = 28·125 |
| | 58·875 |

The weight of an integrant particle of this alum is only 58·875; because the alum of soda weighs only 4, while that of potash is 6.

The constituents of ammoniacal alum are as follows:—

| | |
|---|---|
| 3 atoms sulphate of alumina | = 21·75 |
| 1 atom sulphate of ammonia | = 7·125 |
| 25 atoms water | = 28·125 |
| | 57 |

The weight of the integrant particle is only 57, because ammonia has an atomic weight of only 2·125.

One of the most remarkable differences between these three species of alum is the solubility of each in water. At the temperature of 60°, 100 parts of water dissolve

9·37 parts of ammoniacal alum,
14·79 parts of potash alum,
327·6 parts of soda alum.

This great solubility of soda alum renders the manufacture of it very difficult. It does not easily crystallize; indeed, when the weather is hot, crystals of it can hardly be obtained. This great solubility, together with the inferior weight of its integrant particle, would render it more convenient and more economical for dyers and calico printers, provided it could be furnished at the same rate with common alum. But the greater difficulty attending the making of it would probably prevent it from being saleable at a price sufficiently low to make it available as a mordant.

Soda alum was first mentioned by Mr Winter in 1810, in his account of the Whitby alum processes (Nicholson's *Jour.* xxv. p. 254, 255); but before that time it had been made by Charles Macintosh, Esq. of Crossbasket. Mr William Wilson, at Hurlet, near Glasgow, afterwards made it in considerable quantities. Specimens of it have been still more recently sent by Dr Gillies from the neighbourhood of Mendoza, in South America, where it occurs native in considerable quantity.

These three different species of alum differ also somewhat from each other in their specific gravities, which are as follows:—

| | |
|---|---|
| Ammoniacal alum | 1·56 Sp. Gr. |
| Potash alum | 1·75 |
| Soda alum | 1·88[1] |

The word *alumen*, which we translate *alum*, occurs in Pliny's *Natural History*. In the 15th chapter of his 35th book, he gives us a detailed description of it. By comparing this with the account of *στυπτηρια* given by Dioscorides in the 123d chapter of his 5th book, it becomes quite obvious that he alludes to the same substance. Hence it follows, that *στυπτηρια* is the Greek name for *alumen.* Pliny informs us that alumen was found naturally in the earth. He calls it *salsugo terræ.* Different substances, he informs us, were distinguished by the name of alumen; but they were all characterized by a certain degree of astringency, and were all employed in dyeing and in medicine. The light-coloured alumen was useful in brilliant dyes, the dark-coloured only in dyeing black or very dark colours. One species of alumen was a liquid, which was apt to be adulterated; but, when pure, it had the property of striking a black with the juice of the pomegranate. This property seems to characterize a solution of sulphate of iron in water. It is quite obvious that a solution of our alum would possess no such property. Pliny says that there is another kind of alum which the Greeks call *schistos.* It forms in white threads upon the surface of certain stones. From the name *schistos*, and the mode of formation, there can be little doubt that this species was the salt which forms spontaneously on certain slaty minerals, as alum slate and bituminous shale, and which consists chiefly of sulphate of iron and sulphate of alumina. Possibly in certain places the sulphate of iron may have been nearly wanting, and then the salt would be white, and would answer, as Pliny says it did, for dyeing bright colours. Several other species of alumen are described by Pliny, but we are unable to make out to what minerals he alludes.

The alumen of the ancients, then, was not the same with the alum of the moderns. It was most commonly a sulphate of iron, sometimes probably a sulphate of alumina, and usually a mixture of the two. But the ancients were unacquainted with our alum. They were acquainted with sulphate of iron in a crystallized state, and distinguished it by the names of *misy*, *sory*, *chalcanthum.* (*Pliny*, xxxiv. 12.) As alum and green vitriol were applied to a variety of purposes in common, and as both are distinguished by a sweetish and astringent taste, writers, even after the discovery of alum, do not seem to have discriminated the two salts accurately from each other. In the writings of the alchemists we find the words *misy*, *sory*, *chalcanthum*, applied to alum as well as to sulphate of iron; and the name *atramentum sutorium*, which ought to belong, one should suppose, exclusively to green vitriol, applied indifferently to both.

When our alum was discovered is entirely unknown. Beckman devoted a good deal of time to trace the history of this salt, and published a curious dissertation on the

[1] The soda alum whose specific gravity is here given was the native, from the province of St Juan, on the north of Mendoza. It contains less water, and therefore is probably heavier than common soda alum.

subject; but his attempts to trace its origin were unsuccessful. The manufacture of it was discovered in the East, but at what time or place is totally unknown. It would appear that, about four or five hundred years ago, there was a manufactory of it at Edessa in Syria, at that time called Rocca; hence, it is supposed, the origin of the term *Rock alum*, commonly employed in Europe: though there are others who pretend that the term originated at Civita Vecchia, where alum is made from a yellow mineral in the state of a hard rock.

Different alum works existed in the neighbourhood of Constantinople. About the time of the fall of the Grecian empire, the art of making alum was transported into Italy, at that period the richest and most manufacturing country in Europe. Bartholomew Pernix, a Genoese merchant, discovered alum ore in the island of Ischia, about the year 1459. Nearly at the same time John di Castro, who was well acquainted with the alum works in the neighbourhood of Constantinople, suspected that a mineral fit for yielding alum existed at Tolfa, because it was covered with the same trees that grew on the alum mineral near Constantinople. His conjecture was verified by trials, and the celebrated manufactory at Tolfa established. Another was begun in the neighbourhood of Genoa; and the manufacture flourished in different parts of Italy. To this country it was confined for the greater part of a century. Various manufactories of it were established in Germany by the year 1544. In the time of Agricola there was a manufactory of it at Commotau, in Bohemia. About the same time an alum work was established at Alcmaron, near Carthagena, in Spain.

England possessed no alum works till the reign of Charles I. Thomas Chaloner, Esq. son of Dr Chaloner, who had been tutor to Charles, while hunting on a common in Yorkshire took notice of the soil and herbage, and tasted the water. He found them similar to what he had seen in Germany, where alum works were established. In consequence of this, he got a patent from Charles for an alum work. This manufactory was worth two thousand a year, or perhaps more. But some of the courtiers thinking this too much for him, prevailed with the king, notwithstanding the patent, to grant a moiety of it to another person. This was the reason why Mr Chaloner was such a partisan of the parliament, and such an enemy of the king, that, at the end of the civil war, he was one of those who sat in judgment upon his majesty and condemned him.[1] Since that time various alum works have been established in different parts of England and Wales; but no one at present exists in Britain except the Whitby works, originally established by Mr Chaloner, and two works at Hurlet and Campsie, both in the neighbourhood of Glasgow.

Several alum works likewise exist in Sweden, particularly in West Gothland. There is one, for example, at Hænsæter, near the borders of the Wene Lake, on the west side of the mountain called Kinnekulle. But, for a description of the Swedish works, we refer to Bergman's *Opuscula*, vol. i. p. 284, or the English translation, vol. i. p. 342. We do not know if any alum works exist in Poland or Russia; but as the greater part of these extensive countries consists of alluvial soil to a great depth, it is probable that little alum ore will be found in them.

Various minerals are employed in the manufacture of alum, but by far the most important of them are the following three: *alum-stone, alum-slate, bituminous shale.*

Alum-stone was first observed at Tolfa, in the neighbourhood of Rome; afterwards in Hungary; and Cordier has shown that it is very common in volcanic rocks, but that it never occurs anywhere else. (*Annales des Mines*, tom. iv. p. 205, and tom. v. p. 303.)

The colour is white, greyish-white, or sometimes yellowish-white; most commonly amorphous; but it occurs also crystallized in rhomboids approaching to cubes, the angles being about 89° and 91°. In some crystals the apex of the rhomboid is replaced by a tangent plane. The size of these crystals varies from 0·03937 to 0·11811 of an inch in length.

The specific gravity is 2·7517; but the amorphous specimens, owing probably to cavities, are rather lighter. Haüy states the specific gravity to be 2·587; harder than calcareous, but softer than fluor spar; fracture foliated in a direction perpendicular to the axis of the rhomboid; in all other directions the fracture is conchoidal; fragments irregular, with blunt edges; easily pulverized; feels harsh, and does not stain; decrepitates before the blowpipe; gives out sulphureous acid when heated on platinum-foil; and tastes of alum when applied to the tongue. In a strong heat it loses its acid, and becomes tasteless.

The constituents of the pure crystals, according to the analysis of Cordier, are—

| | |
|---|---|
| Sulphuric acid | 35·495 |
| Alumina | 39·654 |
| Potash | 10·021 |
| Water and loss | 14·830 |
| | 100 |

This approaches very nearly to

| | |
|---|---|
| 3 atoms trisulphate[2] of alumina... = | 35·25 |
| 1 atom sulphate of potash......... = | 11 |
| 7 atoms water..................... = | 7·875 |
| | 54·125 |

We see from this constitution that alum-stone contains in itself all the ingredients of alum. The absence of iron accounts for the superior purity for which Roman alum was so long celebrated.

In the alum manufactory at Campsie, near Glasgow, the alum is made from a shale taken out of the old abandoned coal-pits in the neighbourhood. At first this shale furnished alum by simple lixiviation with water. This process having been continued for a number of years, a great quantity of washed shale gradually accumulated in the neighbourhood of the works. This shale, when burnt, was found to yield a new crop of alum. Now, in this burnt shale thin bands of a greyish-white matter occasionally make their appearance, intermixed with portions having a yellow colour, and which are unequally distributed. The fracture is earthy; the matter is opaque, friable, and has an astringent, acid, and sweetish taste. The specific gravity is 1·887.

It occurred to the writer of this article, that this substance bore a considerable analogy to *alum-stone*. This induced him to subject it to chemical examination.

When digested in water it dissolves, with the exception of a white powder, amounting to 15·31 per cent., which is a subsulphate of alumina.

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[1] *Letters written by Eminent Persons in the Seventeenth and Eighteenth Centuries*, &c.; *and Lives of Eminent Men*, by John Aubrey, Esq. vol. ii. p. 281. Lond. 1813.

[2] By *trisulphate of alumina* is meant a compound of *three* atoms of alumina and *one* atom of sulphuric acid. *Tersulphate* indicates a compound of three atoms of sulphuric acid and one atom of base.

When heated it melts somewhat like alum, and gives out pure water. When heated to redness it swells out like alum, and finally leaves a yellowish-white, porous, tasteless matter, nearly similar to what would be left by alum treated in the same manner, making allowance for the difference of colour.

The constituents were found to be—

1. Insoluble portion, amounting to 15·31 per cent.

| | |
|---|---|
| Alumina | 5·11 |
| Sulphuric acid | 10·20 |
| | 15·31 |

2. Soluble portion, amounting to 84·69 per cent.

| | |
|---|---|
| Sulphuric acid | 30·225 |
| Alumina | 5·372 |
| Peroxide of iron | 8·530 |
| Potash | 1·172 |
| Water | 36·295 |
| Loss, chiefly water | 3·096 |
| | 84·690 |

These constituents are equivalent to

24 atoms sulphate of alumina,
9 atoms bipersulphate of iron,
1 atom bisulphate of potash;

and each of these atoms is combined with about 5 atoms of water.

From this analysis we see that the substance which appears after burning the Campsie shale is not the same with *alum-stone;* but it constitutes an excellent article for the manufacture of alum, being highly productive; and is consequently much valued by the manufacturers.

Alum-slate is a much more abundant mineral than alum-stone. It is said to alternate with primitive clay-slate. It occurs abundantly along with transition-slate; and there can be little doubt that it occurs likewise in the flœtz formations. In West Gothland in Sweden, it constitutes a part of different hills, as Kinnekulle, Hunneberg, and Halleberg; in all of which it appears to alternate with flœtz trap rocks. It occurs likewise abundantly at Whitby, in Yorkshire. We have never ourselves been upon the spot; but, from the general structure of Yorkshire and the neighbouring counties, indeed of the whole east coast of England, there can be very little doubt that, in this position, it is also a flœtz rock.

Alum-slate, as the name implies, is a slaty rock, though sometimes it occurs in balls. The colour is bluish-black, with a strong shade of grey; fracture straight slaty; fragments tabular; its internal lustre is glimmering; it retains its colour in the streak, but acquires more lustre; soft; not particularly brittle; when exposed to the air it effloresces, and acquires an aluminous taste.

This mineral has never been accurately analyzed; but there can be no doubt that it contains silica, alumina, iron, sulphur, charcoal, and often likewise potash. Probably this was the mineral upon which the *alumen scissile* of the ancients was found.

Bituminous shale, the *Brandschiefer* of the Germans, is a slaty mineral, which almost constantly accompanies beds of coal, and accordingly is very common in Great Britain. Its colour is brownish-black; its fracture is thin slaty; fragments tabular; internal lustre glimmering, but the colour is not altered; very soft; rather sectile; feels rather greasy; easily frangible. When heated it burns with a pale flame and sulphureous odour, and becomes white. It has never been accurately analyzed; but it is probably nothing more than slate-clay, which occurs so abundantly in the independent coal formation, impregnated with the matter of coal. Its other principal constituents must be silica, alumina, and iron pyrites.

Alum.

Slate-clay itself, at least not sufficiently impregnated with coaly matter to deserve the name of bituminous shale, is frequently employed in the making of alum. This is the case in the neighbourhood of Glasgow.

Several native varieties of sulphate of alumina and soda alum occur in South America, some of the most remarkable of which it may be proper to specify.

1. Sulphate of alumina from Rio Saldana. It is said to occur in nests in the transition-slate of the Andes. The colour is white, here and there tinged yellow, obviously from external impurities. It occurs in fine crystalline needles; lustre silky; taste that of alum, but stronger; specific gravity 1.6606; soft; before the blowpipe behaves like alum. The writer of this article subjected it to a chemical analysis, and found its constituents as follows:—

| | |
|---|---|
| Water | 46·375 |
| Alumina | 14·645 |
| Peroxide of iron | 0·500 |
| Soda | 2·262 |
| Sulphuric acid | 35·872 |
| Mechanical impurity, consisting of ferruginous silica | 0·100 |
| | 99·754 |

This is equivalent to

1 atom sulphate of alumina,
6 atoms water,
$\frac{7}{100}$ atom sulphate of soda,
$\frac{1}{80}$ atom persulphate of iron.

So that if the sulphate of soda and persulphate of iron be only accidental ingredients, the mineral is a compound of

| | |
|---|---|
| 1 atom sulphate of alumina | = 7·25 |
| 6 atoms water | = 6·75 |
| | 14 |

2. Polcura, or alum-earth, found near the summit of a lofty ridge near El Paso de las Damas, in the Chilian Andes, and used as a mordant by the inhabitants in dyeing red. This mineral was brought over to Great Britain by Dr Gillies, who was kind enough to favour the writer of this article with a specimen. It occurs in hard masses, partly earthy, partly fibrous. The fibres have a silky lustre. The colour is white, and the taste that of alum.

When digested in water, a portion was dissolved, and a portion remained in the form of a white insipid earth. The quantity of insoluble matter differed very much in different parts of the specimen. The least was 8·62, and the greatest 34·65 per cent. This insoluble matter contained a little sulphur; for, when heated, it emitted a blue flame with the smell of sulphureous acid. The rest of it was a mixture of alumina and silica, tinged yellow by peroxide of iron. The portion dissolved in water, being subjected to analysis, was found to consist of

| | |
|---|---|
| 1 atom disulphate[1] of alumina | = 9·5 |
| 1 atom sulphate of soda | = 9 |
| | 18·5 |

3. Soda-alum. It occurs native in the province of St Juan, situated to the north of Mendoza, on the east side of the Chilian Andes, at about lat. 30° S. The alum is white, and composed of fibres adhering longitudinally,

[1] By *disulphate of alumina* is meant a compound of *one* atom of sulphuric acid and *two* atoms of alumina.

and having a certain breadth, but very thin. It bears some resemblance to fibrous gypsum, but is harder, not being scratched by the nail, though the knife scratches it with great ease. It is sectile. The outer fibres are white and only slightly translucent, as if they had lost a portion of their water; but the internal fibres are transparent, and have a silky aspect.

It tastes precisely like alum, and is very soluble, water at the temperature of 62° dissolving 3·773 parts of it, and boiling water dissolving any quantity whatever. When exposed to heat, it behaves very nearly as common alum.

Its constituents were found to be—

| | |
|---|---|
| Sulphuric acid | 20·000 |
| Alumina | 6·360 |
| Soda | 4·000 |
| Silica | 0·012 |
| Lime | 0·136 |
| Protoxide of iron | 0·423 |
| Peroxide of iron | 0·110 |
| Water | 22·209 |
| | 53·250 |

It will be observed that the sulphuric acid constitutes just four atoms, the soda one atom, and the alumina just 0·29 less than three atoms. But the quantity of lime and oxides of iron present is exactly equivalent to 0·29 atom of alumina. Hence these substances appear to have displaced a small quantity of alumina in the salt. The water amounts to very nearly twenty atoms. It is obvious from all this, that the true constitution of the salt is—

| | |
|---|---|
| 3 atoms sulphate of alumina | = 21·75 |
| 1 atom sulphate of soda | = 9·00 |
| 20 atoms water | = 22·50 |
| | 53·25 |

It contains five atoms less water than soda-alum artificially crystallized.

4. There is a mineral called *aluminite*, which was observed in the environs of Halle many years ago, and which was afterwards detected by Mr Webster in the chalk rocks of Newhaven in Sussex, which, if it were sufficiently abundant, would constitute an excellent material for the manufacture of alum.

Its colour is snow-white. It occurs in reniform pieces of greater or smaller size; fracture fine earthy; dull; streak glistening; opaque; adheres feebly to the tongue; soils very slightly; very soft; feels fine, but meagre; specific gravity 1·7054. Its constituents, as determined by three several analyses of Stromeyer, are—

| | |
|---|---|
| 1 atom sulphuric acid | = 5 |
| 3 atoms alumina | = 6·75 |
| 9 atoms water | = 10·125 |
| | 21·875 |

It is therefore a hydrous trisulphate of alumina.

Four different processes are employed in the manufacture of alum, according to the nature of the mineral from which the alum is to be extracted.

The process employed at Tolfa is the simplest of all. If the Tolfa stone be kept constantly moistened with water for about two months, it falls to powder of itself, and yields alum by lixiviation. But this is not the process employed by the manufacturers. The alum-stone is broken into small pieces, and piled on the top of a perforated dome, in which a wood fire is kindled. The smoke and flame of the wood penetrate through the pieces of alum-stone, and a sulphureous odour is disengaged, owing to the decomposition of a portion of the sulphuric acid in the stone. This roasting is twice performed; the pieces of ore which, the first time, were at the edge of the dome, being the second time put in the middle. The process of roasting this stone requires considerable attention. If the heat be too great, the quality of yielding alum is destroyed: if the heat be too small, the stone does not readily fall to powder. There can be little doubt that the unroasted stone would yield more alum than the roasted; but probably the additional labour requisite in the latter case would more than swallow up the increase of product.

The roasted stone, which has now acquired a reddish colour, is placed in rows between trenches filled with water. This liquid is so frequently sprinkled on it, that the stone is always moist. In two or three days it falls to powder, like slacked quicklime; but the daily watering is continued for a month. The success of this part of the operation is said to depend very much on the weather. When the weather is rainy, the alum is all washed out, and little or nothing left for the manufacturer to extract. In such cases, it is obvious that the alum-stone should be protected from the rain by a shed.

When the stone has by this process been reduced to a sufficiently fine powder, it is thrown into a leaden boiler filled two thirds with water. During the boiling, the powder is frequently stirred up, and the water that evaporates is replaced. When the boiling has been continued for a sufficient time, the fire is withdrawn, and time allowed for the earthy matter to subside to the bottom. A cock is then opened, which allows the clear liquor to flow out into deep wooden square vessels, so made that they can be easily taken to pieces. Here the alum gradually crystallizes, and attaches itself to the sides and bottom of the vessel. The mother liquid is now drawn off into shallower wooden troughs, where more alum crystals are deposited. The liquid has now a red colour, and is muddy; and the last alum crystals are mixed with this red matter. They are washed clean in the mother liquor, which is finally pumped into a trough, and used in subsequent processes.

The alum obtained at Tolfa is known by the name of *Roman alum*, and is in very high estimation. It is always mixed with a little reddish powdery matter, which is easily separated from it. What this red matter is, has not been ascertained; but it is not peroxide of iron. To the eye it has very much the appearance of a vegetable matter. We have some notion that it is added artificially by the sellers of Roman alum. Probably Roman alum at first had a red tinge, in consequence of the red matter in the mother liquor remaining partially attached to it. The goodness of the alum may have given the purchasers a partiality to the red colour, and induced the sellers to add a red powder artificially. We have never had an opportunity ourselves of examining this matter, but have been informed by those who have, that it contains no iron.

It is not improbable that this process would be improved by grinding the Tolfa stone to a fine powder in a mill, without any previous roasting, and then keeping the powder moistened with water for a considerable time. If the residual earth, after the alum is extracted, be boiled with sulphuric acid, the liquid yields alum crystals by evaporation. This is a demonstration that neither the alumina nor the potash is exhausted, and that the sulphuric acid driven off by the roasting is so much alum lost to the manufacturer. Indeed the quantity of sulphuric acid in the alum-stone is not sufficient to occupy the whole of the potash in the formation of alum. It would be necessary to add about one tenth of the weight of the alum-stone of sulphuric acid, if it were wanted to employ the whole potash present in the stone. The consequence of this addition, supposing no loss, would be an additional quantity of alum, amounting to rather more than one fifth of the weight of the alum-stone employed.

Alum-slate, being very different in its composition, requires a different treatment to fit it for yielding alum. If the alum-slate contain a notable quantity of lime or magnesia, it does not answer the purposes of the manufacturer so well. Indeed the proportion of lime present may be conceived to be such that no alum whatever would be obtained. As alum-slate has never been subjected to accurate analysis, we do not know in what proportion these two earths exist in it, or whether they may not, in many cases, be absent altogether. The essential ingredients in alum-slate, for the alum-makers, are alumina and iron pyrites.

The first process is to roast the ore. In Sweden, where the fuel is wood, and consequently expensive, it is customary to use the alum-slate itself as fuel for roasting the ore. For this purpose a small layer of brushwood is covered with pieces of alum-slate, and set on fire; and, as the combustion proceeds, new layers of alum-slate are added. It is usual to place alternate layers of roasted and unroasted alum-slate. The combustion continues for a month or six weeks. At Whitby, coal is employed for roasting the alum-slate. Indeed the alum-slate of Whitby is lighter coloured than that of Sweden, and probably would not burn of itself. So great is the quantity of combustible matter in the Swedish alum-slate, that it is employed as fuel for burning limestone. Great quantities of limestone are burnt in this manner at Hunneberg, near the south side of the lake Wener. The roasted ore has usually a brown colour. When it is red, the quantity of alum which it yields is considerably diminished.

By this roasting the pyrites is decomposed. The sulphur is converted into sulphuric acid, while the iron is oxidized. In what manner this change is produced it is not easy to say. Indeed it does not seem certain that pyrites is a constant ingredient in alum-slate. We have never been able to detect any, by the eye, in any specimens of Whitby alum-slate which we have examined. At Hænsæter, in Sweden, no sulphate of iron crystallizes when the liquid is evaporated; yet, if pyrites had been present, it is difficult to see any reason that should prevent this salt from being formed. Hence it is probable, that in alum-slate the sulphur is sometimes at least combined with other substances than iron. It must always be in a state of combination; for, if it were in a loose state, it would be driven off by the roasting. This point deserves to be elucidated by analyzing different varieties of alum-slate.

The roasted ore has an astringent taste, owing to the sulphate of iron and sulphate of alumina which it contains. The next process is to lixiviate it with water, in order to dissolve these salts. For this purpose it is put into reservoirs made of wood or masonry, with a stopcock at the bottom to draw off the water. The usual method is to keep the water for twelve hours in contact with ore that has been twice lixiviated; then to draw it off, and allow it to remain for an equal period on ore that has been once lixiviated. Lastly, it is run upon fresh ore, and allowed to remain on it for twelve hours longer. If the specific gravity of the liquid thus treated be 1·25 at the temperature of 55°, it may be considered as saturated with sulphate of alumina and sulphate of iron. But we presume that this specific gravity is not often obtained.

The liquid, thus impregnated with salt, is now boiled down in leaden vessels to the proper consistency for crystallization. In Sweden, the fuel employed for this purpose is alum-slate. By this means a double effect is produced; the liquid is evaporated, and the alum-slate is roasted. During the boiling, abundance of oxide of iron falls mixed with selenite, if lime be one of the constituents of the alum-slate. When the liquid is sufficiently concentrated, it is let into a square reservoir, in order to crystallize. Great quantities of sulphate of iron crystals are usually deposited in this vessel. These are collected by drawing the liquid off into another reservoir. When all the sulphate of iron that can be obtained has been separated, a quantity of sulphate of potash, muriate of potash, or putrid urine, is mixed with the liquid. The sulphate of potash is procured from the sulphuric acid-makers, and the muriate of potash from the soap-makers. By this addition, alum is formed in the liquid, and it gradually deposits itself in crystals on the sides of the vessel. These crystals are collected, and dissolved in the smallest quantity of boiling water that will take them up. This solution is poured into large wooden casks. In a fortnight or three weeks the alum crystallizes, and covers the sides and bottom of the cask. The hoops are now taken off, and the staves of the cask removed. A mass of alum crystals, having the shape of the cask, remains. This mass is pierced, the mother liquor allowed to run out, and preserved for a subsequent process. The alum, being now broken in pieces, is fit for sale.



The manufacture of alum from bituminous shale and slate-clay bears a considerable resemblance to the manufacture from alum-slate, but differs in several particulars. There are two works of this kind in the neighbourhood of Glasgow, managed with great skill, and excellent in every respect. We shall give a sketch of the processes followed in these works. The bituminous shale and slate-clay employed are obtained from old coal-pits, which are very extensive in the neighbourhood of Glasgow. The air in these coal-pits is moist, and its average temperature about 62°. The shale, having been exposed for many years, has gradually opened in the direction of its slaty fracture, so as to resemble in some respects a half-shut fan; and all the chinks in it are filled with a saline efflorescence in threads. This salt is white, with a shade of green; has a sweetish astringent taste; and consists of a mixture of sulphate of iron and sulphate of alumina. In order to obtain these salts in a state of solution, nothing more is requisite than to lixiviate this shale with water. The lixiviated ore being left exposed to the weather, forms more salt, which is gradually washed out of it by the rain-water, and this water is collected and preserved for use.

The next step in the process is to boil down the liquid to a sufficient state of concentration. At Campsie, all these boilers are composed of stone, and the heat is applied to the surface. This is a great saving, as leaden vessels are not only much more expensive, but require more frequent renewal. When the liquid is raised to a sufficiently high temperature in the stone reservoir, pounded sulphate of potash, or muriate of potash, as they can be procured, is mixed with it; and there is an agitator in the vessel, by which it is continually stirred about. This addition converts the sulphate of alumina into alum. The liquid is now let into another trough, and allowed to remain till it crystallizes. In this liquid there are two salts contained in solution, viz. sulphate of iron and alum; and it is an object of great consequence to separate them completely from each other. The principal secret consists in drawing off the mother liquor at the proper time; for the alum is much less soluble in water than the sulphate of iron, and therefore crystallizes first. The first crystals of alum formed are very impure. They have a yellow colour, and seem to be partly impregnated with

Alum. sulphate of iron. They are dissolved in hot water, and the solution poured into troughs, and allowed to crystallize a second time. These second crystals, though much purer, are not quite free from sulphate of iron; but the separation is accomplished by washing them repeatedly with cold water; for sulphate of iron is much more soluble in that liquid than alum. These second crystals are now dissolved in as small a quantity of hot water as possible, and the concentrated liquid poured while hot into large casks, the surface of which is covered with two cross beams. As the liquor cools, a vast number of alum crystals form on the sides and surface. The casks are allowed to remain till the liquid within is supposed to be nearly of the temperature of the atmosphere. This, in winter, requires eleven days; in summer, fourteen or more. We have seen the liquid in a cask that had stood eleven days in summer, still more than blood-hot. The hoops are then removed, precisely as in the manufacture of alum from alum-slate.

There always remains in the boilers a yellowish substance, consisting chiefly of peroxide of iron. This is exposed to a strong heat in a reverberatory furnace, and it becomes red. In this state it is washed, and yields more alum. The red residue is ground to a fine powder, and dried. It then answers all the purposes of Venetian red as a pigment. By altering the temperature to which this matter is exposed, a yellow ochre is obtained instead of a red.

In France, where alum-ores are by no means abundant, alum is manufactured from clay. This method of making the salt was first put in practice by Chaptal, when professor of chemistry at Montpellier. His methods have been since gradually improved, and brought to a state of considerable perfection. The first process tried was this: the clay was reduced to a fine powder in a mill, and then mixed with sulphuric acid. After remaining some days, it was exposed for twenty-four hours to a temperature of about 130°. It was then lixiviated, and the liquid mixed with urine or potash. This method being found inconvenient, was abandoned for the following: the clay being well ground, was mixed with half its weight of the saline residue from a mixture of sulphur and nitre. This residue is little else than sulphate of potash. The mixture was formed into balls about five inches in diameter, which were calcined in a potter's furnace. They were then placed on the floor of a chamber in which sulphuric acid was made. The acid vapour caused them to swell, and to open on all sides. In about a month they were sufficiently penetrated with the acid. They were then exposed to the air, under shades, that the saturation might become more complete. Finally, they were lixiviated, and the liquid being evaporated, yielded pure alum.

This process has been considerably improved by Berard, the present proprietor of the Montpellier alum work. Instead of exposing the calcined balls to the fumes of sulphuric acid, he sprinkles them with a quantity of sulphuric acid of the specific gravity 1·367, equal to the weight of the clay employed: but it is obvious that the proportion must vary with the nature of the clay. The solution takes place with the greatest facility, and crystals of alum are obtained by evaporating the liquid.

Another process was put in practice by Chaptal, in the neighbourhood of Paris, and is still followed, or was at least followed some years ago, by M. Bouvier. A mixture is made of 100 parts of clay, 50 parts of nitre, and 50 parts of sulphuric acid of the specific gravity 1·367; and this mixture is put into a retort, and distilled. Aquafortis comes over, and the residue in the retort being lixiviated with water, yields abundance of excellent alum.

We may mention another process described by Caraudau, and certainly practicable, and even easy, though we do not believe that it would be attended with profit. He forms 100 parts of clay into a paste with water, holding 5 parts of common salt in solution. This paste is formed into cakes, and calcined in a reverberatory furnace. The calcined mass is reduced to powder, and well mixed with the fourth part of its weight of concentrated sulphuric acid. When the muriatic acid vapours are dissipated, as much water is added as there had been employed of acid, and the mass is carefully kneaded. A strong heat is produced; the composition swells; more water is added; and at last a solution of potash, in which the alkali amounts to one fourth of the acid employed. The liquor is now drawn off, and, on cooling, it yields a copious deposite of alum crystals. (T. T.)

ALUNNO, Nicolo, a painter of Foligno, who flourished between 1468 and 1492. The heads in his historical pictures are generally portraits, which gave a vivacity and force to his compositions rarely seen in works of that age. *Lanzi Stor. Pittor. II.*

ALUNTIUM, or Alontium, in *Ancient Geography*, a town in the north of Sicily, situated on a steep eminence at the mouth of the Chydas; said to be as old as the war of Troy. It is now in ruins; and from these has arisen the hamlet San Filadelfo, in the Val di Demona.

ALVA de Tormes. See Alba.

Alva. Alva, or Alba, *Fernando Alvarez de Toledo, Duke of,* was born in 1508, and descended from one of the most illustrious families in Spain. His grandfather, Ferdinand of Toledo, was his preceptor in the military and political arts; and he displayed his valour at the battle of Pavia and at the siege of Tunis. The ambitious Charles V. selected Alva as a proper instrument for conducting his military enterprises. In 1538 he made him his general; and, after several operations, in which he displayed both valour and military skill, in 1542 he successfully defended Perpignan against the dauphin of France.

In 1546 Alva was made general-in-chief of the army which marched against the German Protestants, who were marshalled under the banners of the elector of Saxony. Francis, the king of France, died at Rambouillet, and by his death a considerable change was made in the state of Europe. Charles therefore instantly began his march from Egra on the borders of Bohemia, and entering the southern frontier of Saxony, attacked Altorf upon the Elster. Incessantly pushing forward, he arrived on the evening of the 23d of April on the banks of the Elbe, opposite to Muhlberg. The river at that place was three hundred paces in breadth and about four feet in depth, its current rapid, and the bank possessed by the Saxons was higher than that which he occupied. In opposition to the opinion of the duke of Alva and his other officers, Charles, with undaunted courage, though with inexpressible difficulty, led his army through the river and engaged the Saxons. The elector displayed great personal courage and military knowledge; but having received a wound in the face, he at last surrendered himself prisoner. The emperor proceeded towards Wittenberg, whither the remains of the Saxon army had fled, carrying along with him the captive prince, as a spectacle of consternation and amazement to his own subjects. But when he approached the town, he found it defended by the vigorous efforts of the elector's wife, Sibylla, along with the inhabitants. He summoned her once and a second time to open the gates, informing her that if she persisted in her obstinacy the elector should answer for it with his head. Accordingly he brought his prisoner to an immediate trial. The proceedings against him were as irregular as the stratagem was barbarous. Instead of consulting the states of the empire, or remitting the cause to any court, which, according to the German constitution, might have legally taken cognizance of the elector's crime, he subjected the greatest prince in the empire to the jurisdiction of a court-martial. The emperor selected the unrelenting duke of Alva as a proper instrument to carry into effect any measure of violence and oppression, and therefore made him president of that court, composed of Spanish and Italian officers. Moved more by the entreaties of his wife than by a sense of his own danger, the elector, in order to save his life, submitted to all the rigorous and unjust measures that were proposed; but when it was added that he should also renounce the Protestant faith and become a Roman Catholic, he refused to act in opposition to his conscience, and bravely fell a sacrifice to the cause of truth.

In 1552 Alva was intrusted with the command of the army intended to invade France, and was constrained by the opinion and authority of the emperor to lay siege to Mentz, in opposition to his own military knowledge; but, notwithstanding all his valour and abilities, the duke of Guise successfully defended the place. In consequence of the success of the French arms in Piedmont, he was made commander-in-chief of all the emperor's forces in Italy, and at the same time invested with unlimited power. Success did not, however, attend his first attempts, and after several unfortunate attacks he was obliged to retire into winter quarters. The next year he was sent into the pope's territories; and, had he not been restrained by his master, he would have taken possession of all his fortified places, and deterred Henry from entering into any new connection with him, and have thereby prevented the renewal of the war. Philip was strongly disposed to peace, but Alva was inclined to severe measures. He yielded, however, to the instructions of his master, until being deluded, and sometimes haughtily answered, he at length sent Pino de Loffredo with a letter to the college of cardinals, and another to Paul, in which, after enumerating the various injuries which his master had received, and renewing his former offers of peace and friendship, he concluded with protesting that, if his offers were again rejected, the pope should be chargeable with all the calamities that might follow. The pope threw Loffredo into prison; and, had not the college of cardinals interposed, he would even have put him to death; and on account of Philip's failing to pay tribute for Naples, he deprived him of the sovereignty of that kingdom. This violent conduct of Paul gave great offence throughout all Europe, and greatly lessened his influence in Italy; but Philip, though a young, ambitious, and powerful monarch, and of a temper impatient of injuries and affronts, moved with a religious veneration, discovered an amazing reluctance to proceed to extremities. After much time spent in negotiation, Philip was at last forced to give orders for Alva to take the field. He cheerfully obeyed, and began his march in the beginning of September 1556, with a well-disciplined army; and after reducing several towns in the Campagna di Roma, he pursued his conquests to the very gates of Rome. The circumstances, however, in which Alva found his army induced him to make a truce of forty days, and after several negotiations he yielded to peace. One of its terms was, that the duke of Alva should in person ask forgiveness of the haughty pontiff whom he had conquered. Proud as the duke was by nature, and accustomed to treat with persons of the highest dignity, yet such was the superstitious veneration then entertained for the papal character, that he confessed his voice failed him at the interview, and his presence of mind forsook him. Not long after this he was sent at the head of a splendid embassy to Paris, to espouse, in the name of his master, Elizabeth, daughter of Henry, king of France.

Philip II., his new master, being strongly devoted to the Roman see, and determined, by the most unrelenting severity and unbounded cruelty, to reclaim rebels to his government and dissenters from his faith, pitched upon Alva as the fittest person to carry this system into practice. With this design, therefore, he was sent into the Low Countries in 1567. Having received his orders, armed with such power as left only the shadow of authority to the natural governor, and provided with 10,000 veterans, he marched towards that devoted country. When he arrived, he soon showed how much he merited the confidence which his master reposed in him, and instantly erected a bloody tribunal to try all persons who had been engaged in the late commotions which the civil and the religious tyranny of Philip had excited. He imprisoned the counts Egmont and Horn, the two popular leaders of the Protestants, and soon brought them to an unjust trial, and condemned them to death. In a little time he totally annihilated every privilege of the people, and, with uncontrolled fury and cruelty, put multitudes of them to death. Beholding herself deprived of all authority, and her subjects devoted to destruction, the duchess of Parma resigned her office, disdaining to hold a nominal power, while the actual government was in the hands of Alva. This event increased the general tide of wretchedness, and every place was filled with scenes of horror and dismay. Unable for the present to administer the least aid, the prince of Orange saved his life by flight. This noble prince suddenly collecting an army in Germany, returned to the relief of his countrymen; and at the same time Prince Lewis, his brother, marched with an army into Friesland. Although success at first attended Lewis, yet the activity and experience of Alva prevailed, and he was totally defeated. The prince of Orange proved a more formidable foe; and it required the united talents of Alva and his son Frederick of Toledo to prevent the prince from making a descent upon the Netherlands. But notwithstanding all the address and military skill of the prince of Orange, the descent was prevented; and Alva had the glory of baffling that great leader, and of compelling him, after great loss of men, to disband the remainder of his army. Alva could now indulge his cruelty unrestrained. The executioner was instantly employed in removing all those friends of freedom whom the sword had spared. In most of the considerable towns Alva built citadels. In the city of Antwerp he erected a statue of himself, which was a monument no less of his vanity than of his tyranny: he was figured trampling on the necks of two smaller statues, representing the two estates of the Low Countries. By his unusual and arbitrary demand of new supplies from the states, he greatly aggravated this haughty insult. The exiles from the Low Countries, roused to action by his oppression, fitted out a kind of piratical fleet, and, after strengthening themselves by successful depredations, ventured upon the bold exploit of seizing the town of Briel. Thus Alva, by his cruelty, became the unwitting instrument of the future independence of the seven Dutch provinces. The fleet of the exiles having met the Spanish fleet, totally defeated it, and reduced North Holland and Mons. Many cities hastened to throw off the yoke: while the states-general assembling at Dordrecht, openly declared against Alva's government, and marshalled under the banners of the prince of Orange. This situation of affairs convinced Alva of the instability of a government upheld by terror and oppression; he therefore began, when too late, to employ more lenient measures. His preparations to oppose the gathering storm were concerted with his usual vigour, and he succeeded in recovering Mons, Mechlin, and Zutphen, under the conduct of his son Frederick, where his soldiers more than retaliated upon the prince of Orange. With the exception of Zealand and Holland, he regained all the provinces; and at last his son stormed Waerdan, and massacring its inhabitants with the most savage cruelty, proceeded to invest the city of Haarlem. Fully convinced of the miseries that awaited their surrender, this city stood an obstinate siege; and nothing less than the inflexible and persevering spirit of Alva could have overcome difficulties almost insurmountable. Despairing of success, Frederick was at one time disposed to raise the siege, but the stern reproaches of his father urged him on; and at length the inhabitants, overcome with fatigue, surrendered. The victorious Frederick gave tolerable conditions to the town; but his inhuman father arriving on the third day after the surrender, sacrificed to his vengeance many who had been flattered with a promise of mercy. Their next attack was upon Alcmaar; but the spirit of desperate resistance was raised to such a height in the breasts of the Hollanders, that the Spanish veterans were repulsed with great loss, and Frederick constrained reluctantly to retire. Alva now resolved to try his fortune by sea, and with great labour and expense fitted out a powerful fleet, with which he proceeded to attack the Zealanders; but was entirely defeated, and the commander taken prisoner. About the same period the prince of Orange proceeded to attack the town of Gertruydenberg. Alva's feeble state of health and continued disasters induced him to solicit his recal from the government of the Low Countries; a measure which, in all probability, was not displeasing to Philip, who was now resolved to make trial of a milder administration. In December 1573 that devoted country was relieved from the presence and oppressions of the duke of Alva, who, returning home, accompanied by his son, made the infernal boast that during the course of six years, besides the multitudes destroyed in battle and massacred after victory, he had consigned 18,000 persons to the executioner.

Returning from this scene of oppression and blood, he was treated for some time with great distinction by his master. Justice, however, soon overtook the crimes of Alva; for his son, having debauched one of the king's attendants, under promise of marriage, was committed to prison; and being aided in his escape by his father, and married by him to a cousin of his own, Alva was banished from court, and confined in the castle of Uzeda. In this disgraceful situation he remained two years, when the success of Don Antonio, in assuming the crown of Portugal, determined Philip to turn his eyes towards a person in whose fidelity and abilities he could on this occasion most confide. A secretary was instantly despatched to Alva, to ascertain whether his health was sufficiently vigorous to enable him to undertake the command of an army. The aged chief returned an answer full of loyal zeal, and was immediately appointed to the supreme command in Portugal. It is a striking fact, however, that the enlargement and elevation of Alva were not followed by forgiveness. In 1581 Alva entered Portugal, defeated Antonio, drove him from the kingdom, and soon reduced the whole under the subjection of Philip. Entering Lisbon, he seized an immense treasure. and suffered his soldiers, with their accustomed violence and rapacity, to sack the suburbs and vicinity. It is reported, that Alva being requested to give an account of the money expended on that occasion, sternly replied, "If the king asks me for an account, I will make him a statement of kingdoms preserved or conquered, of signal victories, of successful sieges, and of sixty years' service." Philip deemed it proper to make no further inquiries. Alva, however, did not enjoy the honours and rewards of his last expedition, for he died in 1583, at the age of 74. See HOLLAND.

ALVARADO, PEDRO DE, a native of Badajos, who, as the lieutenant of Hernando Cortes the famous conqueror of Mexico, was himself scarcely less celebrated. He died in 1541.—See Barcia, *Historiadores Primitivos;* and De Solis, *Historia de la Conquista.*



ALVARES DE LUNA, treasurer and favourite of John II., king of Castile, celebrated for the powerful ascendency which he gained over this prince. He was a natural son of Don Alvaro de Luna, lord of Cañete in Aragon, and of a woman of infamous character. He was born in 1388, and named Peter; but Pope Benedict XIII. who was charmed with his wit though yet a child, changed Peter to Alvares. He was introduced to court in 1408, and made a gentleman of the bed-chamber to King John, in whose service he acquired the most distinguished favour. In 1427 the hostility of the courtiers occasioned his banishment from court for a year and a half. His absence was a source of the utmost affliction to the king, who could now speak or think of nothing but Alvares. He was therefore recalled; and being invested with his former authority, he revenged himself severely upon his enemies, by persuading the king to banish them. He spent 45 years at court, and during 30 of them maintained such an ascendency over the king, that nothing could be done without his concurrence: nay, it is related by Mariana, that the king could not change an officer or servant, or even his clothes or diet, without the approbation of Alvares. He was master of the treasury, and had so gained the affections of the subjects by his profusion, that the king, though his eyes were now opened, and his favour withdrawn, was afraid to complain. A day of retribution however was at hand; the popular favour, as well as the affections of the monarch, declined, and Alvares was thrown into prison. Being brought to trial and condemned, he was removed to Valladolid, and there beheaded in the market-place. He met his fate with the utmost intrepidity.

ALVAREZ, FRANCISCO, of Coimbra, a priest, and almoner to Emanuel king of Portugal, was sent in 1515 as secretary to Duarte Galvaon on an embassy to David, king of Abyssinia. The expedition having been delayed by the way, it was not until 1520 that he reached Abyssinia, where he remained six years, and returned to Lisbon in 1527. In 1540, the year of his death, he published at Lisbon an account of his travels in one volume folio, entitled *Descripçam das Terras de Preste Joam, &c.* This curious work was translated in Latin, under the title of *De Fide, Regione, et Moribus Æthiopum*, by Damien Goez, a Portuguese gentleman; and has often been reprinted and translated into other languages. The information it contains must, however, be received with caution, as the author is prone to exaggerate, and does not confine his remarks to his own observation.

ALVAREZ, *Don Jose*, an eminent Spanish sculptor, born at Priego in 1768. He was originally a stone mason, but by talent and perseverance he gained the royal gratuity, which sent him to study at Rome, and there obtained much reputation for his invention, the expression, and the grace of his figures. He was favourably noticed by Napoleon when studying at Paris; and was considered by his countrymen as the Canova of modern Spain. His Ganymede is his masterpiece. He was an uncompromising *Spanish Patriot;* on which account he was imprisoned at Rome, where he chiefly resided. He returned to Madrid in 1826, but died in about a year. There was another Spanish sculptor of merit named MANUEL ALVAREZ, who flourished about the middle of the last century.—See *Bermisdez Diccionario.*

ALVERCA, a town and small port on the Tagus, 16 miles north-east of Lisbon. Pop. 3000.

ALVEOLUS, in *Natural History*, the name of the waxen cells in bee-hives. Also the name of a sea-fossil, of the order of Polyparia, of a conical figure, composed of a number of cells like bee-hives, joined into each other with a pipe of communication.

ALVINZ, a market-town on the Maros, in the Austrian province of Transylvania. It contains a Catholic, a Greek, and a Reformed church, and a Franciscan monastery. The inhabitants, who are chiefly Bulgarians and Magyars, amount to 3500.

ALYATTES, king of Lydia, father of Crœsus. He was buried under an immense tumulus near Sardis, by the lake Gygæa; which is described by Chandler as still retaining the form mentioned by Herodotus, among a multitude of smaller tumuli, though erected 562 years B.C.

ALYZIA, an ancient city of Acarnania, about 15 stadia from the coast, the ruins of which are still to be seen in the valley of Kandile.

ALWAIDII, a sect of Mahometans who believe all great crimes to be unpardonable. The Alwaidii stand in opposition to the Morgii. They attribute less efficacy to the true belief in the salvation of men than the rest of the Mussulmans.

ALWUR, in Central India, the capital of the native state of the same name, in the province of Rajpootana, and the residence of the reigning Rajah. This chief has attracted the notice and commendation of the British Government by his departure from the native mode of administering his possessions, and introducing the British method in its place. Under the reformed system the custom of farming the revenue has been abolished; justice is administered separately in the civil and criminal department; revenue duties are no longer blended with those of police, and the troops are maintained by cash payments instead of territorial assignments. The experiment is the more interesting, inasmuch as since its introduction this principality has been represented by competent authority (the late Colonel Sutherland) as one of the most flourishing native states of India. Distance north-west from Calcutta 900 miles. Lat. 27. 34. Long. 76. 40. (E. T.)

ALYPIUS *of Antioch*, a geographer of the fourth century. He was sent by the emperor Julian into Britain as deputy-governor; and after remaining in this situation for some time, he received orders from the emperor to rebuild the temple of Jerusalem. An account of the extraordinary interruption of that undertaking by fiery eruptions from the earth, is given under the article JEWS; and may be read at length in Ammianus Marcellinus, xxxiii. Among the letters of Julian are two (29 and 30) addressed to Alypius; one inviting him to Rome, the other thanking him for a geographical treatise, which no longer exists.

ALYPIUS, one of the seven Greek writers on music whose works are collected and published, with a commentary and explanatory notes, by Meibomius. The time in which he flourished cannot be precisely ascertained. He is said to have written before Euclid and Ptolemy; and Cassiodorus arranges his work, entitled *Introduction to Music*, between those of Nicomachus and Gaudentius. In this work is to be found the most complete nomenclature of all the sounds of the different scales and modes in the ancient Greek music which have escaped the wreck of time.

*ALYPIUS of Tagasta*, a Christian divine of the fourth century. He was baptized at Milan in 388, and consecrated bishop of Tagasta in Africa in 394. He assisted his friend St Augustine in opposing the tenets of the Donatists, who claimed the exclusive honour of being the true Church. In 419 he was sent by the African bishops to Honorius, and was employed by Pope Boniface against the Pelagians. Alypius died in 430. There is extant an epistle of his in Greek addressed to St Cyril, on the heresy of Nestorius.

ALYTARCHA, a magistrate who, at the games instituted in honour of the gods, presided over the officers who carried rods to clear away the crowd and keep order. In the Olympic games, the alytarchai had the same command, and obliged every person to preserve order and decency.



ALYTH, a burgh in Perthshire, with 1840 inhabitants, who support themselves by the manufacture of linen-thread and weaving.

ALZIRA. See ALCIRA.

AMA, in *Ecclesiastical Writers*, denotes a vessel wherein wine, water, or the like, was held for the service of the eucharist. In this sense the word is also written amula; sometimes also hama, and hamula.

AMABYR, a barbarous custom which formerly prevailed in several parts of England and Wales, being a sum of money paid to the lord when a maid was married within his lordship. The word is old British, and signifies *the price of virginity*.

AMAC, surnamed Bokharai, a very distinguished Persian poet, and one of the illustrious men who adorned the court of Kheder Khan. His most celebrated poems are the *History of the loves of Joseph and Zoleiskah*, from the Koran, and an Elegy on the daughter of the Sultan Sandjar.

AMADEUS V. count of Savoy, succeeded his uncle Philip in 1285. In him it appeared that mental excellence can rise superior to riches or extent of territory; for although his dominions were by no means extensive, nor his riches great, yet, in consequence of his wisdom and success, he obtained the surname of *Great*. The cautious prudence of Amadeus, however, enabled him greatly to increase his territory by means of marriage, purchase, and donations. In this situation, with extended dominion, and distinguished for wisdom and prudence, he rose to such eminence among the European powers, that he was constituted their umpire to settle their differences; which office he performed with much reputation to himself and advantage to them. In his character valour and wisdom were combined: for when the Turks attempted to retake the isle of Rhodes from the knights of St John of Jerusalem, he acquired great renown by the valour with which he defended it. A Maltese cross with the letters F. E. R. T. in future became the arms of Amadeus and his successors, in memory of this signal victory. The explanation of this motto is said to be *Fortitudo ejus Rhodum tenuit*, his valour preserved Rhodes. For this important service the grand-master conferred on him the grant of a palace at Lyons. Andronicus, the emperor of the East, had married his daughter; and in order to promote the views of his son-in-law, Amadeus took a journey to Avignon to persuade Pope John XXII. to preach a crusade in favour of Andronicus. He died there in the year 1323. Deep penetration, keen discernment, consummate prudence, great valour, together with no small portion of the religious superstition of his time, appear the most striking features in his character.

AMADEUS VIII. count of Savoy, succeeded his father Amadeus VII. in 1391. With the large sum of 45,000 florins of gold he purchased the country of Genevois from its last earl. Anxious to extend his territories, he purchased the city of Rumilli, upon the lake of Geneva, from the widow of the count of Genevois; and thus the house of Savoy became so powerful, that the emperor Sigismund erected Savoy into a duchy in the year 1416. Historians relate that he assisted John Paleologus against the duke of Milan, who endeavoured to wrest from him the duchy of Montferrat. Deeply sensible of the services which he had received, Paleologus not only resigned to the duke Chivas, Brandis, and several other estates, but submitted to hold all the marquisate of Montferrat as a fief from the house of Savoy. These fortunate acquisitions of territory were not yet limited; for upon the marriage of his daughter with Philip Maria, duke of Milan, he received Vercelli; and about the same time the count of Crescentino submitted to become his feudary. In his ambitious pursuit he laid claim to the sovereignty of the city of Geneva; but that claim, though enforced by the pope, was rejected by the citizens with disdain; and the emperor Sigismund, taking it under his protection, declared it an imperial city. After such an extensive acquisition of dominion, and amassing such sums of money, he formed the singular scheme of abandoning his throne and family; and for that purpose retired to a religious house at a place called *Ripaille*. But although he resigned the dukedom of Savoy to his eldest son Lewis, and made his youngest son Philip count of Genevois, yet their honours were merely nominal; for he constrained them to live on a very scanty allowance, while he in his retirement received all the revenues, and collected such sums of money, that he is said to have purchased the papal honours. Having assumed great sanctity of manners during the previous part of his life, the motives for his retirement were generally reckoned religious; but it was soon discovered that his hermitage was the abode of voluptuous pleasure and of the most refined luxury. Instead of a religious habit, he wore purple robes; and upon his mantle was embroidered a golden cross. His table groaned under a weight of dainties, and the softest music cheered his daily feast: in short, such was the luxury of the place, that in the French language the phrase *faire ripaille* signifies to make exquisitely good cheer.

He instituted a secular knighthood in that place, under the appellation of St Maurice. The brethren assumed the name of hermits, wore beards, and excluded women from their community; and in other respects exhibited the character of decent epicures.

When he obtained the papal dignity, and was crowned by the cardinal of Arles at Basil, all Europe was filled with astonishment in consequence of his elevation; for he had never entered into holy orders. But he had found means to remove every objection, the council confirmed his election, and with pretended reluctance he put on the pontifical ornaments, and was consecrated in the church of St Maurice, under the title of Felix V. The papal dignity was severely contested between him and Eugenius; and, notwithstanding all the importunities of the council, the emperor refused to acknowledge his elevation. This religious dispute involved all Europe in contention. Historians relate that Germany remained neutral, while France, England, Italy, Spain, and Hungary, declared for Eugenius; but Aragon, Poland, and Bretagne, recognised the council only; at the same time that Savoy, Switzerland, Basil, Strasburg, Pomerania, and one of the duchies of Bavaria, recognised Felix. The emperor Frederick III. held a council at Frankfort, before which both the popes urged their respective rights by means of deputies. This attempt, however, to establish peace in Europe proving unsuccessful, the emperor repaired to the vicinity of Basil, and had a personal interview with Felix. Amadeus, that he might the more freely indulge his sensual appetite, again repaired to his favourite retreat; and after the fathers of the council had frequently solicited him in vain to reside at Basil, he prevailed upon them to remove to Lyons, which was near the seat of his pleasures. During the contest Eugenius had excommunicated Felix, the council, and several of the German princes, so that the whole church was then filled with confusion and disorder. The struggle, however, was terminated by the death of Eugenius, when the cardinals at Rome elected Thomas de Sarzan, who assumed the name of Nicholas V. In this state of affairs Amadeus deemed it prudent to enter into a negotiation for the resignation of the papal crown. His policy and address were such that Nicholas was induced to annul all the acts of Eugenius; to confirm the determination of the council of Basil to appoint him perpetual apostolical legate in Savoy, Piedmont, and the other places of his own dominions; and even to confer on him the bishoprics of Basil, Lausanne, Strasburg, and Constance. Nor did his vanity forsake him even in this political transaction, for he provided that he should continue to wear the pontifical dress, unless in a very few particulars. In order to gratify the same haughty disposition, he stipulated that he should not be obliged to go to Rome to attend any general council; and that when he had occasion to approach the pope, he should rise to receive him, and instead of kissing his toe, should be permitted to kiss his cheek. Amadeus retired to Lausanne, and died there at the age of 69, in the year 1451.



Amadeus IX., count of Savoy, succeeded his father Lewis, in his dominion and honours. His bodily constitution was weak, and he was afflicted with the falling-sickness; yet, on account of his piety, virtue, benevolence, and justice, he was surnamed the *Happy*. The clemency of his temper was such that he readily pardoned those who offended him, and in few instances was he induced to punish. In his character the virtue of benevolence shone with peculiar splendour among the other virtues of the Christian. In 1472, in the seventh year of his reign, and the thirty-seventh of his life, he died universally lamented by all his loyal subjects.

AMADIA, a trading town of Asia, in Kurdistan, belonging to the Turks. It is seated on a high mountain. Long. 42. 43. E. Lat. 37. 25. N.

AMADIS de Gaula, the hero of a famous romance of chivalry, written in prose by Vasco Lobeira, a Spaniard, about the end of the twelfth century. It has appeared in numerous editions, and under a variety of forms, both in prose and in verse. The Gaula of the original signifies Wales, and the subject, characters, and localities, are British: the story relates to the fabulous achievements of Welsh and English heroes, previous to the time of Arthur and the knights of the Round Table; and was probably derived by Lobeira from some ancient British or Welsh legend.—See Warton's *History of English Poetry*.

AMADOU, a kind of brown match, tinder, or touchwood, which comes from Germany. It is made of a sort of large mushroom, *Boletus igniarius*, which commonly grows on old trees, especially the oak, ash, and fir. This substance, after being boiled in common water, is dried and well beaten, is then put into a strong ley prepared with saltpetre, after which it is again put to dry in an oven. The druggists sell this match wholesale in France, and it is also retailed by hawkers. Some give to the amadou the name of *pyrotechnical sponge*, because of its aptness to take fire. It is used in surgery to stop hæmorrhage.

AMAIN, in the sea language, a term importing to lower something at once. Thus, *to strike amain* is to lower or let fall the topsails; *to wave amain* is to make a signal, by waving a drawn sword, or the like, as a demand that the enemy strike their topsails.

AMAK, a small island in the Baltic Sea, near Copenhagen, from which it is separated by a canal over which there are three bridges. Amak is about six miles long and three broad, and is chiefly peopled by the descendants of a colony from East Friesland, to whom the island was consigned by Christian II. at the request of his wife Elizabeth, sister of Charles V., for the purpose of supplying her with vegetables, cheese, and butter. From the inter-marriages of these colonists with the Danes, the present inhabitants are chiefly descended; but as they wear their own dress, and enjoy peculiar privileges, they appear a distinct race from the natives. The island contains about 6000 inhabitants. It has two churches, in which the ministers preach occasionally in Dutch and Danish. Long. 12. 35. E. Lat. 55. 30. N.

AMAL, a town of Sweden, in the province of Wenersborg, seated on the lake Wener. It has a good harbour, and carries on a great trade, in iron, timber, deals, and tar. Long. 12. 40. E. Lat. 58. 50. N.

AMALAGAN, one of the Ladrone Islands in Lat. 18. 4. N. Long. 165. 24. 3. E.

AMALARIC was the son of Alaric II., and king of the Visigoths. Deprived of his father when an infant, he would have been bereft of his crown, had not his grandfather Theodoric, king of the Ostrogoths, interposed in his behalf. In defence of the royal infant, Theodoric expelled from the throne his natural brother, who had usurped the government; and, ruling the kingdom during his life, preserved the crown to the natural heir. In 526 the grandfather died, and Amalaric assumed the royal authority. In 527 he married Clotilda, the daughter of Clovis, an amiable lady, who inherited both the piety and orthodoxy of her mother, who was of the same name. The Catholic historians relate, that the king, being violently attached to the Arian cause, used means indicative rather of a cruel than of a pious disposition, to compel his queen to embrace the same opinions. With all the firmness of a great mind, and the amiable patience of a Christian, she endured her wrongs for a considerable period; but at length, worn out with injurious treatment, she was forced to apply to her brothers for assistance, and sent them a handkerchief stained with her blood, in proof of her cruel usage. In order to relieve their sister, one of them, Childebert, king of Paris, entered the territories of Amalaric, who then resided with his court at Narbonne; and their forces having joined battle, the troops of Amalaric were totally defeated, and the king himself forced to save his life by flying into Spain, A.D. 531. It is reported that, when endeavouring to regain Narbonne, he was either slain by an assassin employed by Theudis, his successor, or fell in battle. Some historians say that he died in Barcelona.

AMALASONTHA, or AMALESUENTA, the daughter of Theodoric the Great, king of the Ostrogoths, was born about the year 498. The sister of Clovis was her mother; and in 515 she married Eutharic, the only remaining heir of the legal race of the Amali. Her father having formed the design of making him his successor, sent to bring him from Spain for that purpose. But he never arrived at the destined honour; for Eutharic died before his father-in-law, leaving an only son, Athalaric. The well-known abilities of Amalasontha induced Theodorie to place Athalaric, to whom he had left the kingdom of Italy, under the care of his mother. This princess inherited an ample share of her father's talents, which he had been exceedingly careful to improve by means of a liberal education. She became a great proficient in the philosophy and morals of that age, and with equal elegance and grace could converse in the Greek, Latin, and Gothic languages. Nor were her talents merely qualified to adorn private life: she displayed them in the administration of public justice, and in political discussion. When the chiefs of the Goths were strongly inclined to treat the Romans as a conquered people, she mildly restrained their violent oppression and their ungovernable rapacity. She relieved her subjects from some of the severer impositions of her father; but carefully retained all his laws, magistrates, and political institutions. She patronised learning with an assiduous care, by regularly paying the salaries of public teachers, and giving every encouragement to the improvement of genius. Prompted by maternal affection and a highly cultivated mind, she exerted all her ingenuity in the education of her son Athalaric. Unfortunately, however, both for the mother and the son, neither the general character of the Gothic nation, nor the wayward inclinations of the boy, seconded her laudable endeavours. The Gothic nobles murmured against the effeminate education of their prince, and insisted upon his release from the bondage of learning, and from the restraints of a mother. The unfortunate youth was thus dragged from the habitation of learning, prudence, and virtue; and, plunging into all the extravagancies of dissolute pleasure, his mind became inspired with contempt and aversion for his virtuous mother. At the early age of sixteen, he fell a victim to his debaucheries and follies, and Amalasontha was left devoid of any legal claim to the crown. Spurning the idea of retiring to a private station, she chose her cousin Theodat as her coregent. Theodat, a man of great ability but little principle, soon entered into an intrigue with the ambassador of the emperor Justinian, by which he agreed to remove the unfortunate queen, to make way for the union of the Byzantine and Gothic powers. He accordingly issued an order for her confinement in an island on the lake Bolsena; and in the year 535 she was strangled in the bath. Some historians ascribe this deed to the influence of the empress Theodora, whose jealousy was excited by the respect paid to Amalasontha by Justinian.



AMALEKITES, a powerful people who dwelt in Arabia Petræa, between the Dead Sea and the Red Sea, or between Havila and Shur (1 Sam. xv. 7), sometimes in one country and sometimes in another. It does not appear that they had cities, for there is no mention of any but one in the Scriptures (1 Sam. xv. 5): they lived generally in hamlets, caves, or tents. They were the descendants of Amalek, the son of Eliphaz, by Timna his concubine, and the grandson of Esau. (Gen. xxxvi. 12, and 1 Chron. i. 36.) Amalek succeeded Gatam in the government of Edom.

The Israelites had scarcely passed the Red Sea on their way to the wilderness, before the Amalekites came to attack them in the deserts of Rephidim (Exod. xvii. 8, &c.), and cruelly put to the sword those who were obliged either through fatigue or weakness to remain behind. Moses, by Divine command, directed Joshua to take vengeance upon this people for their inhumanity. He accordingly fell upon them and defeated them with great slaughter (Exod. xvii. 13).

The ground of the enmity of the Amalekites against the Israelites is generally supposed to have been an innate hatred, from the remembrance of Jacob's depriving their progenitor both of his birthright and blessing. Their falling upon them, however, and that without any provocation, when they saw them reduced to so low a condition by the fatigue of their march and an excessive drought, was an inhuman action, and justly deserved the severe punishment inflicted on them by Joshua. Under the Judges (vi. 3), we see the Amalekites united with the Midianites and Moabites in a design to oppress Israel; but Ehud delivered the Israelites from Eglon, king of the Moabites (Judg. iii.), and Gideon (chap. viii.) delivered them from the Midianites and Amalekites. About the year of the world 2930, Saul marched against the Amalekites, advanced as far as their capital, and put all the people of the country to the sword; but he spared the best of the cattle and movables, contrary to a Divine command; which act of disobedience was the cause of his future misfortunes.

After this war the Amalekites scarcely appear any more in history. However, about the year of the world 2949, a troop of Amalekites came and pillaged Ziklag, which belonged to David (1 Sam. xxx.), where he had left his two wives, Ahinoam and Abigail; but on returning from an expedition which he had made in the company of Achish into the valley of Jezreel, he pursued, overtook and dispersed them, and recovered all the booty which they had carried off from Ziklag.

The Arabians maintain that Amalek was the son of Ham, and grandson of Noah; that he was the father of Ad, and grandfather of Schedad. Calmet thinks that this opinion is

Amalfi.

by no means to be rejected, as it is not very probable that Amalek, the son of Eliphaz, and grandson of Esau, should be the father of a people so powerful and numerous as the Amalekites were when the Israelites departed out of Egypt. Moses, in the Book of Genesis (xiv. 7), relates, that in Abraham's time, long before the birth of Amalek the son of Eliphaz, the five confederate kings carried the war into Amalek's country, about Kadesh; and into that of the Amorites, about Hazezon-tamar. Moses also (Num. xxiv. 20) relates, that the soothsayer Balaam, observing at a distance the land of Amalek, said, in his prophetic style, "Amalek is the first, the head, the original of the nations; but his latter end shall be that he perish for ever." Our commentator observes that this epithet of the first of nations cannot certainly agree with the Amalekites descended from the son of Eliphaz, because the generation then living was but the third from Amalek. Besides, Moses never reproaches the Amalekites with attacking their brethren the Israelites; an aggravating circumstance which he would not have omitted had the Amalekites been descended from Esau, in which case they would have been the brethren of the Israelites. Lastly, we see the Amalekites almost always classed in Scripture with the Canaanites and the Philistines, and never with the Edomites; and when Saul made war upon the Amalekites, and almost utterly destroyed them, we do not find that the Edomites made the least attempt to assist them, or to avenge their cause afterwards. Thence it is thought probable that the Amalekites who are so often mentioned in Scripture were a free people descended from Canaan, and devoted to the curse as well as the other Amorites, and very different from the descendants of Amalek, the grandson of Esau.

The accounts which the Arabians give us of the Amalekites destroyed by Saul are as follows: Amalek was the father of an ancient tribe in Arabia, exterminated in the reign of Saul. This tribe contained only the Arabians who are called *Pure*, the remains whereof were mingled with the posterity of Joktan and Adnan, and so became Mosarabes or Mostaarabes; that is to say, Arabians blended with foreign nations. They further believe that Goliath, who was overcome by David, was king of the Amalekites; that the giants who inhabited Palestine in Joshua's time were of the same race; and that at last part of the Amalekites retired into Africa while Joshua was yet living, and settled upon the coasts of Barbary, along the Mediterranean Sea. The son of Amalek was Ad, a celebrated prince among the Arabians. Some make him the son of Uz, and grandson of Aram the son of Shem. Be this as it may, the Mahometans say that Ad was the father of an Arabian tribe called *Adites*, who were exterminated, as they tell us, for not hearkening to the patriarch Eber, who preached to them the unity of God. Ad had two sons, Schedad and Schedid.

AMALFI, seven miles to the west of Salerno, and thirty to the south of Naples, was one of the first Italian cities in which the spirit of commercial enterprise revived after it had been suppressed by the irruption of the barbarians. Though now an obscure village, containing only about 3500 fishermen, it attained, at a remote epoch, to distinction as a maritime republic, and is said by Gibbon to have preceded Venice in re-opening an intercourse with the East. But the more recent researches of Darn, who enjoyed sources of information inaccessible to previous historians, show that this statement is inaccurate, and that Venice carried on a considerable traffic with the Levant before any competitor appeared in the field. But the Amalfitans entered at a very early period on this career, with singular energy and success. In the ninth century, their city is said to have had 50,000 inhabitants. They were extensive navigators and merchants. Their trade comprised the products of Africa, Arabia, and the East; and their settlements in Antioch, Jerusalem, and Alexandria, acquired the privileges of independent colonies. William of Apulia, a writer of the eleventh century, has noticed Amalfi in verses, partly quoted by Gibbon, and said by him to "contain much truth and some poetry."

Amalgam || Amalgamation.

The government was popular under the administration of a duke and the supremacy of the Greek emperor. The mariners who swarmed in her ports excelled in the theory and practice of navigation and astronomy.

We are said to owe a peculiar and not easily exaggerated debt of gratitude to Amalfi. It was, says Sismondi, a citizen of that republic, Flavio Gioja, who invented the compass or introduced it into navigation; in her was found a unique copy of the Pandects which revived the knowledge and the study of jurisprudence in the west; and the maritime laws of Amalfi (*Tabula Amalphitana*) early acquired in the Mediterranean the same influence that was enjoyed by the laws of the Rhodians in antiquity, and that was acquired at a later period by the laws of Oleron in the countries bordering on the Atlantic. Very large deductions must, however, be made from this too partial statement. Gioja may have improved the compass by rendering the needle more suitable to the purposes of navigation; but if he did this much, it is all, for there can be no doubt that it had already been applied to them. Some authorities treat as a fable the story of the famous manuscript of the Roman law carried off by the Pisans from Amalfi, and now at Florence. And though there be no reasonable ground for this exaggerated scepticism, Savigny and others have shown that the study of the civil law was vigorously prosecuted long previously to the alleged discovery of the MS. referred to. The statements respecting the Tabula Amalphitana appear to be entitled to no credit, and to be wholly founded on a mistake. Though several distinguished authorities have referred to this table, none of them quote it, or appear to have seen it. No trace or vestige can now be found of any such table or law. And the presumption is, that it never had any real existence, and that some other law had been mistaken for it. Though brilliant, the prosperity of Amalfi was but short. It was sacked by the Pisans in 1135, when the MS. of Justinian's Compilations is said to have fallen into their hands, and was soon after subjugated by the Normans. Her commerce having been diverted into other channels, she speedily sunk into total obscurity.[1]

At present Amalfi is subject to Naples, and is the see of an archbishop. It is but a shadow of what it was in its flourishing state, when it extended over the stupendous rocks that hang on each side, still crowned with battlemented walls and ruined towers. Its buildings, Mr Swinburne says, are not remarkable for elegance or size, and contain at most 4000 inhabitants, who seem to be in a poor line of life. The cathedral is an uncouth building. Under the choir is the chapel and tomb of the apostle St Andrew, to whose honour the edifice was dedicated, when Cardinal Capuano, in 1208, brought his body from Constantinople.

AMALGAM, mercury united with any other metal.

AMALGAMATION, the operation of making an amalgam, or mixing mercury with any metal.

For the combination of one metal with another, it is generally sufficient that one of them be in a state of fluidity. Mercury being always fluid, is therefore capable of amalgamation with other metals without heat, iron excepted; nevertheless, heat considerably facilitates the operation.

[1] For the above description we are chiefly indebted to Mr M'Culloch's History of Commerce contained in his Treatises on Economical Policy.

To amalgamate without heat requires nothing more than rubbing the two metals together in a mortar; but the metal to be united with the mercury should be previously divided into very thin plates or grains. When heat is used (which is always most effectual, and with some metals indispensably necessary), the mercury should be heated till it begin to smoke, and the grains of metal made red hot before they are thrown into it. If it be gold or silver, it is sufficient to stir the fluid with an iron rod for a little while, and then to throw it into a vessel filled with water. This amalgam is used for gilding or silvering on copper, which is afterwards exposed to a degree of heat sufficient to evaporate the mercury.

Amalgamation with lead or tin is effected by pouring an equal weight of mercury into either of these metals in a state of fusion, and stirring with an iron rod. Copper amalgamates with great difficulty, and iron not at all.

AMALIA, Grand Duchess of Saxe-Weimar, the enlightened patroness of Wieland, Herder, Schiller, and Goethe, governed the duchy after her husband's death till 1775, when she resigned it to her son. She died in 1807. See Weimar.

AMALTEO, Girolamo, Giovanni Battista, and Cornelio, three celebrated Latin poets of Italy, who flourished in the sixteenth century. Their compositions were printed at Venice in 1627, and at Amsterdam in 1684. One of the prettiest pieces in that collection is an epigram, by Girolamo, on two children of extraordinary beauty, each of whom was deprived of an eye:

> Lumine Acon dextro, capta est Leonilla sinistro:
> Et potis est formâ vincere uterque Deos.
> Parve puer, lumen quod habes concede sorori;
> Sic tu cæcus Amor, sic erit illa Venus.

Amalteo, *Pomponio*, an excellent painter of the *second*, or most brilliant epoch of the Venetian school, a pupil of Pordenone, distinguished for his correct design, as well as for his skill in colouring. He was born in 1505, and died in 1588.—See *Zanetti*, and *Lanzi*, tom. iii.

AMALTHÆA, the name of the Cumæan Sibyl, who offered to Tarquinius Superbus nine books containing the Roman destinies, and demanded 300 pieces of gold as their price. The monarch disregarding her demand, she threw three of them into the fire, and returning asked the same price for the remaining six; which being also denied, she burnt three more, and returning demanded the same price for the three that were left. Tarquin, astonished at her behaviour, consulted the pontiffs, who advised him to buy them. These books were so highly esteemed, that two magistrates (*duumviri*) were created to consult them upon extraordinary occasions.—See *Roman History*, xix.

Amalthæa, in *Pagan Mythology*, daughter of Melissus, king of Crete, and nurse of Jupiter, whom she fed with honey and goats' milk. According to others, Amalthæa was a goat, which Jupiter translated into the sky, with her two kids, and gave one of her horns to the daughters of Melissus, as a reward for their care over his infant years. This horn had the peculiar property of furnishing them with whatever they wished for, and was thence called the *cornu copiæ*, or horn of plenty.

AMAMA, Sixtinus, professor of the Hebrew tongue in the university of Franeker, a man of great learning, was born in Friesland, and studied under Drusius. He published a criticism upon the translation of the Pentateuch; collated the Dutch translation of the Bible with the original and the most accurate translations; and wrote a censure of the Vulgate translation of the historical books of the Old Testament, Job, the Psalms, and Canticles. It is impossible to answer the reasons whereby he shows the necessity of consulting the originals. This he recommended so earnestly, that some synods, influenced by his reasons, decreed that none should be admitted into the ministry but such as had a competent knowlege of the Hebrew and Greek text of the Scriptures. Amama died in 1629.



AMAND, Marc Antoine Gerard, Sieur de St, a French poet, was born at Rouen, in Normandy, in 1594. In the epistle dedicatory to the third part of his works, he tells us that his father commanded a squadron of ships in the service of Elizabeth, queen of England, for 22 years, and was for three years a prisoner in the Black Tower at Constantinople. He mentions also that two brothers of his had been killed in an engagement with the Turks. His own life was spent in a continual succession of travels, which proved of no advantage to his fortune. The miscellaneous poems of this author are chiefly of the burlesque and the amorous kind; and though they abound in blemishes, yet his manner of reading them was so agreeable, that they were universally admired. Amand wrote also a very devout piece, entitled *Stances à M. Corneille, sur son Imitation de Jésus Christ*, which was printed at Paris in 1656. He was admitted a member of the French academy when it was first founded by Cardinal Richelieu, in the year 1633; and M. Pellisson informs us that in 1637, at his own desire, he was relieved from the obligation of making a speech, which each member was obliged to make in rotation, on condition that he should collect the burlesque terms, and compile the comic part of the dictionary which the academy had undertaken. For this task he was peculiarly adapted, his writings proving him to be extremely conversant in these terms, which he seems to have diligently collected from the market-places, and other resorts of the populace. He died in 1661.

Amand, *Saint*, a town in France in the department of Cher, capital of the arrondissement of the same name, about 40 miles W.N.W. of Moulins. It is situated on the river Cher. It was built in 1410, on the ruins of Orval. Its principal trade is in cattle, chesnuts, and leather. Population of the town, 7747; of the arrondissement, 103,723. Lat. 46. 40. N. Long. 2. 30. E.

Amand, *Saint*, a town of France, in the department du Nord, on the river Scarpe, about 7 miles N.W. of Valenciennes. It is much frequented for its mud baths, and its mineral and artesian wells. Large quantities of flax are grown in the vicinity. Pop. 9500. Lat. 50. 27. N. Long. 3. 25. E.

AMANTEA, a seaport town and bishop's see of the kingdom of Naples, situated near the bay of Euphemia, in the province of Calabria, 15 miles south-west of Cosenza. Pop. 3000.

AMANUS, a mountain of Syria, separating it from Cilicia; a branch of Mount Taurus (Cicero, Strabo, Pliny), extending chiefly eastward, from the sea of Cilicia to the Euphrates. It is now called *Monte Negro*, or rather *Montagna Neres*, by the inhabitants; that is, the watery mountain, as abounding in springs and rivulets.

AMARA SINHA, a celebrated Sanscrit poet and grammarian, who published a valuable Thesaurus of that language, called *Amara Kosha*. He is believed by some to have flourished in the fifth century of our era. It is stated by Wilson, that his work contains only the *roots* of Sanscrit, amounting to 10,000. The best edition of his work is that of Scrampore, by H. T. Colebrooke, in 1806, reprinted in 1829. See Wilson's *Sanscrit Dict.*, and *Asiat. Res.* vii.

AMARANTE, an order of knighthood instituted in Sweden by Queen Christina in 1653, at the close of an annual feast celebrated in that country called *Wirtschaft*. This feast was solemnized with entertainments, balls, masquerades, and similar diversions, and continued from evening till the next morning. Christina considering the name too vulgar, changed it into that of the *feast of the gods*, because each of the party represented some heathen deity. The queen herself assumed the name of *Amarante;* that is, unfading, or immortal. The young nobility, dressed in the habit of nymphs and shepherds, served the gods at table. At the end of the feast the queen threw off her habit, which was covered with diamonds, leaving it to be pulled in pieces by the maskers; and, in memory of so gallant a feast, founded a military order, called in Swedish *Geschilschafft*, into which all that had been present at the feast were admitted, including sixteen lords and as many ladies, besides the queen. Their device was the cipher of *Amarante*, composed of two A's, the one erect, the other inverted, and interwoven together; the whole enclosed with a laurel crown, with this motto, *Dolce nella memoria*.

AMARANTACEÆ, a natural order of plants, some of which are indigenous with us; but most of them are tropical. None of them are poisonous.

AMARAPURA. See Ummerapura.

AMARYNTHIA, or Amarysia, a festival of Artemis, celebrated with extraordinary splendour at Amarynthus in Eubœa, and afterwards at Athens, and elsewhere.

AMARYLLIDEÆ, a natural order of plants with monopetalous flowers, and bulbous roots, several of which are deadly poisons, as the *Hæmanthus toxicanus* used by the Bosjesmans of the Cape, to poison their arrows. Many of them contain wholesome fecula when the acrid juice is separated from it.

AMASA, son of Abigail, a sister of David king of Israel, and commander of Absalom's army in his rebellion. He afterwards obtained a similar command from his uncle.—(2 Sam. xvii. 25, xix. 13.)

AMASIA, an ancient town of Turkey, in Natolia, and the birthplace of Strabo the geographer. It is the residence of a bashaw, and gives its name to the province where it is situated, which produces the best wines and fruits in Natolia. It is situated near the river Iris or Yeshil-Irmak, and was anciently the residence of the kings of Cappadocia. Long. 36. 26. E. Lat. 40. 33. N.

AMASIS, king of Egypt, ascended the throne B.C. 569. From the rank of a common soldier he gradually rose to be one of the principal officers in the court of Apries. Being commissioned by his prince to pacify some insurgents who had rebelled against the royal authority, he attached the disaffected subjects to his own interest, and took up arms against his master. Apries, apprised of his treachery, sent another of his officers to bring the rebel before him; but this messenger returning with an insolent reply from Amasis, was barbarously mutilated by the tyrannical monarch. The nobles who still remained obedient to their prince, shocked by the barbarity with which he treated his ambassador, immediately joined the standard of the usurper. The tyrant, thus deserted by his subjects, took the field with an army of mercenaries, and meeting Amasis near Memphis, was defeated and taken prisoner. The usurper treated the captive prince with great lenity; but so violent was the popular hatred, that he was compelled to deliver him into the hands of his enraged countrymen, who instantly put him to death by strangling.

Under his prudent administration Egypt enjoyed the greatest prosperity. He adorned it with numerous and splendid buildings, among which were a portico to the temple of Minerva, at Sais, and the great temple of Isis, at Memphis. He also erected a colossus before the temple of Vulcan, 75 feet in length, resting on its back; and on the basis stood two statues, each 20 feet high, cut out of the same stone. Besides these, he erected several monuments in Greece.

The liberality and respect for science which Amasis displayed, and the encouragement he gave to learned strangers, particularly to the Greeks, to visit his country, manifested an enlightened mind. To induce Grecian strangers to remain in Egypt, he marked out settlements for them on the sea-coast, permitting them to build temples, and to observe all the rites of their religion unmolested. Solon, the celebrated lawgiver, is reported to have visited Amasis. Such was his generorsity, that when the temple of the Delphians was burnt, he presented them with 1000 talents to assist them in rebuilding it. To gratify the vanity, or secure the alliance of the Greeks, he married a Grecian lady, named Ladice, the daughter of Battus. The evening of his reign was clouded by the prospect of the invasion of Cambyses, king of Persia, who shortly after subjugated his kingdom. In this emergency Phanes, captain of the Greek auxiliaries in the service of Amasis, being offended at his master, deserted his cause, and went over to the enemy. Polycrates also, tyrant of Samos, who had long been a friend and ally of the Egyptian monarch, now joined the standard of Cambyses. Whether apprehensions of the impending storm tended to impair his health, is not related; but about this time he died, in 525 B.C., after a reign of 44 years.



AMATI, Pasquale, an Italian antiquary, born at Savignano in 1716, the author of several learned works, the best known of which is that—*De Restitutione Purpurarum*.

His two sons were also distinguished: the elder, Girolamo, was the author of several dissertations on inscriptions, and other learned works; and Basilio, the younger son, wrote *L'Isola del Congresso triumvirale*, &c., and some poetry.

AMATUS LUSITANUS, properly João Roderiguez, a learned Hebrew physician of the sixteenth century. Concealing his religion, he studied at Salamanca, and long lived in Italy, where he was called to attend Pope Julius III., about the middle of that century. The fear of the Inquisition drove him to Thessalonica, where he openly professed the Jewish religion. His remarks on Dioscorides show him to have been skilled in Greek and Arabic; and his Latin work on practical medicine contains many curious observations. He was born in Portugal in 1511, and died at Thessalonica (Saloniki) in 1568.

AMAUROSIS, ἀμαὺρωσις, a deprivation of sight, the eye remaining seemingly unaffected. A perfect amaurosis is when the blindness is total. When there is still a power of distinguishing light from darkness, the disease is called by M. de St Ives an *imperfect amaurosis*. There is a periodical sort, which comes on instantaneously, continues for hours or days, and then disappears.

AMAXICHI, a seaport and capital of Santa Maura, one of the Ionian Islands. The town is small and ill built; and the harbour is only fit for small craft. Population 6000. It is the residence of a British governor and of a Greek archbishop.

AMAZIAH, the eighth king of Judah, succeeded his father Joash in the 25th year of his age. At the commencement of his reign he showed some reverence for the Divine authority, but, in the language of Scripture, "not with a perfect heart." He speedily inflicted capital punishment on the murderers of his father; but from respect to the law of Moses he spared their families, an extension of clemency not very common in those times. He gave early proof of his military spirit, by collecting a numerous army to attack the Edomites. This force was composed not only of all his own subjects capable of bearing arms, but of a powerful body of auxiliaries hired from the children of Israel. By the advice of a prophet, however, the Israelites, amounting to 100,000 men, were dismissed, and he prosecuted his enterprise with the remainder of his army. Having engaged the Edomites in the valley of Salt, he defeated them with the loss of 10,000 men, and following up his victory, made himself master of Selah, their metropolis. He also possessed himself of the enemy's idols, and impiously made them the objects of his adoration. Meanwhile the Israelites, whom he had discharged, either offended by their dismissal, Amazon. or disappointed of their hope of plunder, turned their arms against the kingdom of Judah, and plundered many of the cities. Amaziah, elated by his success, sent a hostile challenge to Joash, king of Israel, to which Joash contemptuously replied in a fable. (2 Kings xiv. 9.) Indignant at the insult, Amaziah immediately took the field, and encountering the Israelites at Bethshemesh, was defeated and taken prisoner. After his victory, Joash procceded to Jerusalem, carrying along with him his vanquished enemy; and having broken down part of the wall of the city, and plundered the temple and palace, he returned with the spoil to Samaria. This misfortune seems to have damped the military ardour of Amaziah; for although he reigned 15 years after his defeat, we are not informed of his engaging in any hostility with his neighbours. He fell by the hands of conspirators, in the 29th year of his reign. (2 Kings xiv.; 2 Chron. xxv.)

AMAZON, Maranon, or Orellana, a river of South America, and the largest in the world. Its proper and most remote source is the Ucayale, a branch of which rises near La Paz, in 18° of south latitude. The Marañon, a more northern branch, rises in a lake north-eastward of Lima, and, after a course of many miles to the north, is joined by the Chinchipe at Jaen. From this point, which is only about 200 miles from the Pacific Ocean, the river continues navigable to its embouchure in the Atlantic, a distance of 2100 miles in a direct line, or 3000 miles by the course of the stream. Humboldt measured the height of this spot by the barometer, and found it to be 194 toises, or 1240 English feet; and hence it appears that the fall in the bed of the river is on an average about five inches per mile; but the inclination is of course greater in the upper than in the lower part of the stream. Condamine found the width of the river at some distance below Jaen to be 135 toises, or 860 feet, and the depth to exceed 180 feet. The Marañon is joined by the Ucayale in west longitude 73°, by the Napo at $71\frac{1}{2}$°, by the Japura at 65°. The other most considerable branches are the Negro on the north side, and the Juruay, the Madeira, and the Tapajos, on the south. Many of the tributaries of the Amazon greatly surpass in size the Rhine or the Danube; and their number is very great. It flows through 22° of longitude, near the equator. The country, watered by the river and all its branches, embraces an area of 2,100,000 square English miles, and includes one third part of South America. At a pass called the Pongo, about 140 miles below Jaen, the bed of the stream is suddenly contracted from 250 fathoms to 25, the Amazon having here cut its way through the rocks, which rise like perpendicular walls to a great height. At the junction with the Napo, in longitude $71\frac{1}{2}$°, its breadth is 900 fathoms, and its depth was found to exceed 100 fathoms. Between the Negro and the Madeira it has the breadth of a league, which extends to two leagues at those parts where islands abound; but during the annual swell of the water it covers a great part of the adjoining country, and has then no determinate limits. At Pauxis, 200 miles from the sea, the tides are sensibly felt every ten hours; and Mr Condamine infers, from the time which the swell of the waters requires to travel this distance, that there must be a succession of tides in the river at all times, and that its surface of course presents an undulating line. This traveller computes that the water passes from Jaen to the sea in 45 days, flowing about 66 miles per day, or $2\frac{3}{4}$ miles in the hour. But the influence of the tides is felt 400 miles from the embouchure. In the rainy season the rapidity of this river is four miles an hour; and where it meets the ocean its breadth is fully thirty miles. The sea retreats before this mighty mass of rushing water, which causes a very agitated swell; and the river current is said to be still perceptible at more than 400 miles from the shore. Some reckon the Rio Tunguragua the source of the Marañon, which would give it a course of 3300 English miles; but if we consider the Rio Ucayale as its source, its course cannot be less than 3700 English miles.

Amazons. It receives enormous tributaries,—from the north the Rio Napo and Rio Putumayo, each about 700 miles long; the Yapura, 900 miles; the Rio Negro, 1400;—from the south, the Yavari, the Yutia, the Tefe, the Puru, and above all, the Rio Madeira, that joins the Marañon after a course of 1800 miles; besides the Topayos of 900, and the Xingu of 1000 miles.

It is a remarkable fact that the great South American rivers, the Marañon and Orinoco join, by a large branch, the Rio Cassiquiare. The Amazon traverses a region thickly covered with lofty forests, which are the haunts of the jaguar, bear, panther, and many other wild animals, and are inhabited by numerous small tribes of savages, among whom the Spaniards and Portuguese have established missionaries. The river abounds in fish, many of which are of the most delicious kinds; and turtles of an excellent quality are numerous. Large alligators are seen stretched motionless in the mud, like trunks of trees. Nearly all the branches of this noble stream are navigable to a great distance from their junction with the main trunk; and collectively, the whole afford an extent of water communication unparalleled in any other part of the globe. What adds to this advantage is, that as the wind and the current are always opposed to each other, a vessel can make her way either up or down with great facility, by availing herself of her sails in the one case, and committing herself to the force of the current in the other.

AMAZONS, in *Antiquity*, a nation of female warriors, who are said to have founded an empire in Asia Minor, upon the river Thermodon, along the coasts of the Black Sea. They are reported to have formed a state, out of which men were excluded, their commerce with that sex being confined to strangers. They killed all their male children, and cut off the right breasts of their females, to make them more fit for the combat. From the last circumstance they are supposed to derive their name, viz., from the privative α, and μάζος, *mamma*, breast. But Bryant, in his *Analysis of Ancient Mythology*, vol. iii. p. 463, rejects this account as fabulous; and observes that they were in general Cuthite colonies from Egypt and Syria, who formed settlements in different countries, and that they derived their name from *zon*, the sun, which was the national object of worship.

The Amazons are mentioned by the most ancient of the Greek writers. In the third book of the Iliad, Homer represents Priam speaking of himself as having been present, in the earlier part of his life, in a battle with the Amazons; and some of them afterwards came to the assistance of that prince during the siege of Troy.

The Amazons are particularly mentioned by Herodotus. That historian informs us that the Greeks fought a battle with them on the river Thermodon, and defeated them. After this victory the Greeks carried off in three ships all the Amazons they had taken prisoners. But while they were out at sea, the Amazons conspired against the men, and killed them all. Having, however, no knowledge of navigation, nor any skill in the use of the rudder, sails, or oars, they were driven by wind and tide till they arrived at the precipices of the Lake Mæotis, in the territories of the Scythians. Here the Amazons went ashore, and marching into the country, seized and mounted the first horses they met with, and began to plunder the inhabitants. The Scythians at first conceived them to be men; but after having several skirmishes with them, and taking some prisoners, they discovered them to be woman. They were then unwilling to carry on hostilities against them; and by degrees a number of the young Scythians formed connections with them, and were desirous that these gentle dames should live with them as wives, and be incorporated with the rest of the Scythians. The Amazons agreed to continue their connection with their Scythian husbands, but refused to associate with the rest of the inhabitants of the country, and especially with the women. They afterwards prevailed upon their husbands to retire to Sarmatia, where they settled.

Diodorus Siculus says, "There was formerly a nation who dwelt near the river Thermodon, which was subjected to the government of women, and in which the women, like men, managed all the military affairs. Among these female warriors, it was said, was one who excelled the rest in strength and valour. She assembled together an army of women, whom she trained up in military discipline, and subdued some of the neighbouring nations. Afterwards, having by her valour increased her fame, she led her army against the rest; and being successful, she was so puffed up, that she styled herself the daughter of Mars, and ordered the men to spin wool, and do the work of the women within doors. She also made laws, by which the women were enjoined to go to the wars, and the men to be kept at home in a servile state, and employed in the meanest offices. They also debilitated the arms and thighs of those male children who were born of them, that they might be rendered unfit for war. They seared the right breasts of their girls, that they might be no interruption to them in fighting: whence they derived the name of Amazons. Their queen, having become extremely eminent for skill and knowledge in military affairs, at length built a large city at the mouth of the river Thermodon, and adorned it with a magnificent palace. In her enterprises she adhered strictly to military discipline and good order; and she added to her empire all the adjoining nations, even to the river Tanais. Having performed these exploits, she at last ended her days like a hero, falling in a battle in which she had fought courageously. She was succeeded in the kingdom by her daughter, who imitated the valour of her mother, and in some exploits excelled her."

Diodorus also mentions another race of Amazons who dwelt in Africa, and whom he speaks of as being of greater antiquity than those who lived near the river Thermodon.

Justin represents the Amazonian republic as having taken its rise in Scythia. The Scythians had a great part of Asia under their dominion upwards of 400 years, till they were conquered by Ninus, the founder of the Assyrian empire. After his death, which happened about 1150 years before the Christian era, and that of Semiramis and their son Ninyas, Ilinus and Scolopites, princes of the royal blood of Scythia, were driven from their country by other princes, who like them aspired to the crown. They departed with their wives, children, and friends; and being followed by a great number of young people of both sexes, they passed into Asiatic Sarmatia, beyond Mount Caucasus, where they formed an establishment, supplying themselves with the riches they wanted, by making incursions into the countries bordering on the Euxine Sea. The people of those countries, exasperated by the incursions of their new neighbours, having united, surprised and massacred the men.

The women then resolving to revenge their death, and at the same time to provide for their own security, resolved to form a new kind of government, to choose a queen, enact laws, and maintain themselves without men, even against the men themselves. This design was not so very surprising as at first sight appears: for most of the girls among the Scythians had been inured to the same exercises as the boys; to draw the bow, to throw the javelin, to manage other arms; to riding, hunting, and even the painful labours that seemed reserved for men; and many of them among the Sarmatians accompanied the men in war. No sooner had they formed their resolution than they prepared to execute it, and exercised themselves in all military operations. They soon secured the peaceable possession of the country; and, not content with showing their neighbours that all their efforts to drive them thence or subdue them were ineffectual, they made war upon them, and extended their own frontiers. They had hitherto made use of the instructions and assistance of a few men that remained in the country; but finding at length that they could stand their ground and aggrandize themselves without them, they killed all those whom flight or chance had saved from the fury of the Sarmatians, and for ever renounced marriage, which they now considered as an insupportable slavery. But as they could only secure the duration of their new kingdom by propagation, they made a law to go every year to the frontiers, to invite the men to come to them; to deliver themselves up to their embraces, without choice on their part, or the least attachment; and to leave them as soon as they were pregnant. Those whom age rendered fit for propagation, and who were willing to serve the state by breeding girls, did not all go at the same time in search of men: for in order to obtain a right to promote the multiplication of the species, they must first have contributed to its destruction; nor was any one thought worthy of giving birth to children till she had killed three men.

If from this commerce they brought forth girls, they educated them; but, with respect to the boys, if we may believe Justin, they strangled them at the moment of their birth.

Plutarch, treating of the Amazons in his life of Theseus, considers the accounts which have been preserved concerning them as partly fabulous and partly true. He gives some account of a battle which had been fought between the Athenians and the Amazons at Athens; and he relates some particulars of this battle which had been recorded by an ancient writer named Clidemus. In another place he says, "It appears that the passage of the Amazons through Thessaly was not without opposition; for there are yet to be seen many of their sepulchres near Scottussa and Cynocephalæ;" and in his life of Pompey, speaking of the Amazons, Plutarch says, "They inhabit those parts of Mount Caucasus that look towards the Hyrcanian Sea, not bordering upon the Albanians, for Gelæ and Leges lie between; and with these people do they yearly, for two months only, accompany and cohabit, bed and board, near the river Thermodon. After that they retire to their own habitations, and live alone all the rest of the year."

Quintus Curtius has given a circumstantial account of the visit of the Queen of the Amazons to Alexander the Great.

Justin also repeatedly mentions this visit of Thalestris to Alexander; and in one place he says that she made a march of 25 days in order to obtain this meeting with him. The interview is likewise mentioned by Diodorus Siculus.

The Amazons are represented as being armed with bows and arrows, with javelins, and also with an axe of a particular construction, which was denominated the axe of the Amazons. According to the elder Pliny, this axe was invented by Penthesilea, one of their queens. On many ancient medals are representations of the Amazons armed with these axes. They are also said to have had bucklers in the shape of a half-moon.

That at any period there should have been women who, without the assistance of men, built cities and governed them, raised armies and commanded them, administered public affairs, and extended their dominions by arms, is undoubtedly so contrary to all that we have seen and known of human affairs, as to appear in a very great degree incredible; but that women may have existed sufficiently robust and sufficiently courageous to have engaged in warlike enterprises, and even to have been successful in them, is certainly not impossible, however contrary to the usual course of things. That much of what is said of the Amazons is fabulous, there can be no reasonable doubt; but it does not therefore follow that the whole is without foundation. The ancient medals and monuments on which they are represented are very numerous, as are also the testimonies of ancient writers. It seems not rational to suppose that all this originated in fiction, though it be much blended with it. We now know that in the Negro kingdom of Dahomey the present ruler of that country, who humbled the power of the Ashantees, has among his choicest troops battalions of women, who are as fearless and redoubtable as the ancient Amazons.

AMBACHT is a word which denotes a kind of jurisdiction or territory, the possessor whereof has the administration of justice, both in *alto* and *basso;* or of what is called in the Scottish law, *a power of pit and gallows*, i. e., a power of drowning and hanging. In some ancient writers, ambacht is particularly used for the jurisdiction, government, or chief magistracy of a city. The word is very ancient, though used originally in a sense somewhat different. Ennius calls a mercenary, or slave hired for money, *ambactus;* and Cæsar gives the same appellation to a kind of dependents among the Gauls, who, without being slaves, were attached to the service of great lords.

AMBARVALIA, in *Antiquity*, an annual ceremony among the Romans, on the Ides of May, when, in order to procure from the gods a happy harvest, they conducted the victims thrice round the corn-fields in procession before sacrificing them. *Ambarvalia* were either of a private or public nature: the private were performed by the master of a family, and the public by the priests, called *fratres arvales*, who officiated at the solemnity. The prayer preferred on this occasion, the formula of which we have in Cato, *de Re Rustica*, cap. cxlii. was called *carmen ambarvale.* At these feasts they sacrificed to Ceres a sow, a sheep, and a bull or heifer; whence they took the name of *suovetaurilia.* The method of celebrating them was, to lead a victim round the fields, while the peasants accompanied it, and one of their number, crowned with oak, hymned forth the praises of Ceres in verses composed for the occasion. The processions and ceremonies of *Rogation*, or *Gang-week* of the Latin Church, bore a great resemblance to the ancient ambarvalia. Since the Reformation the perambulation of the parish boundaries has been substituted in their place.

AMBASSADOR, a word of disputed origin, but probably adopted into the English language from the French, means, in its general sense, a minister authorised by any state to represent it in some other. In its distinctive sense, as indicating a particular kind of minister so appointed, it means the highest class; and by authority as well as practice, there are states which may be represented at others, yet are understood not to be entitled to appoint so high a representative as an ambassador. Messages require to be interchanged by all moderately civilised nations, unless those which, like the Chinese or the Japanese, peculiarly isolate themselves. Hence such messages, and the manner in which they were sent and received, are familiar occurrences in all histories. Some understanding that the persons who undertook such a function should enjoy freedom and safety in the state to which they were sent was absolutely necessary for its performance. The Romans adopted strict rules for the safety of ambassadors; but the less definite provisions of other nations were liable to be affected by momentary impulses, and many incidents of ancient warfare arose out of insults or injuries committed on ambassadors. It was on the ground of an insult offered to his ambassadors that Alexander destroyed Tyre. The Persian invasions of Greece were stimulated by the slaughter of the ambassadors of Darius—who, however, demanding earth and water as tokens of dependence, were rather messengers of hostility than ambassadors, in anything like the modern sense of the term. Ambassadors now communicate privately with sovereigns or official persons, not with legislative bodies. In Greece, however, ambassadors sometimes pleaded the cause of their state in the public assemblies, and in Rome they were formally received by the senate. The *legatus* of the Romans answered pretty nearly to our Ambassador Extraordinary; but the term was also used to mean another and totally different officer who accompanied the proconsul or governor of a province, and was more like a colonial secretary. It became the practice to give honorary legations of this kind on account of the privileges which they conferred on the holder in the province to which he was accredited. There is, however, a distinction of a generic and very characteristic kind between the ambassador of modern diplomacy and any ancient representatives of states. The ambassador of old was chosen for a particular message or negotiation, and a permanent resident representative of one state within another was unknown, at least as a system. It is not yet intelligible to nations beyond the circle of European diplomacy. The Turks had the inveterate practice, on going to war with a state, of committing its representative to the seven towers; and though the reason assigned for the practice was the safety of the person of the ambassador from outrage, even this, if it were sincere, showed that the feelings of hatred indulged against a member of a hostile state would break out too strongly to be controlled even by that despotic government. The Chinese, and their neighbours nearer Hindustan, can look on an ambassador or diplomatic agent as merely a dignified spy, to whose presence nothing but necessity compels them to submit. Nor are they entirely wrong, since the European embassies may be counted a mutually tolerated system of espionage. Even Wickefort calls the ambassador an honourable spy, protected by the law of nations; and La Bruyere says epigramatically, that the ambassador's function is to cheat without being cheated. The understanding that an ambassador was a person ever ready to do whatever he could with safety to the advantage of his own country, and the injury of that to which he was accredited, became a standing object of sarcasm with the wits of the seventeenth century. Sir Henry Wotton, himself an ambassador, when asked to write something in an album at Augsburg, could not resist a sarcasm on the same subject, and spoke of an ambassador as a person sent abroad to lie for the good of his country. In its English form, his apophthegm generally involves a pun or equivoke in the words "lie abroad," of which the original Latin is, however, not susceptible. Scioppius published it as a declaration of the morality of English diplomacy, and brought Wotton under temporary disgrace with King James; to whom the jest seemed the more dangerous that it announced that false and treacherous system of diplomacy on which he with most of the sovereigns of the age acted when it was safe to do so.

Permanent embassies, with the eminent personal privileges conceded to ambassadors, have existed in feudal Europe from an early time. To find the origin of an institution seemingly so much at variance with the selfish and ravenous national habits amidst which it arose, we must look to the peculiar sacredness claimed for their persons by the great community of European monarchs. The privileges of the ambassador did not arise from principles of jurisprudence founded on general public utility, but from the practice of the sovereign investing his representative with his own sacredness, and the acknowledgment on the part of the brother sovereign of the

Ambassador.

sufficiency of the investiture. Thus in ages when international law was rude and little respected, ambassadors claimed privileges which would in the present day be deemed preposterous; such total exemption from liability to the laws, civil or criminal, of the country to which they were accredited, and the right to have their official places of residence respected, as sanctuaries for criminals fleeing from justice. Ambassadors of old, in fact, thus received concessions which, though claimed by them as belonging properly to their masters as sovereign princes, and descending to themselves only as substitutes, would not practically have been enjoyed by sovereign princes though theoretically conceded to them. The advantage obtained over a state by seizing the person of the sovereign, would have rendered it unsafe for the principal to trust to privileges which, in the less available person of his representative, were scrupulously respected.

From this fictitious royalty came many of the practical peculiarities of the embassies of the present day. The qualification of "Excellency" applied to ambassadors is a communication from the titles of sovereign princes. They have the right of appearing covered before sovereigns in their formal audiences—a right not actually exercised, but still symbolically acknowledged. The ambassador's immunities extend to the persons brought in his train, not as participating in his fictitious sovereignty, but as his subjects who are exempt from the authority of the state to which he is accredited, and responsible solely to him as their local and temporary sovereign. Thus, by the "exterritoriality," as it has been termed, of an embassy, the persons of the ambassador and his suite, his dwelling-house and his carriages were all deemed a part of his own nation, as inviolable by diplomatic understanding as the court of his sovereign was by distance and armed protection. The most prominent relic at the present day of this fictitious royalty, is the splendour and costliness of the embassies of the great powers —qualifications in which the United States of America, not having the same traditional dignity to support, have had the good sense not to compete with them.

As the theory, indeed, of the ambassador's rank and privileges were that he represented, not the state or people from whom he came, but the king, a disposition has often been shown to deny at least the higher privileges of embassy to republics. Until Cromwell's power commanded respect, the representatives of the English Commonwealth were treated with much indignity, and two of them were slain by royalist refugees—Dorislaus in Holland, and Ascham in Spain. In 1663 the court of Louis XIV. haughtily refused to concede the usual honours to the representatives of the Swiss cantons. It is not the practice of the United States to profess to accredit ambassadors of the highest diplomatic grade, nor does their condition in European diplomacy fortunately tempt them to transgress this prudent rule. On the other hand, it is not usual to accredit the highest class of ambassadors to that frugal government; though, for the adjustment of the late difficulties about the Oregon boundary, Lord Ashburton was commissioned with high and peculiar power to negotiate with the States. It is curious to find in the article *Ambassadeur* in the *Encyclopédie Moderne*, written between the fall of Louis Philippe and the re-establishment of the empire by Louis Napoleon, complaints of the still extant humiliations to which republican ambassadors are liable.

The privileges conceded to the fictitious sovereignty of the ambassador, like many other institutions of a like barbarous origin, have been directed in the progress of civilisation to serviceable ends. That the representative should be able to keep himself from being in any way involved in the social or political movements of the state to which he is accredited, is an unquestionable advantage. The exterritoriality has been found serviceable in adjusting many difficulties in international law; that which is done under the auspices of the ambassador, as a marriage in his chapel, being deemed the same in law as if it had taken place in his country. Thus in very intolerant countries an embassy has often acted as a little centre of toleration, which governments, prevented by high priestly influences from avowedly acting on liberal principles, have been glad rather to cherish than discourage.

It has always been difficult in countries not despotic to preserve the sacredness of embassies when circumstances have made them offensive to the people. Thus it was difficult to keep Gundomar the celebrated Spanish ambassador in James the First's reign from violence by the London mob for introducing sedan-chairs, which they called a device for enslaving Englishmen and making them do the work of beasts. In the anti-Popery riots of 1780 the chapels of the Bavarian and Sardinian embassies were burned. It has ever been usual to exact high satisfaction for injuries offered to ambassadors, and despotic courts have had no difficulty in conceding the demand where this was rendered prudent by the power of the offended party. Diplomatic difficulties of a serious kind have often occurred, however, in constitutional countries where the asserted privileges of the foreign ambassador were found to clash with the undoubted rights of the home citizen. In 1668 the Portuguese minister was imprisoned for debt in Holland, and in 1708 a similar event produced a serious diplomatic difficulty in England. The Russian ambassador, having had his audience of leave, was arrested for debt by some tradesmen in the open streets of London. Deeming that he was attacked by bravos, he defended himself, and was not secured without suffering much violence and indignity. The Czar immediately demanded the infliction of capital punishment on those who had been guilty of the outrage. Much parade was made about instituting prosecutions against all the parties concerned in the affair; but it was impossible for the government ultimately to treat it otherwise than as a matter for which unfortunately the law made no provision. All that could be done was to pass an act to remedy the defect; and to sooth the Czar its preamble denounced in very angry terms the unparalleled wickedness of those turbulent and disorderly persons who had outrageously insulted the person of his excellency the ambassador-extraordinary of his Czarish majesty, emperor of Great Russia, to whom a copy of the act was sent with distinguished pomp. The diplomatic body in general, discontented with the haughty tone of the English court, took up the question. When the bill was passing they objected to some parts of it, and particularly to a condition of the protection of ambassadors' retinues, that their names should be recorded with the Secretary of State and the sheriffs of London; but parliament, then exulting in the continental triumphs of Marlborough, received their demands with haughty silence.

It happened almost at the same time that the British government had shown a memorable instance of the sternness with which it insisted on preserving the inviolability of its own ambassadors. When the Earl of Manchester was ambassador at Venice in 1708, some persons had managed, under the protection of his diplomatic privileges, to attempt smuggling operations, and in the efforts to detect them, the Earl's gondola was seized with smuggled goods in it. In such matters the British government has generally acted on the knowledge that in despotic states the government can prevent or cause all such incidents. In this instance, there were high state-reasons for demanding satisfaction, since there was reason to suppose that the Senate was secretly in league with France, then projecting an invasion of

Britain; and Lord Manchester would not be appeased until three official persons were sent to the galleys and others pilloried. In 1716, Britain again excited the indignation of the diplomatic circle by the seizure of the Swedish representative and his correspondence. His residence was suddenly surrounded by a party of soldiers, and his confidential papers—some of which his wife was concealing—were appropriated. The question whether such an act was consistent with the law of nations, was pretty effectually answered in the particular occasion, by an exposure of the resident's flagitious breach of this law, in employing his opportunities as ambassador to foster treason and make arrangements for an invasion of the country to which he was accredited.

The rank of ambassadors is regulated by a double gradation—the importance of the object of the mission, and the rank of the court they represent. It has always been the object of governments rising in power, like that of Prussia under the great Frederic, to obtain some step in diplomatic rank, while old states have resisted the demand and endeavoured in other ways to hold their previous relative position. Ambassadors have, from incidental circumstances, been admitted to a representative rank in some courts, which has been denied to them in others. Thus the representatives of the knights of Malta were in the middle of the eighteenth century received as ambassadors of the highest order at the courts of Rome and Vienna.

The various sources of distinction, founded on the title given to the ambassador, the rank of the state sending, that of the state receiving, and sometimes the social rank of the ambassador himself, make an almost insoluble complexity of positions, which have exercised the ingenuity of the writers on diplomacy. But the complexity has this advantage, that when there is an earnest wish to transact business, means are found for evading questions of etiquette. The great resource of those states whose right to send a minister of the highest order is disputed, is to transact their business through a minister of a secondary class; for as the class may depend as much on the rank of the court sent to as that of the court accrediting, direct assumptions or humiliations are thus avoided.

It has been usual since the Congress of Vienna to divide representatives into three great classes—ambassadors, envoys, and residents or *charges des affaires*. The first and second are accredited from the head of the government, and communicate with the head; the third class have instructions from the foreign department of their own government, and communicate with that of the state they are sent to. The term Ambassador-Extraordinary having been applied to those sent on temporary missions of high importance, the term extraordinary came to be extended to the permanent ambassadors at the courts of the great powers, as it was deemed desirable that no diplomatic rank should be deemed higher than theirs. There are at present (1853) accredited from Britain, ambassadors-plenipotentiary at the courts of France and Turkey. To Austria, Prussia, Russia, Spain, Denmark, Sweden, Hanover, Sicily, the Netherlands, Belgium, Sardinia, the United States, and Brazil, there are envoys extraordinary. In smaller states our representatives are called ministers plenipotentiary, or *charges des affaires;* and in some states, many of them important in trade, though not in diplomacy, as China, a consulate is deemed sufficient. The ceremonial system connected with embassies has naturally ceased to retain its old importance of late years, a portion of it only being preserved by routine, but it is still usual to gratify oriental courts by receiving their representatives with noisy pomp. The manner in which an ambassador's conduct must be regulated by the relative condition to each other of the states between which he acts, belongs to the subject of diplomacy. The ambassador has occupied a large place in the treatises on diplomacy and international law from Grotius downwards, and Wickefort devoted two considerable quarto volumes to *L'Ambassadeur et ses Fonctions*. See Diplomacy, International Law.

Ambassador.

We subjoin the official return of the allowances of the ambassadors, envoys, ministers, chargés d'affaires, secretaries of legation, or secretaries of embassy, and paid attachés, in the diplomatic service of Britain.

| | |
|---|---|
| *France.* | |
| Ambassador | L.8000 |
| Secretary of Embassy | 1000 |
| First paid Attaché | 400 |
| Second ditto | 300 |
| *Turkey.* | |
| Ambassador | 7000 |
| Secretary of Embassy | 800 |
| Oriental Secretary | 500 |
| First paid Attaché | 300 |
| Second ditto | 250 |
| Third ditto | 250 |
| Fourth ditto | 250 |
| Fifth ditto | 250 |
| Sixth ditto | 250 |
| *Russia.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 6700 |
| Secretary of Legation | 900 |
| First paid Attaché | 400 |
| Second ditto | 300 |
| *Austria.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 6400 |
| Secretary of Legation | 600 |
| First paid Attaché | 350 |
| Second ditto | 250 |
| *Spain.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 5400 |
| Secretary of Legation | 550 |
| Paid Attaché | 250 |
| *Prussia.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 5500 |
| Secretary of Legation | 550 |
| Paid Attaché | 250 |
| *United States.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 5000 |
| Secretary of Legation | 800 |
| Paid Attaché | 200 |
| *Two Sicilies.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4400 |
| Secretary of Legation | 500 |
| Paid Attaché | 250 |
| *Portugal.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4400 |
| Secretary of Legation | 500 |
| Paid Attaché | 250 |
| *Brazil.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4500 |
| Secretary of Legation | 550 |
| Paid Attaché | 250 |
| *Netherlands.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4000 |
| Secretary of Legation | 500 |
| Paid Attaché | 250 |
| *Belgium.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4000 |
| Secretary of Legation | 750 |
| Paid Attaché | 250 |
| *Sardinia.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4100 |
| Secretary of Legation | 500 |
| Paid Attaché | 250 |
| *Bavaria.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4000 |
| Secretary of Legation | 500 |
| *Denmark.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 4000 |
| Secretary of Legation | 500 |

| | |
|---|---|
| *Sweden.* | |
| Envoy Extraordinary and Minister Plenipotentiary | L.3400 |
| Secretary of Legation | 500 |
| *Hanover.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 3400 |
| Secretary of Legation | 750 |
| *Frankfort.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 2900 |
| Secretary of Legation | 400 |
| Paid Attaché | 250 |
| *Greece.* | |
| Minister Plenipotentiary | 2800 |
| Secretary of Legation | 400 |
| Paid Attaché | 250 |
| *Wurtemberg.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 2300 |
| Secretary of Legation | 500 |
| Paid Attaché | 250 |
| *Saxony.* | |
| Minister Plenipotentiary | 2300 |
| Secretary of Legation | 850 |
| *Tuscany.* | |
| Envoy Extraordinary and Minister Plenipotentiary | 2300 |
| Secretary of Legation | 400 |
| Paid Attaché | 500 |
| *Switzerland.* | |
| Minister Plenipotentiary | 2250 |
| Secretary of Legation | 400 |
| *Mexico.* | |
| Minister Plenipotentiary | 4000 |
| Secretary of Legation | 600 |
| Paid Attaché | 200 |
| *Bolivia.* | |
| Chargé d'Affaires | 365 |
| *Buenos Ayres.* | |
| Chargé d'Affaires | 365 |
| *Chili.* | |
| Chargé d'Affaires | 365 |
| *Monte Video.* | |
| Chargé d'Affaires | 365 |
| *New Granada.* | |
| Chargé d'Affaires | 365 |
| *Peru.* | |
| Chargé d'Affaires | 365 |
| *Venezuela.* | |
| Chargé d'Affaires | 365 |
| *Persia.*[1] | |
| Envoy Extraordinary and Minister Plenipotentiary | 5000 |
| Secretary of Legation | 750 |
| First part Attaché | 460 |
| Second ditto | 300 |
| Third ditto | 200 |

(J. H. B.)

AMBE, in *Surgery*, the name of an instrument formerly used for reducing dislocated bones; in *Anatomy*, a term for the superficial jutting out of a bone.

AMBER. *Bernstein*, Germ.; *Succin, carabé, ambre jaune*, Fr.; *Electrum, succinum*, Lat.; *Yellow mineral resin*, Haidinger.

This substance has been in repute from the earliest times, and, in consequence of certain properties it possesses, gave rise to many romantic and fabulous stories. According to the poets, when the sisters of Phaethon were lamenting his fate, their tears, instead of mixing with the waters of the Po, into which he had been precipitated by the thunder of the incensed Jupiter, consolidated, and were transformed into amber, on which the ancients set such an immense value. Sophocles, too, according to Pliny, hesitates not to avouch that beyond India it proceeds from the tears that fall from the eyes of the birds Meleagrides wailing and weeping the death of Meleager. Again, the electricity of this substance, which was long observed before it could possibly be understood, was another source of surprise and conjecture, and induced individuals to believe that amber was possessed of some living principle; and Thales went so far as to imagine it had a soul, and even Pliny appears to have entered into the same idea. This property, which has subsequently been discovered in a multitude of other bodies, gave rise to the science of electricity,—a denomination derived from the Greek ελεκτρον, by which name amber was known to the ancients. The Arabian name Karabé, meaning *attract-chaff*, is also very significant of this property. We thus find that a bit of amber was the first electric machine ever put in use. Little, however, did Pliny and the philosophers of his days, when debating on the tears of the sisters of Phaethon, or of the birds that wept the fate of Meleager, dream of the researches of their successors, or of the effects to be produced by the multiplication and concentration of the power originally discovered in a bit of amber.

It was not surprising that a substance so prized and so valuable should be found to possess many important medicinal qualities. It is to be suspected, however, that, taken *per se*, the virtues it possesses may be summed up in what Pliny states, viz., "True it is, that a collar of amber beads worn about the necks of young infants, is a singular preservative to them against secret poison, and a countercharm for witchcraft and sorceries." The same feelings may probably have handed down even to our own time the superstitious veneration with which the necklace of *lammer beads* has always been held among the lower classes of our own countrywomen, whose necks may still be seen ornamented with this esteemed heirloom, while their backs are supporting a load of fish or of salt to the market.

The use of amber in medicine might now be considered as *nil*, were it not that chemists have succeeded in extracting from it, by distillation, a liquid of a very pungent smell, which is a good antispasmodic, but now little used. The oil of amber entered into the composition of the syrup of karabé, in the older pharmacopœias.

As a matter of course, the origin of amber was also wrapt in mystery, but for this there seems to be no longer occasion; with very few exceptions, it seems always to occur in beds of bituminous wood. "Near the sea-coast in Prussia there are regular mines for the working of amber: under a stratum of sand and clay, about 20 feet thick, a stratum of bituminous wood occurs, from 40 to 50 feet thick, of a blackish brown colour, and impregnated with pyrites. Parts of these trees are impregnated with amber, which sometimes is found in stalactites depending from them. Under the stratum of trees were found pyrites, sulphate of iron, and coarse sand, in which were rounded masses of amber. The mine is worked to the depth of 100 feet; and, from the circumstances under which the amber is found, it seems plain that it originates from vegetable juices." (*Phillips.*) The next unequivocal example of this being the fact as to the origin of amber occurs in the brown coal of Hasen Island in Greenland. Here it presents itself usually in very small specks; but these are often of a highly brilliant transparent character. Similar repositories are found in France, at St Paulet, department du Gard; at Coboalles, in the province of the Asturias in Spain; and in Saxony. Nowhere, however, does amber occur so abundantly as on the Prussian coasts of the Baltic, between Köningsberg and Memel.

[1] The salaries of the mission in Persia are not charged upon the Consolidated Fund, but are paid out of the sum of L.12,000, which is received annually by the Treasury from the East India Company towards defraying the general expenditure of the diplomatic service in Persia.

The bed of coal which we have described above seems to extend under the sea; and, subsequent to every heavy storm, a large quantity of amber is sure to be found on the coast. It is secured by fishermen by means of nets, and being the property of the crown, is delivered to the proper officers at a certain rate. It is said that the revenue derived from this sometimes amounts to 16,000 or 17,000 dollars. This has been the great source of supply to the whole of Europe from the earliest times.

Besides these sources, amber is found in other situations removed from all apparent connection with vegetable origin. In the neighbourhood of Paris it occurs in small grains in the plastic clay; it likewise occurs at Aix in Provence, disposed in clay; and it has often been found among the gravel in the neighbourhood of London. The coasts of Sicily and the Adriatic likewise afford amber. The most beautiful specimens are perhaps those which are found at Catania. They often possess a beautiful play of colour, approaching to purple, not to be observed in the product of other places.

The predominant colour of amber is yellow, generally of a pale straw colour; but it passes into honey yellow and yellowish white. Occasionally it is perfectly transparent, and in this state it is in the greatest esteem for work.

It has been said that individuals had invented the means of rendering opaque and dark-coloured amber transparent, and of even communicating peculiar colours; but these processes have perished with the inventors. It is said, that by exposing opaque amber, covered with sand, in an iron pot, to a gentle heat for forty hours, or by boiling it for twenty hours in rapeseed oil, it will become transparent; but in either case it loses its electric qualities.

In mineralogical cabinets amber is placed among the inflammable substances. It occurs in irregular and spheroidal masses, with a rough uneven surface. It presents no natural cleavage; its fracture is conchoidal; its lustre is resinous, and the streak white.

It is brittle, and its hardness varies from 2·0 to 2·5; specific gravity 1·078 to 1·081; and, when rubbed, acquires a strong negative electrical virtue. According to the analysis of Drapier it consists of

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| Carbon | 80·59 | Lime | 1·54 |
| Hydrogene | 7·31 | Alumina | 1·10 |
| Oxygene | 6·73 | Silica | 0·63 |

These three earthy ingredients seem to be accidental; for Schrötter found in it only carbon, 78·82; hydrogene, 10·23; oxygene, 10·95; equivalent to $C^{10}\ H^{8}\ O$.

It burns with a pale yellow flame, with a good deal of black smoke, and evolves an agreeable odour, leaving a carbonaceous residue. It is cut into various ornaments and works of art, and is a favourite article for the construction of mouthpieces to smoking apparatus.

One of the most singular peculiarities in the history of amber, is the circumstance of its very often containing insects and even reptiles enclosed within it. The high prices which such rarities commanded set the ingenious to work to imitate and forge specimens to all appearance genuine; which has cast so much discredit upon the fact itself, that all specimens of this description are now viewed with jealousy and suspicion. That, however, being admitted, there can be no doubt whatever that such objects are actually found in amber, and sometimes present appearances which it would be extremely difficult if at all possible to imitate. Of those insects which have been orginally inclosed in amber, some are plainly seen to have struggled hard for their liberty, and even to have left their limbs behind them in the attempt; it being no unusual thing to see, in a mass of amber that contains a stout beetle, the animal wanting one, or perhaps two of its legs, and those legs left in different places, nearer that part of the mass from which it has travelled. This also may account for the common accident of finding legs or wings of flies, without the rest of their bodies, in pieces of amber; the insects having, when entangled in the yet soft and viscid matter, escaped at the expense of leaving those limbs behind them. Drops of clear water are sometimes also preserved in amber. These have doubtless been received into it while soft, and preserved by its hardening round them. Beautiful leaves of a pinnated structure, resembling some of the ferns or maidenhairs, have been found in some pieces; but these are rare, and the specimens of great value. Mineral substances are also found at times lodged in masses of amber. Some of the pompous collections of the German princes boast of specimens of native gold and silver in masses of amber; but as there are many substances, as sulphurets of metals, and mica, that have all the glittering appearance of gold and silver, it is not to be too hastily concluded that these metals are really lodged in these beds of amber. The most celebrated manufactures of amber are, in Prussia, at Köningsberg and Dantzic; in Sicily, at Catania and Tripani; at Leghorn; and at Constantinople.



The value of amber depends upon its colour, its lustre, and its size. In 1576 a mass weighing 11 pounds was found in Prussia, and deemed worthy of being presented to the emperor; latterly a mass of 13 pounds was found, for which 5000 dollars were said to be refused. Such masses are of very great rarity. The principal demand for the amber of commerce is among the Armenians, through whom it is conveyed to Egypt, Persia, China, and Japan; and a great quantity is purchased to be consumed at the shrine of Mahomet, by the pilgrims bound to Mecca.

*Amber Tree*, the English name of a species of Anthospermum.

AMBERG, a walled town of Bavaria, in the circle of the Upper Palatinate, and capital of a bailiwick of the same name. It is situated on the river Vils, on the road between Ratisbon and Bayreuth, and 26 miles east of Nuremburg. It was formerly the capital of the circle of Upper Palatinate, and at present is the seat of its appeal court. It has a castle, an arsenal, eight churches (of which St Martin's has many beautiful paintings and monuments), a Franciscan cloister, a theatre, elementary and advanced schools, and several manufactories, including a royal manufactory of arms. In its vicinity is an extensive iron mine, and a chapel of the Virgin Mary, much resorted to by pilgrims. Pop. in 1846, 10,225. Lat. 49. 26. 52. N. Long. 11. 47. 27. E. The bailiwick has an area of 288 square miles, or 184,320 acres.

Amberg, a lofty mountain of East Gothland, in Sweden. On this mountain, near the Wetter lake, antimony has been found. On its top is the burying-place of one of the ancient kings of the country. The spot is marked by a flat stone.

AMBERGER, Christopher, a German painter, born at Amberg, who obtained reputation chiefly by his portraits, carefully finished in the style of Holbein. His historical pieces are small, hard, and dry, and are chiefly to be seen in his native place. He died in 1568, about 78 years of age.

AMBERGRIS, or Gray Amber, is a solid, opaque, ash-coloured, fatty, inflammable substance, variegated like marble, remarkably light, rugged, and uneven in its surface, and of a fragrant odour when heated. It does not effervesce with acids; it melts freely over the fire into a kind of yellow rosin; and is hardly soluble in spirits of wine.

Ambergris is found swimming upon the sea, on the sea-coast, or in the sand near the sea-coast; especially in the Atlantic Ocean, on the sea-coast of Brazil, and that of Madagascar; on the coasts of Africa, of the East Indies, China, Japan, and the Molucca Islands; but most of the ambergris which is brought to England comes from the Bahama Islands, from Providence, &c., where it is found on the

Ambergris.

coast. It is also sometimes found in the abdomen of whales by the whale-fishermen, always in lumps of various shapes and sizes, weighing from half an ounce to a hundred and more pounds. The piece which the Dutch East India Company bought from the king of Tydore weighed 182 pounds. An American fisherman from Antigua found, inside a whale, about fifty-two leagues south-east from the Windward Islands, a piece of ambergris which weighed about 130 pounds, and sold for L.500 sterling.

The most satisfactory account of the real origin of ambergris is that given by Dr Swediaur, in the 73d volume of the *Philosophical Transactions.*

We are told by writers on ambergris, that sometimes claws and beaks of birds, feathers of birds, parts of vegetables, shells, fish, and bones of fish, are found in the middle of it, or variously mixed with it. Of a very considerable number of pieces, however, which Dr Swediaur examined, he found nonc that contained any such thing; though he allows that such substances may sometimes be found in it; but in all the pieces of any great size, whether found on the sea or in the whale, he always found a considerable number of black spots, which, after the most careful examination, appeared to be the beaks of the *Sepia Octopodia;* and these beaks, he thinks, might be the substances which have hitherto been always mistaken for claws or beaks of birds or shells. The presence of these beaks in ambergris proves evidently that all ambergris containing them is in its origin, or must once have been, of a very soft or liquid nature; as otherwise those beaks could not so constantly be intermixed with it throughout its whole substance.

That ambergris is found either upon the sea and sea-coast, or in the bowels of whales, is a fact universally credited. It is, however, of consequence to know whether ambergris is found in all kinds of whales, or only in a particular species of them; whether it is uniformly to be met with in those animals; and if so, in what part of their body it is to be found.

All these questions we find very fully discussed by Dr Swediaur. According to the best information that he could obtain from several of the most intelligent persons employed in the spermaceti whale-fishery, and in procuring and selling ambergris, it appears that this substance is sometimes found in the belly of the whale, but in that particular species only which is called the *spermaceti whale*, and which, from its description and delineation, appears to be the *Physeter macrocephalus* of Linnæus.

The persons who are employed in the spermaceti whale-fishery confine their views to the *physeter macrocephalus.* They look for ambergris in all the spermaceti whales they catch, but it seldom happens that they find any. Whenever they harpoon a spermaceti whale, they observe that it constantly not only vomits up whatever it has in its stomach, but also generally discharges its fæces at the same time; and if this latter circumstance takes place, they are commonly disappointed in finding ambergris in its belly. But whenever they discover a spermaceti whale, male or female, whieh seems torpid and sickly, they are always pretty sure to find ambergris, as the whale in this state seldom voids its fæces upon being harpooned. They likewise generally meet with it in the dead spermaceti whales, which they sometimes find floating on the sea. It is observed also, that the whale in which they find ambergris often has a morbid protuberance, or, as they express it, a kind of gathering in the lower part of its belly, in which, if cut open, ambergris is found. It is remarkable that all those whales in whose bowels ambergris is found, seem not only torpid and sick, but are also constantly leaner than others; so that, if we may judge from the constant union of these two circumstances, it would seem that a larger collection of ambergris in the belly of the whale is a product of disease, and probably sometimes the cause of its death. As soon as they harpoon a whale of this description, torpid, sickly, emaciated, or one that does not void on being harpooned, they immediately either cut up the above-mentioned protuberance, if there be any, or they rip open its bowels from the orifice of the anus, and find the ambergris sometimes in one, sometimes in several lumps, of generally from three to twelve and more inches in diameter, and from one pound to twenty or thirty pounds in weight, at the distance of two, but most frequently of about six or seven feet from the anus, and never higher up in the intestinal canal, which, according to their description, is in all probability the intestinum cæcum, hitherto mistaken for a peculiar bag made by nature for the secretion and collection of this singular substance. That the part cut open to come at the ambergris is no other than the intestinal canal is certain, because they constantly begin their incision at the anus, and find the cavity everywhere filled with the fæces of the whale, which, from their colour and smell, it is impossible to mistake. The ambergris found in the intestinal canal is not so hard as that which is found on the sea or sea-coast, but soon grows hard in the air. When first taken out it has nearly the same colour, and the same disagreeable smell, though not so strong, as the more liquid fæces of the whale; but on exposing it to the air, it grows by degrees not only grayish, having its surface covered with a grayish dust like old chocolate, but it also loses its disagreeable smell, and, when kept for a certain length of time, acquires the peculiar odour which is so agreeable to most people.

In considering whether there be any material difference between the ambergris found upon the sea or sea-coast and that found in the bowels or among the fæces of the whale, Swediaur refutes the opinion that all ambergris found in whales is of an inferior quality, and therefore much lower in price. Ambergris, he observes, is only valued for its purity, lightness, compactness, colour, and smell. There are pieces of ambergris found on different coasts, which are of a very inferior quality; whereas there are often found in whales pieces of it of the first value; nay, several pieces found in the same whale, according to the above-mentioned qualities, are more or less valuable. All ambergris found in whales has at first, when taken out of the intestines, very nearly the same smell and blackish colour as the liquid excrements of that animal; sometimes it is quite hard, sometimes softish, but never so liquid as the natural fæces. By being accumulated after a certain length of time in the intestinal canal, it seems even there to become of a whiter colour, and less ponderous, and to acquire its agreeable smell. The only reason why ambergris found floating on the sea generally possesses this agreeable smell and hardness in a superior degree is because it is commonly older, and has been longer exposed to the air. It is more frequently found in males than in females: the pieces found in females are generally smaller than those found in males, and inferior in quality. The disproportionately high price obtained for the larger pieces, therefore, proceeds from an intrinsic value in respect to quality, rather than a fictitious value on account of their rarity.

From the preceding account, and his having constantly found the beaks of the sepia in all pieces of ambergris of any considerable size, Dr Swediaur concludes, with great probability, that all ambergris is generated in the bowels of the physeter macrocephalus or spermaceti whale, and there mixed with the beaks of the sepia octopodia, which is the principal food of that whale. It seems most probable that this substance is nothing more than the bile of the animal secreted in undue quantity, and altered by disease.

The opinion of Dr Swediaur with regard to the origin of ambergris has been confirmed by the information of Captain J. Coffin, master of a ship employed in the southern whale-fishery, given to a Committee of Privy Council in the year 1791. The ambergris of the whale taken by Captain Coffin was mostly sold at 19s. 9d. per ounce; and a small part of it, when it was scarce, at 25s. It was bought partly for home consumption, and partly for exportation to Turkey, Germany, and France. (*Philosophical Transactions*, vol. lxxxi.)

The use of ambergris in Europe is now nearly confined to perfumery, though it has formerly been recommended in medicine by several eminent physicians. In Asia and part of Africa ambergris is not only used as a medicine and a perfume, but considerable use is also made of it in cookery, by adding it to several dishes as a spice. The Turks make use of it as an aphrodisiac.

Ambergris may be known to be genuine by its fragrant scent when a hot needle is thrust into it, and its melting like fat of a uniform consistence; whereas the counterfeit will not yield such a smell, nor prove of such a fat texture.

AMBERT, chief town of the arrondissement of the same name in France, department of Puy de Dôme. The town is situated on the river Dore, 35 miles south-east of Clermont, and is chiefly celebrated for its paper-works and cheese; besides which it manufactures ribands, lace, woollens, and pins. Population of town in 1851, 8044; of arrondissement, 90,048. The arrondissement is divided into eight cantons, and those into fifty-two communes, with an area of 477 square miles, or 305,280 acres.

AMBIANI, or Ambianensis Civitas, now Amiens, a city of Picardy. It is called *Samarobriva* by Cæsar and Cicero; which, according to Valesius, signifies the bridge of the *Samara* or *Somme*. *Ambiani* is a later name, taken from that of the people, after the usual manner of the lower age. This people, according to Cæsar, furnished 5000 men for the siege of Alesia.

AMBIDEXTER, a person who can use both hands with the same facility, and for the same purposes, that the generality of people use their right hand. Many think that, were it not for education and habit, all mankind would be ambidexters; and, in fact, we frequently find nurses obliged to be at a good deal of pains before they can bring children to forego the use of their left hand. The apparent cause why the right arm is generally most in use is, that the impetus of the heart is more *directly* communicated, in the ordinary structure, to the right subclavian artery than to the left, and therefore more blood is thrown into the former: but in true ambidexters the structure is similar on both sides.

Ambidexter, among *English Lawyers*, a juror or embracer who accepts money of both parties for giving his verdict; an offence for which he is liable to be imprisoned, for ever excluded from a jury, and to pay ten times the sum he accepted.

AMBIENT, a term used for such bodies, especially fluids, as encompass others on all sides. Thus, the air is frequently called an ambient fluid, because it is diffused round the earth.

AMBIGENÆ Oves, in the heathen sacrifices, an appellation given to such ewes as, having brought forth twins, were sacrificed together with their two lambs, one on each side. We find them mentioned among other sacrifices to Juno.

AMBIGENAL Hyperbola, a name given by Sir Isaac Newton to one of the triple hyperbolas of the second order, having one of its infinite legs falling within an angle formed by the asymptotes, and the other without.

AMBIGUOUS, a term applied to a word or expression which may be taken in different senses. An anonymous writer has published a dictionary of ambiguous words, *Lexicon Philosophicum de Ambiguitate Vocabulorum*, Francof. 1597, 4to.



AMBIT, in *Geometry*, is the same with what is otherwise called the perimeter of a figure.

Ambit was particularly used in *Antiquity* to denote a space of ground to be left vacant between one building and another. By the laws of the twelve tables, houses were not to be built contiguous, but an ambit or space of $2\frac{1}{2}$ feet was to be left about each for fear of fire. The ambitus of a tomb or monument denoted a certain number of feet in length and breadth around the same, within which the sanctity assigned to it was limited. The whole ground wherein a tomb was erected was not to be secreted from the common uses; for this reason, it was frequent to inscribe the ambit on it, that it might be known how far its sanctity extended: thus, *in fronte pedes tot, in agrum pedes tot.*

AMBITION (*ambitio*) is generally used, in a bad sense, for an immoderate or illegal desire of power. In the strict meaning of the word, however, it signifies the same with the *ambitus* of the Romans.

AMBITUS, in *Roman Antiquity*, the competition for some magistracy or office, and formally going round the city to solicit the interest and votes of the people. *Ambitus* differed from *ambition*, as the former lies in the act, the latter in the mind. Ambitus was of two kinds; one lawful, the other infamous. The first, called also *ambitus popularis*, was when a person offered his service to the republic frankly, leaving it to every body to judge of his pretensions as they found reasonable. The means and instruments here made use of were various: 1. *Amici*, or friends, under different relations, including *cognati, affines, necessarii, familiares, vicini, tribules, clientes, municipes, sodales, collegæ;* 2. *Nomenclatura*, or the calling and saluting every person by his name; to which purpose the candidates were attended by an officer, under the denomination of *interpres* or *nomenclator;* 3. *Blanditia*, or obliging persons, by serving them or their friends, patrons, or the like, with their vote and interest on other occasions; 4. *Prensatio*, the shaking every person by the hand, offering him his service, friendship, &c. The second kind was that wherein force, cajoling, money, or other extraordinary influence, was made use of. This was held infamous, and several severe laws (*leges de ambitu*) were enacted from time to time, to prevent bribery. Ambitus was practised not only at Rome and in the forum, but in the meetings and assemblies of other towns in Italy, where numbers of citizens were usually found, on account of trade and business. The practice ceased in the city from the time of the emperors, as offices were not then to be obtained by courting the people, but by favour of the prince. Persons who had causes depending practised the same, going about among the judges to implore their favour and mercy. They who practised this were called *ambitiosi*. Hence we also meet with *ambitiosa decreta*, and *ambitiosa justa*, used for such sentences and decrees as were thus procured from the judges contrary to reason and equity, either gratuitously or for money.

AMBLESIDE, a small market-town of Westmoreland, about a mile from the head of Windermere, and 12 miles north-west of Kendal. During the summer months it is much frequented by tourists, on account of its beautiful situation and the numerous places of interest in its vicinity, including Rydal Mount, for many years the residence of the poet Wordsworth. In a field near the lake, are indistinct remains of Roman fortifications, in which coins, urns, and other relics, have been frequently discovered. It has a free grammar school, and manufactories of coarse woollens. Market-day Wednesday.—Pop. in 1851, 1592.

AMBLETEUSE, a decayed seaport town of France, in the department of the Pas de Calais, on the English Channel, 12 miles south-west from Calais, and 6 north from Boulogne. From the accumulation of sand in its harbour it has lost its importance as a seaport, and the town is now almost deserted. Pop. 581. At this port Cæsar embarked his cavalry when he invaded England; and at it James II. landed when he abdicated the crown.

AMBLYGON, in *Geometry*, denotes an obtuse-angled triangle, or a triangle one of whose angles consists of more than 90 degrees.

AMBLYGONITE, a mineral of greenish-white colour, found in Norway and Saxony. It appears to be a phosphate of alumina and lithia, according to Berzelius. Its form is a rhombic prism. Specific gravity 3·01.

AMBLYOPY, among *Physicians*, signifies an obscuration of the sight, so that objects at a distance cannot be clearly distinguished.

AMBO, or AMBON, a kind of pulpit or desk in the ancient churches, where the priests and deacons stood to read or sing part of the service, and preach to the people; called also *Analogium.* The term is derived from *αναβαινειν, to mount.* The ambo was mounted upon two sides; whence some also derive the appellation from the Latin *ambo*, both. The ambo was ascended by steps; which occasioned that part of the office performed there to be called the *Gradual.* The modern reading-desks and pulpits have been generally substituted for the ancient ambos; though in some churches remains of the ambos are still seen. In that of St John Lateran at Rome there are two moveable ambos.

AMBOISE, a town of France, in the former province of Touraine, now the department of the Indre and Loire, seated at the confluence of the rivers Loire and Masse. The town is the capital of a district, and has been rendered famous in history by the conspiracy of the Protestants in 1560, which opened the fatal wars of religion in France. The castle is situated on a craggy rock, extremely difficult of access, and the sides of which are almost perpendicular. At its foot flows the Loire, which is here crossed by a handsome wooden bridge with stone piers. To this fortress the duke of Guise, when he expected an insurrection among the Huguenots, removed Francis II., as being a place of perfect security. Only two detached parts of the ancient castle now remain, one of which was constructed by Charles VIII. and the other by Francis I. The former of these princes was born and died at Amboise. Pop. 4859. Manufactures, fire-arms, files, &c.

AMBOISE, *François d'*, son of a surgeon to Charles IX. of France. His eloquence and extensive information raised him in 1572 to the place of solicitor of the French nation. He afterwards applied to the study of the law, and became one of the most accomplished advocates of the parliament of Paris. He was next advanced to be counsellor in the parliament of Bretagne, and afterwards to be a master of requests and counsellor of state. He visited different countries, and published the history of his travels, and several poetical pieces. He prefixed an apologetical preface to the edition of Abelard's works in 1616, and with much industry collected many of his manuscripts. His brother Adrian rose to considerable consequence in the church; and his brother James was not less eminent as a physician.

AMBOISE, *George d'*, a French cardinal and minister of state, was born in the year 1460. His father was a descendant of the renowned house of Amboise, and through the influence of his powerful connections the path of church preferment lay open before his son: he accordingly destined him to the clerical order. In these sanguine expectations he was not disappointed; for he had sufficient influence to procure for him the bishopric of Montauban at the early age of fourteen. Louis XI. appointed him one of his almoners; and in the course of political events he became strongly attached to the duke of Orleans, and suffered imprisonment in his cause. When this prince, however, had regained his favour at court, he was elevated to the archbishopric of Narbonne. After he had remained there for some time, he changed that station for the archbishopric of Rouen. When the duke of Orleans was governor of Normandy, he made him lieutenant-general; and in that situation he was of essential service to the province in restoring justice and order. When the duke of Orleans became Louis XII. Amboise was suddenly raised to the elevated station of cardinal and prime minister. The same regard to equity which characterised his conduct when lieutenant-general induced him to diminish the imposts, which rendered him very popular as first minister of France. In 1499, by his advice, the king undertook the conquest of the Milanese; and on their revolt the prime minister was sent to quell the rebellion. The great confidence which Louis had reposed in him induced the pope to make him his legate in France; and in that station he piously laboured to reform the ecclesiastical orders. He enforced his doctrine by precept, and not only set them an example of holding only one benefice at a time, but also devoted two-thirds of its revenue to the poor, and to the repair of religious edifices. According to his own account, he was ambitious of the papal chair "merely for the purpose of effecting the reformation of abuses and the correction of manners." It is said that, upon the death of Pius III., he would have been elected pope had he not been deceived by the Italian cardinals. Disappointed in his views with regard to the papal honours, he persuaded his master to declare war against the Venetians, to whose influence he attributed his failure. But this imprudent undertaking was suddenly interrupted; for, in the prosecution of his journey for the Venetian war, he was seized with illness in the city of Lyons. Affliction rouses the reflecting powers of the mind, and calls to remembrance the past actions of life. The consciousness of his past errors called forth his pathetic expression of compunction to the lay-brother who attended him at the convent of the Celestines: "Frère Jean, que n'ai je été toute ma vie frère Jean!" In the year 1510, and in the 50th of his age, he breathed his last in that place. Industry, steadiness, and good intention, characterised his conduct as a prime minister; and under his liberal patronage the arts and sciences flourished during his administration. It may be proper to add that, assisted by some of the ablest lawyers in the kingdom, he formed a code of laws to reform the reigning abuses in the nation. Thus, by steadily pursuing the general welfare, he obtained the appellation of the "father of the people."

AMBOYNA is one of the Moluccas or Spice Islands, in the Eastern Archipelago, and belongs to the Dutch. It lies south-west of Ceram, in S. Lat. 3. 41. E. Long. 128. 10., and is 32 miles in length, of a very irregular figure, with a superficial area of 13·3 geographical square leagues. Though but fourth-rate in size, it is the most populous of all the Moluccas, Ceram excepted, the number of its inhabitants in 1840 being 29,660. Its proper name is Hitoe; but it is usually designated Amboyna, from its town. The town of Amboyna contains 13,000 inhabitants, and is situated on the south-east of the island, in the peninsula of Leitimor, which is united to Hitoe by an isthmus about one mile broad. The arm of the sea separating these two very unequal peninsulas forms the extensive bay and roadstead of Amboyna, which affords good anchorage for ships, with shelter from most winds. In the exterior bay there are no dangerous rocks or shallows: on the contrary, it has a depth of 50 fathoms, except in a few places; as, for instance, in the roadstead itself, towards the point of the Gibbet, and the other side of the bay, within the point of Laha. Ships, however, seldom cast anchor in this last place, unless, when attempting to enter the bay, the wind suddenly becomes

Amboyna.

contrary, which would otherwise compel them to take to the open sea.

Amboyna is a clean neat town, with broad unpaved streets running at right angles to each other, and intersected by numerous rivulets. The houses are of wood, roofed with palm leaves, and mostly of one story, the better to endure the shock of earthquakes, which are not infrequent. The Chinese and the Europeans occupy separate quarters of the town. An esplanade of 250 yards reaches from Fort Victoria to the town, and is terminated by a handsome range of houses, with a double row of nutmeg trees in front. Another fort has been erected in a more advantageous position, and is called Van der Capellen, in honour of the late excellent governor of that name. The town-house is a neat structure of two stories, fronting the esplanade. There are two Christian churches, a fine garden and menagerie, several bazaars and markets, and a hospital. The site of the town is level; but immediately to the east and south the country is hilly, and many mountain-streams descend to the sea close to the town: the country around is highly picturesque, and diversified with numerous villas; the forests are rich and varied, vegetation is most luxuriant, and the air is embalmed with the odours of flowers. Viewed from the sea, the aspect of this fertile island is high and mountainous, watered by innumerable streams, and interspersed with clove plantations. The average temperature is 80° Fahr., rarely sinking below 72°, and until the great earthquake in 1835 the climate was accounted highly salubrious; but since that period fever has been very prevalent, probably in consequence of mephitic vapours still exhaling from the fissures in the earth. Amboyna produces most of the common tropical fruits and vegetables, including the sago-palm, bread-fruit, cocoa-nut, sugar-cane, maize, coffee, pepper, cotton, &c., and a small quantity of very fine indigo. The variety of its ornamental woods is such, that Rumphius, the author of the *Herb Amboniense*, had a cabinet composed of no fewer than 400 of its choice native woods. The governor of the Moluccas resides here, having under his jurisdiction the islands of Boeroe, Amblauw, Ceram, Manippa, Kilang, Bonoe, Haroekoe, Honimoa or Saparoea, Noesa-laut, and Hila. The varied climatic effects of the monsoons are felt at Amboyna, Ceram, Banda, the east coast of Celebes, and the adjacent seas; the east monsoon bringing rains, lightning, and hurricanes, the west monsoon fine weather. The monsoons also occasion irregularities of the tides.

This island is especially remarkable for producing the best cloves of commerce, and formerly was appropriated almost exclusively to that production; for its Dutch legislators, in order to secure a monopoly, exterminated thousands of clove trees, prohibited their culture in the other islands subject to them, and often burnt whole cargoes of spices, with the view to keep up their market-price. By an act passed in 1824 these prohibitory laws were abolished; and consequently the fraud, extortion, and tyranny to which they gave rise: the cultivation of land was opened to all; but on account of the indolence and indifference of the natives the government deemed it advisable to assign a plantation of this tree to each *negory*, or village, under the superintendence of a chief, who is bound to deliver the annual produce to government at a just valuation.[1]

The clove-tree (*Caryophyllus aromaticus*) attains the height of 30 or 40 feet, is slender and elegant, with a light-coloured stem, branches little spread, the leaves entire, small, and oblong. It bears about its fifteenth year, and its average duration is 75 years. The spice is the undeveloped flowers of the plant, the tubular part being the *calyx*, and the knob the unexpanded *corolla*. A tree will yield annually from 5 lb. to 20 lb. of cloves, according to its size and vigour; and some very large trees are said to produce even so much as 50 lb. It flourishes best in a dry, rocky soil, sheltered from blasts and sea-spray, and requires much care. In the other Moluccas it bears earlier, and is hardier; but it is in Amboyna that this plant is produced in greatest perfection. From the leaves is extracted an oil powerfully aromatic. The harvest takes place in November and December, and averages from 250,000 to 300,000 lb. of cloves, which are dried quickly in the shade to preserve their aroma. The sago-tree (*Sagus Rumphii*), which furnishes the principal food of the Amboynese, is in danger of becoming extinct in that island from the constant destruction of the trees—a circumstance deserving the attention of the government. In Amboyna a tree now yields but about 400 lb. of sago, while those of Ceram give 1200 lb. or more. It flowers between its 20th and 25th year, and after lasting two years in this state, languishes and dies; but before this period the pith has become ligneous, and is useless. The best sago is in small round grains of a pale reddish-white: as usually found in commerce the grain is larger, and whitened artificially.

The natives of Amboyna are a mixed race of Haroforas or aborigines, Malays, Chinese, Arabians, and various European nations, with a consequent variety of complexion and feature; and it is worthy of remark that the descendants of the Portuguese are much darker than the aborigines. Of the latter very few now remain, and they are confined to the mountains. The Malays constitute the main population. They are indolent and effeminate, but expert fishers. Their *corocoros*, or war-canoes, are often 100 feet long, and carry 80 men. They live in wooden houses of one story, with roofs of palm-leaves, and windows of matted cane Malay, the common language, is pleasing in utterance: the Arabic character is employed in writing it, which they derived from the Arabians in the middle of the 16th century. The natives are of middle height and well formed. They are high spirited and of facile disposition, with more inclination for the military life than the inhabitants of the other Moluccas. Their costume differs little from that of the Malays of Java: it consists of a loose frock and trousers, and a round hat, their glossy hair twisted into a queue, or turned up with a comb. The chiefs of the villages dress like the Europeans. Mohammedanism is the prevailing religion; but some profess Christianity, and distinguish themselves by black garments.

If the ancient statistical documents may be relied on, this island once contained 50,000 inhabitants. The great decrease at the present day has been ascribed to several causes; such as piracy, the ravages of smallpox and cholera, enrolment for military service in 1806, 1809, and 1826, the insurrections of 1817 and 1829, and the epidemic of 1837: to which may be added the grievous oppression they so long endured.

Amboyna has the usual domestic animals, but is very barren in indigenous mammals. Its birds are few in species, nor is it richer in mollusca and zoophytes. The splendid

[1] Many errors have been propagated respecting the policy of the Dutch with regard to their East India possessions; the fact being that the chartered privileges of the Dutch Chamber of Commerce (like those of our own East India Company under its original charter), constitute a monopoly of the carrying trade in the hands of that body, to the exclusion of the majority of the Dutch merchants and merchant seamen; and all that the British have received in accordance with the provisions in the treaty of 1824 is a parity of exclusion with the great majority of the Dutch themselves.—See *Edinburgh Review*, No. cxcv. p. 71.

Amboyna. and valuable shells sold by the Chinese merchants at Amboyna are rarely found on its shores; and in this and other instances mistakes have frequently arisen in making Amboyna the habitat of animals not found there. In the Moluccas but thirty mammiferous animals have hitherto been observed: they do not possess a single quadruman, nor any formidable beast of prey: the feline tribe is not even represented: no marsupialia: the insectivora are wanting: of the rodentia there is but the *mus decumanus*, which is found everywhere, or a species nearly allied to it: no edentata: the pachydermata are represented by the wild boar and the horse, and the ruminantia by the deer (*Cervus axis*): the monotremata are wanting. The birds of these islands form characteristic groups: such are the cockatoos with plumage almost purely white, and parrots beautifully variegated with scarlet, purple, and bright blue. Among the gallinaceæ are the *megapodes*, remarkable for the disproportionate size of their eggs, and their habit of subjecting them to the heat of fermenting vegetable matter, instead of hatching them in the usual way. The serpents that occur in Amboyna are described by M. Schlegel as the following:—*Calamaria brachyorrhos, Lycodon modestus, Dendrophis rhodopleuron, Dipsas irregularis*, and the *Homalopsis Schneideri*, and *Python Schneideri*, inhabiting Amboyna; and in the surrounding seas are found the *Hydrophis striata, H. pelamis, H. pelamoides, H. colubrina*, and probably some others. The entomology of these isles is peculiarly rich; and we may specially notice the brilliant *lepidoptera*, and the *phasma* of enormous size. In the pith of the sago tree is found the larva of a *cerambix*, which is eaten as a great delicacy, like the *grugru* worm of the West Indies. The seas are very prolific: the dugon is common: the antarctic whale, the porpesse, the balænoptera or *finner*, but especially the cachalot (*Physeter macrocephalus*) which yields the spermaceti of commerce, attract many English, American, and other vessels to these seas. Extravagant estimates have been made of the number of cachalots annually taken; but it is stated that 190 large whaling vessels are annually engaged in this pursuit.

*Geology.*—The greatest part of the island of Amboyna is composed of rocks of ignigenous formation. To the north of Leitimor, near the village of Roebang, there is a hill several hundred feet in height composed entirely of granite; in other places this rock underlies serpentine, and a calcareous rock of more recent formation. The island in other parts presents a volcanic aspect; and earthquakes and sudden oscillations of the sea, from time to time, attest the agency of subterranean fire. Pennant mentions a dreadful eruption of the Wawani Mountain of Amboyna in 1691. Sulphur is found in some quantity, and gold occurs in the granite districts.

*History.*—Amboyna was first visited in 1512 by the Portuguese, who established a factory there in 1521; but they did not obtain peaceable possession of it till 1580. They were dispossessed by the Dutch, after repeated attempts, in 1605. The British seized it in 1615; and in turn were expelled by the Dutch, but retained a factory in the island. The destruction of this establishment by the Dutch in 1622, and the frightful tortures inflicted on the unfortunate persons connected with it, long formed the theme of fruitless political negotiations; till Oliver Cromwell compelled them to give the sum of L.300,000, together with a small island, as compensation to the descendants of those who suffered in the "Amboyna massacre." In 1796, the British, under the Admiral Rainier, captured Amboyna, but restored it to the Dutch at the peace of Amiens. They re-captured it in 1810; and once more restored it to the Dutch after the treaty of Paris in 1814.

The sources of public revenue are customhouse and port dues, imposts on merchandise, a monopoly of arrack, and various licenses. The exports are spices and other natural produce: the imports chiefly opium, and some Indian and European goods.—See *Coup-d'œil General sur les Possessions Neerlandaises dans l'Inde Archipélagique, par* C. J. Temminck. Cannabich, *Lehrbuch*. (T. S. T—L.)

Ambracia. AMBRACIA, or AMPRACIA, an important town of ancient Epirus, on the left bank of the river Arachthus, about eight miles from the Ambracian Gulf. It was well fortified by walls of about three miles in circumference, besides being defended on the one side by the river Arachthus, and on the other by steep and craggy hills, on one of which stood the Acropolis. It was originally a Thesprotian town, but tradition stated that it was founded by Ambrax son of Thesprotus, or by Ambracia daughter of Augeas. About the year B.C. 635, a colony of Corinthians settled here, on which it became a Greek city. It soon became the most important Corinthian colony on the Ambracian Gulf, and about the time of the Peloponnesian war the Ambracians had attained their highest importance. They then had possession of the whole of Amphilochia, including its town named Argos. A colony from Ambracia had settled here, and after a time drove out the original inhabitants, and took possession of the town. The expelled Amphilochians threw themselves under the protection of the Acarnanians, who, with the assistance of the Athenians, retook Argos. The Ambracians two years after (about B.C. 430) made an unsuccessful attack on the town. Having obtained the assistance of Eurylochus the Lacedæmonian general, they again determined to attack the town (B.C. 426), but were repulsed with great slaughter by the conjoined armies of the Amphilochians and Acarnanians under the command of Demosthenes, their general Eurylochus being left dead on the field. Being greatly weakened by this last defeat, they for some time took no active part in the affairs of Greece. Ambracia subsequently fell into the hands of the Macedonians, and at a later period became subject to Pyrrhus, who made it the capital of his dominions, and enriched it with numerous works of art. It afterwards came into the possession of the Ætolians, and in the war between them and the Romans it sustained the siege for which it is so celebrated. In B.C. 189, the Roman consul M. Fulvius Nobilior resolved to attack the town, and formed two camps, one on each side of the river, but with a communication between them; the Romans being posted in one, and the Epirots, their allies, in the other. He then threw up two lines, one of circumvallation, the other of contravallation; and built a wooden tower in form of a castle, over against the citadel.

The lines being completed, the city was attacked in five different places at once. The battering-rams shook the wall on all sides; and the Romans, from their moveable towers, pulled down the battlements with a kind of scythes, which they fastened to long beams. The besieged made a vigorous defence. They were night and day on the walls, and indefatigable in preventing the effects of the rams and scythes. The strokes of the former they deadened by letting down upon them beams, large stones, lumps of lead, &c., by means of pulleys, when they were in motion; the others they rendered useless, by pulling the beams to which they were fastened into the city with hooks contrived for the purpose.

But while these operations were going on, the Ætolians concluded a peace with the Romans, and the city thereupon opened its gates to the besiegers, who removed many of its valuable works of art to Rome. Its ruin was afterwards completed by Augustus, who removed its inhabitants to Nicopolis, a city which he founded in commemoration of his victory at Actium.

The modern Arta occupies the site of the ancient Ambracia, where remains of its fortifications are still to be seen.

From this time the city of Ambracia made no figure in history.

AMBRESBURY. See Amesbury.

AMBROGI, Domenico, or del Brizio, a Bolognese painter who excelled in design, especially in cabinet pieces. He was the pupil and favourite of Francesco Brigio, who was the most distinguished scholar of the Caracci, excepting Domenichino and Guido. Domenico was living in 1678.

AMBRONES, a people of Gaul who lived near the foot of the Alps, about Embrun, between Switzerland and Provence. They invaded the Roman territories in conjunction with the Cimbri and Teutones; but were defeated with great slaughter by Marius, about 101 years before Christ. Their women, who during the engagement had staid in a kind of fortification made with their carts, on seeing their husbands flying, and the Romans at their heels, armed themselves with axes, and, gnashing with their teeth, fell with fury on the pursuers and the pursued. Their first rage being spent, they desired to surrender themselves upon the single condition that their chastity should not be violated; but this equitable request being denied, they first killed their children and then themselves, not one remaining alive out of the whole multitude.

AMBROSE, of Alexandria, lived in the beginning of the third century, and was the intimate friend of Origen. Jerome and Eusebius differ in the account they give of this man. The one denominates him a Marcionite, the other a Valentinian; but they both agree that he was converted to the orthodox faith by the preaching of Origen. As is generally the case with new proselytes, he became very zealous, and was appointed deacon either at Alexandria or at Cæsarea, where Protectetus was presbyter. Origen dedicated many of his works, and among others his book on martyrdom, to Ambrose, at whose desire and expense they were published. Origen and Ambrose were alike indefatigable in their application to study, and lived on terms of the most intimate friendship. According to some historians, Ambrose died a martyr, along with his friend Protectetus, in the persecution under Maximin, about the year 236; but the dedication of Origen's eight books against Celsus proves, that though he died before Origen, yet he lived to the year 250, or near that period. Origen speaks of him as a man of sincere piety, and much devoted to the study of the sacred Scriptures.

Ambrose, *Saint*, Bishop of Milan, was one of the most eminent fathers of the church in the fourth century. He was a citizen of Rome, and born in France; according to some historians, in the year 334, but according to others in 340. At the period of his birth his father was prætorian prefect of Gallia Narbonensis; but upon his death the widow repaired to Rome with her family. Ambrose received a religious education, and was reared in habits of virtue by his mother, an accomplished woman, and eminent for her piety. The names of his instructors in the rudiments of Greek and Roman literature have not been transmitted to posterity: but in these branches he made early proficiency; and, having directed his attention to the law, he employed his eloquence with such reputation in the prætorian court of Anicius Probus, that he was soon deemed worthy of a place in the council. After he had continued in this station for some time, Probus appointed him consular of Liguria and Emilia, comprehending the territories of Milan, Liguria, Turin, Genoa, and Bologna. Milan was chosen for the place of his residence; and, by the prudent and gentle use of his power, he conducted the affairs of the province with general approbation and growing popularity.

In the year 374 Auxentius the bishop of that city died, and his death gave sudden change to the fortune and literary pursuits of Ambrose. At that period the tide of religious contention ran high between the orthodox and the Arians, and there ensued a violent contest concerning the choice of a new bishop. When the people were assembled in the church to elect, Ambrose, in the character of governor of the place, presented himself to the assembly, and in a grave, eloquent, and pathetic address, admonished the multitude to lay aside their contentions, and, in the spirit of religious meekness, to proceed to the important work of choosing a bishop. It is reported that when Ambrose had finished his address, a child cried out, "Ambrose is bishop." The agitated multitude suddenly caught the superstitious flame, and regarding this as a miraculous intimation, they unanimously elected Ambrose bishop of Milan. Some suppose that this was entirely a device of Ambrose or his friends, and others ascribe it to mere accident. Ambrose strongly affected reluctance, and even pretended to fly from the city in order to avoid the intended honour. The place of his concealment, however, was soon discovered when the emperor's confirmation of his election was made known to him; and, after being baptized, he was ordained bishop of Milan, about the end of the year 374. Whatever we may think of the singular conduct of Ambrose in accepting an office for which he was certainly unqualified in respect of previous studies, habits, and employments, it must be admitted that he immediately betook himself to the necessary studies, and acquitted himself in his new elevation with ability, boldness, and integrity. Having appropriated his money to the poor, and settled his lands upon the church, with the exception of making his sister tenant during life; and having committed the care of his family to his brother, he entered upon a regular course of theological study, under the care of Simplician, a presbyter of Rome, and devoted himself to the labours of the church.

Compelled by the irruption of the Goths and the northern barbarians, who rushed down upon the Roman empire, spreading terror and desolation all around, Ambrose, along with several others, fled to Illyricum; but his exile was of short duration, for the northern invaders having been quickly defeated by the forces of the emperor, and driven back with considerable loss into their own territories, he and his companions returned to their respective habitations.

His eloquence and abilities soon found ample scope in the dispute between the Arians and the orthodox. About this era the doctrine of Arius concerning the person of Christ had been extensively received, and had many powerful defenders both among the clergy and the common people. Ambrose espoused the cause of the Catholics: Gratian, the son of the elder Valentinian, marshalled on the same side; but the younger Valentinian, who was now become his colleague in the empire, adopted the opinions of the Arians; and all the arguments and eloquence of Ambrose were insufficient to reclaim the young prince to the orthodox faith. Theodosius, the emperor of the East, also professed the orthodox faith; yet there were numerous adherents to Arius scattered throughout his dominions. In this distracted state of religious opinion, two leaders of the Arians, Palladius and Secundianus, confident of numbers, prevailed upon Gratian to call a general council from all parts of that empire. This request appeared so equitable that he complied without hesitation; but Ambrose, foreseeing the consequence, prevailed upon the emperor to have the matter determined by a council of the western bishops. A synod, composed of 32 bishops, was accordingly held at Aquileia in the year 381. Ambrose was elected president; and Palladius being called upon to defend his opinions, declined, insisting that the meeting was a partial one, and that the whole bishops of the empire not being present, the sense of the Christian church concerning the question in dispute could not be obtained.

Ambrose. Ambrose mentioned several precedents in favour of the authority of the court; and added, that the oriental bishops, being acquainted with the place and nature of the meeting, might have been present, if they had deemed the matter in discussion worthy of their attention. Palladius persisted in his refusal to plead his cause; and on a vote being taken, he, along with his associate Secundianus, was ejected from the episcopal office.

Ambrose was equally zealous in combating the heathen superstitions. Upon the accession of Valentinian II., many of the senators who remained attached to the pagan idolatry made a vigorous effort to restore the worship of the heathen deities. Symmachus, a very opulent man and a great orator, who was at that time prefect of the city, was intrusted with the management of the pagan cause, and drew up a petition, praying that the altar of Victory might be restored to its ancient station in the hall of the senate, and for the proper support of seven vestal virgins, and the regular observance of the other pagan ceremonies. Great eloquence and peculiar insinuation characterised the petition. He argued that this form of religion had long been profitable to the Roman state, reminded the emperor how much Rome had been indebted to Victory, and that it had been the uniform custom of the senators to swear fidelity to the government upon that altar. He likewise produced many facts to prove the advantages derived to the state from its ancient religious institutions, and insinuated that it was one divinity that all men worshipped under different forms, so that ancient practice should not be rashly laid aside. He even proceeded so far as to state the justice of increasing the public revenue by robbing the church, and attributed the late famine which had overtaken the empire to the neglect of the ancient worship. To this petition Ambrose replied in a letter to Valentinian, arguing that the devoted worshippers of idols had often been forsaken by their deities; that the native valour of the Roman soldiers had gained their victories, and not the pretended influence of pagan priests; that these idolatrous worshippers requested for themselves what they refused to Christians; that voluntary was more honourable than constrained virginity; that as the Christian ministers declined receiving temporal emoluments, they should also be denied to pagan priests; that it was absurd to suppose that God would inflict a famine upon the empire for neglecting to support a religious system contrary to his revealed will in the Scriptures; that the whole process of nature encouraged innovations, and that all nations had permitted these, even in religion; that heathen sacrifices were exceedingly offensive to Christians; and that every Christian prince should suppress these pagan ceremonies. In the epistles of Symmachus and of Ambrose both the petition and the reply are preserved, in which sophistry, superstition, sound sense, and solid argument, are strangely blended. It is scarcely necessary to add, that the petition was unsuccessful.

The increasing strength of the Arians proved too formidable for Ambrose. The young emperor and his mother Justina, along with a considerable number of clergy and laity professing the Arian faith, requested from the bishop the use of two churches, one in the city, the other in the suburbs of Milan. The prelate believing the bishops to be the guardians both of the temporal and spiritual interests of the church, and that the religious edifices were the unquestionable property of the church, positively refused to deliver up the temples of the Lord into the impious hands of the heretics. Filled with indignation, Justina resolved to employ the imperial authority of her son in procuring by force what she could not procure by persuasion. Ambrose was required to answer for his conduct before the council. He went, attended by a numerous crowd of people, whose impetuous zeal so overawed the ministers of Valentinian, that he was permitted to retire without making the surrender of the churches. The day following, when he was performing divine service in the Basilica, the prefect of the city came to persuade him to give up at least the Portian church in the suburbs. Still continuing obstinate, the court proceeded to violent measures: the officers of the household were commanded to prepare the Basilica and the Portian churches to celebrate divine service upon the arrival of the emperor and his mother at the ensuing festival of Easter. The order respecting one of them was carried into effect; but the court perceiving the growing strength of the prelate's interest, deemed it prudent to use more lenient measures. But all measures proved in vain; the bishop boldly replied, "If you demand my person, I am ready to submit: carry me to prison or to death, I will not resist; but I will never betray the church of Christ. I will not call upon the people to succour me; I will die at the foot of the altar rather than desert it. The tumult of the people I will not encourage; but God alone can appease." This strong declaration was followed by a torrent of eloquence from the pulpit, enforcing his theme with the most fervent zeal. But the court remained unconvinced; and another attempt being made, under a strong guard of ferocious Goths, to seize the Basilica, when they were about to enter, Ambrose thundered the sentence of excommunication against them, and so overawed them that they retired, while he and his friends remained in possession of the churches. About this time also an Arian bishop challenged Ambrose to a dispute before the emperor; but he declined, saying that matters of faith should be determined by a council of bishops.

Many circumstances in the history of Ambrose are strongly characteristic of the general spirit of the times. The chief causes of his victory over his opponents were, his great popularity, and the superstitious reverence paid to the episcopal character at that period of society. But it must also be admitted that he used several indirect means to obtain and support his popular authority. Many indigent persons were supported by his liberal bounty: in his explanations of Scripture he made constant and severe allusions to existing and public characters: and the alternate mode of singing had no small effect upon the minds of the vulgar. At a time when the influence of Ambrose required vigorous support, he fortunately was admonished in a dream to search for the remains of Gervasius and Protasius, two martyrs who quietly reposed under the pavement of the church. Their skeletons were found entire, stained with blood, and the head of one of them separated from the body. The vulgar crowded in thousands to behold these venerable relics. According to report, a blind man was restored to sight, several demons were expelled, and sick persons healed, by touching these bones. Ambrose exulted in these miracles, and appealed to them in his eloquent sermons; while the court derided and called in question their existence. The bishop continued firm in his opinions, the people believed, and the existence of the miracles was established. It is a very singular fact that these and many other miracles obtained current credit among the Christian historians of the second, third, and fourth centuries: and Dr Cave, in speaking of them, says, "I make no doubt but God suffered them to be wrought at this time on purpose to confront the Arian impieties."

Although the court was displeased with the religious principles and conduct of Ambrose, yet it respected his great political talents; and when necessity required, his aid was solicited and generously granted. When Maximus usurped the supreme power in Gaul, and was meditating a descent upon Italy, Valentinian sent Ambrose to dissuade him from the undertaking; and the embassy was successful. On a second attempt of the same kind

Ambrose was again employed; and although he was unsuccessful, it cannot be doubted that if his advice had been followed, the schemes of the usurper would have proved abortive; but the enemy was permitted to enter Italy, and Milan was taken. Justina and her son fled; but Ambrose remained in his station, and proved beneficial to many of the sufferers, by causing the plate of the church to be melted for their relief. Theodosius, the emperor of the East, espoused the cause of Justina, and by force of arms regained the kingdom.

In the year 390 a tumult happened at Thessalonica, in which Botheric, one of the imperial officers, was slain. At this Theodosius was so enraged that he issued a royal mandate for the promiscuous massacre of the inhabitants of that place; and about 7000 persons were butchered without distinction or mercy. The courageous Ambrose, informed of this deed, wrote to the emperor a severe reproof, and an earnest admonition, charging him not to approach the holy communion with his hands stained with innocent blood. When the emperor was about to enter the church of Milan to attend upon the service, the bishop met him, and with a stern countenance prohibited him from approaching the temple of God. The emperor reminded him that David had been guilty of murder and of adultery. The bishop replied, "You have imitated David in his guilt; go and imitate him in his repentance." The prince obeyed the priest, and, by a course of penitential sorrow during the space of eight months, he laboured to regain the favour of the church. After the termination of this period he was absolved, but at the same time was made to sign an edict that an interval of thirty days should intervene before the sentence of death or confiscation should be put in execution. When we reflect on the pernicious effects of sudden and violent passion, we must acknowledge that this measure was fraught with policy and humanity.

The undaunted courage of Ambrose received another severe trial in the year 392, after the assassination of Valentinian, and the base usurpation of Eugenius. Rather than join the standard of the usurper he fled from Milan; but after the army of Theodosius was victorious, he generously supplicated the emperor for the pardon of those who had supported the cause of Eugenius. Theodosius, soon after he had acquired the uncontrolled possession of the Roman empire, died at Milan. The bishop did not long survive the emperor, but died in the year 397. In his last illness he preserved perfect composure of mind, informing his friends that he had endeavoured so to conduct himself that he might neither be ashamed to live nor afraid to die.

On many accounts the character of the bishop of Milan stands high among the fathers of the ancient church. With unvarying steadiness he delivered his religious sentiments on all occasions; with unwearied assiduity he discharged the duties of his office; with unabated zeal and boldness he defended the orthodox cause in opposition to the Arians; with a liberal hand he fed the numerous poor who flocked to his dwelling; with uncommon generosity he manifested kindness to his adversaries; and with Christian affection he sought the happiness of all men. His general habits were amiable and virtuous, and his powers of mind were uncommonly vigorous and persevering. Ambition and bigotry were the chief blemishes in his character.

The writings of Ambrose are voluminous, although little more than adulterated editions of Origen and other Greek fathers. The great design of his writings was to defend and propagate the Catholic faith. In some of these he recommends perpetual celibacy as the perfection of Christian virtue. Modern judgment and taste may perhaps induce us to esteem some of the writings of Ambrose absurd, trivial, and even ludicrous; but there is a smartness and vigour in his style, and there are excellent sentiments interspersed, which render the writings of the bishop of Milan worthy of a perusal. With his usual severity and acrimony, Gibbon too severely censures this prelate. "Ambrose," says he, "could act better than he could write; his compositions are destitute of taste or genius, without the spirit of Tertullian, the copious elegance of Lactantius, the lively wit of Jerome, or the grave energy of Augustin." The most accurate and complete edition of his works is that published by the Benedictines, printed at Paris in 1686 and 1690, in two volumes folio.



AMBROSE, *Isaac*, an eminent Presbyterian minister, was educated at Brazen-nose College, Oxford, where he took the degree of bachelor of arts, and became minister of Garstang, and afterwards of Preston in Lancashire, whence he was ejected for nonconformity in 1662. It was usual for him to retire every year for a month into a little hut in a wood, where he shunned all society, and devoted himself to religious contemplation. Dr Calamy observes, that he had a very strong presentiment of the approach of death, and took a formal leave of his friends at their houses a little before his departure; and on the last night of his life he sent his discourse concerning *angels* to the press. The next day he shut himself up in his parlour, where, to the great surprise and regret of all who saw him, he was found just expiring. He died in 1663–4, in the 72d year of his age. He wrote several other books, as the *Prima, Media, et Ultima,* or *the First, Middle, and last Things; War with Devils; Looking unto Jesus, &c.*

AMBROSE, *Saint*, an island in the South Pacific Ocean, on the coast of Chili, four or five leagues due west from St Felix Island. It lies in Long. 80. 55. W. and Lat. 26. 13. S. There is a large rock four miles to the northward of the island, called from its appearance *Sail-rock.* Captain Roberts, who was there in 1792, found St Felix Island inaccessible. On St Ambrose Island his crew, in seven weeks, killed 13,000 seals. The island has little else to recommend it. Fish and crawfish abound.

AMBROSIA (α, privitive, and βροτος, *mortal*), in *Heathen Antiquity*, generally denotes the solid food of the gods, in contradistinction to their drink, which was called *nectar.* But the name ambrosia is also applied to drink, ointments, and fragrance delighting the gods.

AMBROSIAN OFFICE or RITE, in *Ecclesiastical History*, a particular formula of worship in the church of Milan, which takes its name from St Ambrose, who instituted that office in the fourth century. Each church originally had its particular office; and when the pope in aftertimes took upon him to impose the Roman office upon all the western churches, that of Milan sheltered itself under the name and authority of St Ambrose; from which time the Ambrosian ritual has prevailed.

AMBROSIN, in the *Middle-age Writers*, denotes a coin struck by the lords or dukes of Milan, whereon St Ambrose was represented on horseback, with a whip in his right hand.

AMBROSIUS AURELIANUS, or AURELIUS AMBROSIUS, a famous general of the ancient Britons, of Roman extraction. He was educated at the court of Aldroen of Armorica, who, at the request of the Britons, sent him over with 10,000 men to assist them against the Saxons, whom Vortigern had invited into Britain. Ambrosius was so successful against the Saxons, that the Britons chose him for their king, and compelled Vortigern to surrender to him all the western part of the kingdom, divided by the Roman highway now called *Watling Street.* Some time after, the Britons being discontented with Vortigern, and having withdrawn their allegiance from him, he retired to a castle in Wales. Here, being besieged by Ambrosius, and the castle taking fire, he perished in the flames, and left his rival sole monarch of Britain, who now assumed the imperial purple, after the manner of the Roman emperors. Geoffrey of Monmouth tells us that Ambrosius built Stonehenge, near Salisbury, in Wiltshire. See STONEHENGE.

After the Britons had defeated the Saxons, and obliged them to retire northward, Ambrosius is said to have convened the princes and great men at York, where he gave orders for repairing the churches destroyed by the Saxons, and restoring the exercise of religion to its former lustre. "He was a man," says Geoffrey, "of such bravery and courage, that when he was in Gaul no one durst enter the lists with him; for he was sure to unhorse his antagonist, or to break his spear into shivers. He was, moreover, generous in bestowing, careful in performing religious duties, moderate in all things, and more especially abhorred a lie. He was strong on foot, stronger on horseback, and perfectly qualified to command an army." The same author tells us that he was poisoned at Winchester, by one Eopa, a Saxon disguised as a physician, and hired for that purpose by Pascentius, one of the sons of Vortigern; but the generally received opinion is, that he was killed in a battle which he lost in the year 508, against Cerdic, one of the Saxon generals.

AMBRY, a place in which are deposited all utensils necessary for house-keeping. In the ancient abbeys and priories there was an office under this denomination, wherein were laid up all charities for the poor.

AMBUBAIÆ, in *Roman Antiquity*, were immodest women who came from Syria to Rome, where they lived by prostitution, and by playing on the flute. The word is derived from the Syriac *abub*, which signifies a flute.

AMBULANCE, an admirable invention of Baron Percy of the armies of France, for removing wounded men from the field of battle. It consists of covered waggons on springs, in which the wounded are removed to the hospitals. Those on whom operations have been performed in the field are thus carried safely to considerable distances; and thus, too, the sick may be removed. The medical men are also, by a sort of wooden horse on wheels, rapidly conveyed to the point where their services are most wanted. In the army of the East, the ambulance was fastened on a camel.—See Larrey, *Mem. de Chir. Milit.* i.

AMBULANT, or AMBULATORY. They gave in France the name of *Ambulant Commissioners*, to those commissioners or clerks of the king's farms who had no settled office, but visited all the offices within a certain district, to see that nothing was done in them against the king's right and the interest of the farm.

AMBULANT is also used to denote those brokers at Amsterdam, or exchange agents, who have not been sworn before the magistrates. They transact brokerage business, but their testimony is not received in the courts of justice.

AMBULATORY, a term anciently applied to such courts, &c., as were not fixed to any certain place, but held sometimes in one place and sometimes in another, in opposition to stationary courts. The court of parliament was anciently ambulatory: so also were the courts of king's bench, &c.

AMBURBIUM, in *Roman Antiquity*, a procession made by the Romans round the city and pomœrium, in which they led a victim, and afterwards sacrificed it, in order to avert some calamity that threatened the city. This festival was for the city of Rome what the Ambarvalia was for the fields.

AMEDABAD, or AHMEDABAD, an ancient and celebrated city of Hindustan in the province of Guzerat, of which it was formerly the Mahometan capital. It is situate on the banks of the river Sabermatty, which washes its western walls, and after a course of about 120 miles falls into the Gulf of Cambay, near the city of that name. It was built in the year 1412 by the Sultan Ahmed Shah of Guzerat, on the site of a town still more ancient. It soon became a populous and splendid city; and in the early part of the seventeenth century, after the subjugation of Guzerat by the emperors of Delhi, was a noted emporium of eastern commerce, to which the Dutch and other European merchants resorted for the purchase of goods. Here were manufactories of rich gold and silver flowered silks of every description; steel, gold, ivory, enamel, mother-of-pearl, and lackered ware, as well as of silk and cotton piece-goods, which were exported through Cambay. This state of prosperity continued until the rise of the Mahrattas, who captured the city in the early part of the last century, and levied a tax on every article, however trifling, and whether of luxury or of necessity, which was either brought within or sent out beyond its walls. Thenceforward Amedabad declined from its ancient splendour; its various manufactories, with some trifling exceptions, rapidly fell into decay and ruin; and its former grandeur is now marked only by the ruins of minarets, palaces, aqueducts, and caravansaries, which extend nearly thirty miles around. In 1780 it was stormed and captured by the British, but shortly afterwards restored by them to the Mahrattas. At that period, from being one of the largest capitals in the East, Amedabad was reduced to a circumference of five miles and three-quarters, surrounded by high walls, with irregular towers every fifty yards, and having twelve principal, besides many inferior gates. On the outside of the walls the country was in a state of desolation, the resort of wild beasts and of noxious reptiles.

In 1818, upon the overthrow of the Peishwa, Amedabad reverted to the British. On its present condition there is little to remark. Some additional consequence was conferred on the city during the administration of the government of Bombay by Sir John Malcolm, who made it the seat of the political residency, previously stationed at Baroda; but in 1838 this advantage was lost by the re-transfer of the residency to its former location. The extent and strength of the walls of Amedabad have been already noticed; but these having become greatly dilapidated, the government in 1834 authorised their thorough repair at a cost of L.25,000. The city contains 130,000 inhabitants: its principal streets are well lighted during the night with oil, and the requisite supply of water for the inhabitants is raised from the river and distributed through the city by pipes of tile. Distance from Bombay, 290 miles; from Poona, 320; from Delhi, 490; and from Calcutta 1020 miles. Long. 72. 36. E. Lat. 23. N. (E. T.)

AMEDIANS, an order of monks in Italy, so called from their professing themselves *amantes Deum*, lovers of God; or rather *amati Deo*, beloved of God. They wore a gray habit and wooden shoes, had no breeches, and girt themselves with a cord. They had 28 convents, and were united by Pope Pius V. partly with the Cistercian order, and partly with that of the Soccolanti, or wooden-shoe wearers.

AMEDNUGGUR, or AHMEDNUGGUR, in Hindustan, the principal place of the British district of the same name in the presidency of Bombay, and formerly the capital of one of the independent kingdoms of the Deccan. It was built in 1494 by Ahmed Nizam Shah, who made it the seat of government of his new monarchy. The rise of the kingdom of Ahmednuggur, and its subversion by Shah Jehan, emperor of Delhi; the subsequent cession of its territories to the Mahrattas; and their final transfer to the British, will be found more fully detailed under the article DECCAN. Distance of the city of Ahmednuggur from Bombay east, 122 miles; from Calcutta by Nagpore south-west, 930. Lat. 19. 6. Long. 74. 46. (E. T.)

AMELAND, an island in the North Sea, being a part of the province of Friesland, in Holland, from which it is separated by a strait called the Wat. It contains three villages, one hamlet, and 3300 inhabitants, who chiefly subsist by fishing, as seamen, by burning lime from mussel-shells, and by agricultural pursuits. Some corn is grown, and butter and cheese are made.

AMELIA, a county in Virginia, situated between the Blue-ridge and the Tide-waters, having Cumberland county on the north, Prince George county on the east, and Lunenburg county on the south and west. In 1810 Amelia contained 10,594 inhabitants, but in 1850 they had declined to 9755.

AMELIA ISLE, on the north-east coast of Florida, lies about twelve leagues north of St Augustin, and about nine or ten miles from the mouth of St John's river. It is 20 miles long and two broad, is very fertile, and has an excellent harbour. Its north end lies opposite to Cumberland Island, between which and Amelia Isle is the entrance to St Mary's river, in Long 81. 36. W. Lat. 30. 35. N.

AMELOT DE LA HOUSSAYE, *Abraham Nicolas*, was born at Orleans in 1634. He was much esteemed at the court of France, and was appointed secretary of an embassy which that court sent to the commonwealth of Venice, as appears by the title of his Translation of Father Paul's History of the Council of Trent; but he afterwards published writings which gave such offence that he was imprisoned in the Bastile. The first works he printed were the History of the Government of Venice, and that of the Uscoks, a people of Croatia. In 1683 he published his translations into French of Machiavel's Prince, and Father Paul's History of the Council of Trent, with political Discourses of his own upon Tacitus. These performances were well received by the public. He did not prefix his own name to the two last-mentioned works, but concealed himself under that of La Mothe Josseval. His translation of Father Paul was attacked by the partisans of the pope's unbounded power and authority. In France, however, it met with great success; all the advocates for the liberty of the Gallican church promoting the success of it to the utmost of their power, though at the same time there were three memorials presented to have it suppressed. In 1684 he printed, at Paris, a French Translation of Balthasar Gracian's *Courtier*, with the title of *L'Homme de Cour*. In 1686 he published *La Morale de Tacite de la Flatterie*, in which work he collected several particular facts and maxims, which represent in a strong light the artifices of court-flatterers, and the mischievous effects of their poisonous discourses. He wrote several other works; and died at Paris in 1706, at the age of 73.

AMELOTTE, DENIS, a celebrated French writer, was born at Saintonge in 1606. He maintained a close correspondence with the fathers of the Oratory, a congregation of priests founded by Philip of Neri. He wrote the life of Charles of Gondren, second superior of this congregation, and published it at Paris in 1643. In this work he said something of the famous abbot of St Cyran which greatly displeased the Port Royalists, who, out of revenge, published a libel against him, entitled *Idée Général de l'Esprit et de Livre de P. Amelotte*. He was so much provoked by this satire, that he did all in his power to injure them. They had finished a translation of the New Testament, and were desirous to have it published; for which purpose they endeavoured to procure an approbation from the doctors of the Sorbonne, and a privilege from the king. Amelotte, however, by his influence with the chancellor, defeated their intention. In this he had also a view to his own interest, being about to publish a translation of his own. Amelotte's translation, with annotations, in four volumes octavo, was printed in the years 1666, 1667, and 1668, and, according to F. Simon, contains some very gross blunders. He entered into the congregation of the Oratory in 1650, and continued amongst them till his death, which happened in 1678.



AMEN, אמן, signifies *true, faithful, certain*. It is made use of likewise to affirm anything, and was a sort of affirmation used often by our Saviour: Ἀμήν, Ἀμήν, λέγω ὑμῖν, i. e., *Verily, verily, I say unto you*. Lastly, it is understood as expressing a wish: as, *amen, so be it*, (Numb. v. 22); or an affirmation, *amen; yes, I believe it*, (1 Cor. xiv. 16.) The Hebrews end the five books of Psalms, according to their way of distributing them, with the words *amen, amen;* which the Septuagint have translated γένοιτο, γένοιτο; and the Latins *fiat, fiat*. The Greek and Latin churches have preserved this word in their prayers, as well as *alleluiah* and *hosannah;* because they observe more energy in them than in any terms which they could use in their own languages. At the conclusion of the public prayers, the people answered with a loud voice, Amen; and St Jerome says, that at Rome, when the people answered amen, the sound of their voices was like a clap of thunder: *In similitudine cœlestis tonitrui amen reboat.*

AMEND, or AMENDE, in French legislation, a pecuniary punishment imposed by a judge for any crime, false prosecution, or groundless appeal.

*AMENDE Honorable*, a species of punishment formerly inflicted in France upon traitors, parricides, or sacrilegious persons, in the following manner: The offender being delivered into the hands of the hangman, his shirt was stripped off, a rope put about his neck, and a taper placed in his hand; he was then led into court, where he implored pardon of God, the king, the court, and his country.

*AMENDE Honorable* is a term also used for making recantation in open court, or in presence of the person injured.

AMENDMENT, in *Parliamentary Language*, is used to signify a word, clause, or paragraph, proposed as an alteration in, or addition to, a bill under consideration. See PARLIAMENT.

AMENTUM. See BOTANY.

AMENTUM, in *Roman Antiquity*, a thong tied about the middle of a javelin or dart, either to give it rotation, or in order to recover the weapon as soon as it was discharged. The ancients made much use of the amentum, thinking it helped to enforce the blow. It was called ἀγκυλή by the Greeks, and the expression *Hastæ ansatæ* probably refers to the same. Amentum sometimes denoted a latchet that bound the sandals.

AMERCEMENT, or AMERCIAMENT, in *Law*, a pecuniary punishment imposed on offenders at the mercy of the court. It differs from a fine, in being imposed arbitrarily, in proportion to the fault; whereas a fine is a certain punishment settled expressly by some statute.

AMERIA, an ancient city of Umbria, situated on a hill between the rivers Tiber and Nar, a few miles above their junction. Its site is occupied by a small modern town of the same name.

# AMERICA.

America.

OUR object in this article is to take a comprehensive survey of the American continent in its physical, moral, and general relations. In attempting this, we do not intend to go much into detail upon those subjects which will be more fully and appropriately discussed in the distinct articles assigned in this work to the several states included in the western world; but we shall dwell at some length upon those great features, peculiarities, and classes of facts, which either belong to it as a whole, or can be most advantageously considered or described when all its parts are viewed in connection with one another. Such are the climate and physical structure of the country, the geographical distribution of its cultivated plants, its indigenous population, its animal tribes, its commercial and political capabilities, and its means of progressive improvement. The new continent may be styled emphatically "a land of promise." The *present* there sinks into nothing in itself, and derives all its importance from the germs it contains of a mighty future. The change must not only be great, but rapid, beyond all which the past history of mankind would lead us to expect. Even after we have familiarised our minds with the principles upon which its progress depends, we find it difficult to reconcile ourselves to the consequences that inevitably result from them. But time will do its work; and the great-grandsons of those now in existence may live to see the new world contain a greater mass of civilised men than the old. It is this greatness in prospect which lends an interest to the Western continent similar to that which the Eastern derives from its historical recollections. The same circumstance requires that we should dwell at some length on the physical structure of America, and on those indigenous tribes which, in the course of three centuries, will only live in poetry and tradition. The future history of the new world must be read by us in the configuration of its surface, the distribution of its mountains and rivers, the productions of its soil, its natural and political capabilities, and in the character rather than the numbers of its civilised inhabitants.

The continental part of America extends from the 54th degree of south to the 71st of north latitude, its extreme length, from the Straits of Magellan to those of Behring, being 10,500 English miles. The islands of Tierra del Fuego reach one degree beyond its southern extremity into the Antarctic Ocean; and Greenland, which is connected by geographers with America, has been traced to the 78th degree of north latitude, and probably is prolonged much farther into the polar circle. The late discoveries of Captains Parry, Ross, and Franklin, have given us much more exact ideas than we formerly possessed of the northern regions of America. The coast of the mainland has been traced almost completely from Behring's Straits to Fox's Channel on Hudsons' Bay, and is found to run in a direction east and west, in an uneven line near the parallel of 70°. The bounds of continental America may therefore be considered as nearly determined on every side. The additional lights furnished by Captain Parry's and other recent voyages render it extremely probable that a great archipelago of islands occupies all the space between the northern coast of the continent and the 80th parallel; and there is even some reason for believing that the country known by the name of Greenland is traversed from east to west by arms of the sea, like the regions on the west side of Baffin's Bay.

The new continent, when compared with the old, enjoys three important advantages. First, it is free from such vast deserts as cover a large part of the surface of Asia and Africa, and which not only withdraw a great proportion of the soil from the use of man, but are obstacles to communication between the settled districts, and generate that excessive heat which is often injurious to health, and always destructive to industry. Secondly, no part of its soil is so far from the ocean as the central regions of Asia and Africa. Thirdly, the interior of America is penetrated by majestic rivers, the Mississippi, Amazon, and Plata, greatly surpassing those of the old continent in magnitude, and still more in the facilities they present for enabling the remotest inland districts to communicate with the sea.

America.

According to the geographical system adopted in the old world, America ought to be considered as two distinct continents, connected by the isthmus of Darien. Its two great divisions have evidently more of a defined and separate character than Africa and Asia, or than Asia and Europe; but though this arrangement may be very properly adopted for the purpose of description, it is too late now to think of assigning separate names to regions which have so long been known by a common appellation. In the physical arrangement of the parts of South and North America there is a remarkable resemblance. Both are very broad in the north, and gradually contract as they proceed southward, till they end, the one in a narrow isthmus, and the other in a narrow promontory. Each has a lofty chain of mountains near its western coast, abounding in volcanoes, with a lower ridge on the opposite side, destitute of any trace of internal fire; and each has one great central plain declining to the south and the north, and watered by two gigantic streams, the Mississippi, corresponding to the Plata, and the St Lawrence to the Amazon. In their climate, vegetable productions, and animal tribes, the two regions are very dissimilar.

The extent of the American continent and the islands connected with it is as follows:—

| | Square Eng. miles. |
|---|---|
| North America | 7,400,000 |
| South America | 6,500,000 |
| Islands | 150,000 |
| Greenland, and the islands connected with it lying north of Hudson's Straits, may be estimated at | 900,000 |
| | 14,950,000 |

The American continent, therefore, with its dependent islands, is fully four times as large as Europe, about one-third larger than Africa, and almost one-half less than Asia, if we include with the latter Australia and Polynesia. It constitutes about three-tenths of the dry land on the surface of the globe. Of the continental part of North America, a considerable portion is condemned to perpetual sterility by the rigour of the climate, as we shall explain more fully by and by. At present it is sufficient to state, that if we draw a line from the head of Cook's Inlet, in latitude 61°, on the west side, to the straits of Bellisle on the east, so as to pass through Fort Churchill, on Hudson's Bay, we shall cut off a space rather exceeding one million and a half of square miles, which may be considered as incapable of cultivation. At the south extremity of America, a small tract, extending 200 miles north of the straits of Magellan, though far within the limits of the temperate zone, is nearly in the same condition. These and the summits of the Andes are the only parts of the American continent which are rendered incapable of cultivation by the severity of the climate.

The vast chain of the Andes is distinguished by several peculiar features from all other mountains in the world. It has its principal direction nearly north and south, while all the great ridges of the old continent run from east to west; it is unparalleled in its prodigious length, in the richness of its mineral treasures, and in the number and magnitude of its volcanoes. The Andes, if we connect with them the Mexican Cordillera and the Rocky Mountains, extend from the Straits of Magellan in a line which may be considered as unbroken, to Point Brownlow on the shores of the Arctic Ocean, in the latitude of 70°, over a space equal to 10,000 miles in length, or two-fifths of the circumference of the globe. Their height, which attains its maximum within the tropics, declines towards both poles, but in such a manner that, with a few exceptions, its higher summits ascend to the line of perpetual snow from one extremity to the other. It may thus be said to carry the temperature of the pole over the whole length of the American continent. The chain of the Andes is common to the two parts of America, and is in fact the link which connects them and makes them one continent. As we propose, however, to describe North and South America separately, we shall reserve the details for another part of this article.

South America is a peninsula of a triangular form. Its greatest length from north to south is 4550 miles; its greatest breadth 3200; and it covers an area, as already mentioned, of 6,500,000 square English miles, about three fourths of which lie between the tropics, and the other fourth in the temperate zone. From the configuration of its surface, this peninsula may be divided into five distinct physical regions, 1. The low country skirting the shores of the Pacific Ocean, from 50 to 150 miles in breadth, and 4000 in length. The two extremities of this territory are fertile, the middle a sandy desert. 2. The basin of the Orinoco, a country consisting of extensive plains or *steppes*, called Llanos, either destitute of wood or merely dotted with trees, but covered with a very high herbage during a part of the year. During the dry season the heat is intense here, and the parched soil opens into long fissures, in which lizards and serpents lie in a state of torpor. 3. The basin of the Amazon, a vast plain, embracing a surface of more than two millions of square miles, possessing a rich soil and a humid climate. It is covered almost everywhere with dense forests, which harbour innumerable tribes of wild animals, and are thinly inhabited by savages, who live by hunting and fishing. 4. The great southern plain, watered by the Plata and the numerous streams descending from the eastern summits of the Cordilleras. Open *steppes*, which are here called Pampas, occupy the greater proportion of this region, which is dry, and in some parts barren, but in general is covered with a strong growth of weeds and tall grass, which feeds prodigious herds of horses and cattle, and affords shelter to a few wild animals. 5. The country of Brazil, eastward of the Parana and Araguay, presenting alternate ridges and valleys, thickly covered with wood on the side next the Atlantic, and opening into steppes or pastures in the interior.

Mountains. The Andes.

The Andes skirt the shores of the Pacific Ocean, like a vast rampart opposed to its encroachments, along the whole line of the western coast, from 12° of north to 53° of south latitude. They derive their name from *anti*, a Peruvian word signifying copper. Except at some points where they have been examined by scientific men, their structure is yet but imperfectly known; and hence they are often incorrectly exhibited in our maps. Though often described as a single chain, they generally consist of a succession of ridges, divided by high and narrow valleys; but these ridges, instead of running in parallel lines, generally ramify from central points in all directions, and thus present the appearance of a confused assemblage of small chains. Between the latitude of 33° and 6° south, they spread out their base to an extent of 300 miles, and even much farther, if we take in the smaller subordinate chains. In the intervals between the ridges are situated many lakes, of which the most considerable are Ondalgola, Pataipo, Hages, and the great lake of Titicaca, 200 miles in length. This lake, and the lake Parimé, in Guiana, are the only sheets of fresh water in South America which vie in magnitude with those singular reservoirs placed on the course of the St Lawrence. From the latitude of 6° south to 2° north, the Andes contract their breadth, and form an elevated plateau. One part of this constitutes the Paramo, or desert of Assuay, a plain at the height of 13,000 feet above the sea, and embracing a surface of 50 square miles, where snow-storms are frequent, and only a few alpine plants grow. Farther north lies another range of table-land, from 9000 to 9440 feet in height, near the north extremity of which the town of Quito is situated. On this elevated plain are placed two lines of lofty summits, standing detached from each other, and crowned with diadems of perpetual snow. Their symmetrical disposition led Bouguer to consider the space between the eastern and western lines as a valley; but Humboldt remarks that it is really the crest of the Cordillera, upon which, as a base, the cones or masses of Pinchincha, Antisana, Atacazo, Chimborazo, and others, rest. When we have lived in this elevated spot for some time, "we forget that every thing which surrounds the observer, those villages which proclaim the industry of a mountainous people, those pastures covered with herds of lamas and flocks of European sheep, those orchards, those fields cultivated with care, and promising the richest harvests, hang as it were suspended in the lofty regions of the atmosphere, at a height exceeding that of the Pyrenees." From Quito, a single chain extends to Popayan, where it parts into three parallel chains. The westmost of these ridges, which scarcely rises to an elevation of 5000 feet, divides the valley of the river Cauca from the Pacific Ocean; and a branch proceeding from it passes through the isthmus of Panama, where it sinks to the small elevation of 600 or 800 feet above the sea. The second, or central ridge, maintains nearly the general height of the main trunk, and has summits which rise into the regions of perpetual snow. It separates the valley of the Cauca from that of the Magdalena. The pass of Quindiu, described by Humboldt, is one of the Quebradas, or transverse ravines, which open a passage through this mountain. It is so narrow in some places as to have the appearance of a gallery cut artificially and open to day. It is steep and uneven, and is kept almost perpetually wet by the rains. Travellers are carried through this ravine in chairs strapped on the backs of porters, who follow this mode of life voluntarily for the sake of gain, and think themselves sufficiently paid with twelve or fourteen piasters for a toilsome journey of fifteen or twenty days. Even the bottom of this ravine, at its highest point, is 11,400 feet above the sea, and of course exceeds the highest summit of the Pyrenees in altitude. The third or eastern ridge separates the valley of the Magdalena from the plains of the Rio Meta, and has its northern termination at Cape Vela, in longitude 72°. This chain, though lower than the centre one, has summits which reach to the height of 14,000 feet. Between the eastern and central chains is situated the city of Santa Fe de Begota, in a large and beautiful plain 8700 feet above the sea, and which, from the perfect level of its surface, and the barrier of rocks that incloses it, appears to have been an ancient lake. The waters of this plain escape by a narrow outlet, and rushing down a cleft, leap at two bounds to a depth of 573 feet, forming the celebrated fall of Tequendama, which, in the attributes of beauty and sublimity, is said not to be surpassed in the world. These three parallel ridges are properly component parts of the main trunk, like the two ridges of Upper Peru.

South America.

The mean height of the Andes in Peru, or that of the continuous ridge, independent of projecting cones, is estimated by Humboldt at 11,000 or 12,000 feet (1850 toises): in Chili, according to Mr Miers, the most elevated summits, at the latitude 33°, only reach the height of 15,000 feet, and the mean height of the chain is in some places as low as 8000; in Patagonia its height is unknown. Till lately, the loftiest summits were supposed to be in Quito, where Chimborazo attains the prodigious altitude of 21,440 English feet, and the volcanic cones of Antisana and Cotopaxi have the elevations of 19,150 and 18,890 feet respectively; but Mr Pentland, an English gentleman attached to the Peruvian embassy, has ascertained, by measurements performed with care, that the mountains of Quito are greatly surpassed in altitude by some of those of Upper Peru. The Andes here form two chains, which are separated by a large district of table-land, the northern extremity of which is occupied by the lake Titicaca. The eastern chain presents, between the 14th and 17th parallels, a range of snow-covered peaks, of which several have an elevation exceeding 20,000 feet. Among these, towards the north, in the latitude of 15° 30′, is Sorate, 25,250, and farther south Illimani, 24,450 feet in height. The former, therefore, is nearly 4000 feet higher than Chimborazo, but still 3000 feet lower than the loftiest summits of the Himalaya. The western chain is lower than the eastern, but one of its summits has an altitude of 18,800 feet. Mr Pentland concludes from astronomical observations, that the eastern chain is 310 geographical or 360 English miles from the coast. The mineral wealth of the district has attracted a large population to this table-land, which, with the single exception of Thibet, is probably the highest inhabited soil on the face of the globe. Here are flocks, gardens, cultivated fields, and populous cities, suspended above the region of the clouds. La Paz, with 20,000 inhabitants, and Potosi, which had once 150,000, are situated in this plain, at the height of 12,190 and 13,500 feet above the level of the sea; and there are cottages near the mines at 15,700 feet, an elevation exceeding that of Mont Blanc.[1] This table-land, from Cusco to Potosi, was the primitive seat of the empire of the Incas, and the centre of Peruvian civilisation.

Though nothing appears more capricious than the distribution and elevation of mountains, they yet afford, on the great scale, striking proofs of beneficent design, and of adaptation to the wants of civilised man. Many chains of mountains, for instance, enter within the regions of eternal frost with one or more of their summits; but there is not a single great chain in any of the fruitful and habitable parts of the world which so far transcends this limit as to present an unbroken line of snow along its whole length. The height of the curve of congelation diminishes as we approach the pole; and if there were not a corresponding diminution in the elevation of the mountains, or if the principal chains in the different habitable zones were raised a little higher, they would sever the nations living on their opposite sides as effectually as a wall of brass reaching above the clouds. The Andes, if we disregard their projecting summits, form an unbroken dike about $2\frac{1}{4}$ miles high, and 4500 miles long. Were three or four thousand feet added to their height, all access across, from one side of the chain to the other, would be denied to the foot of man. If great perils attend the short journey to the summit of Mont Blanc, what human skill or power could encounter the terrors of a snowy desert a hundred miles in breadth, beset with avalanches, and visited with storms? In these circumstances, such towns as Arica and La Paz, or Mendoza and Santiago, which are separated only by a journey of three days, would be as far asunder, for the purposes of traffic or intercourse, as England and Jamaica. But the line which bounds the means of communication varies from clime to clime. Were the Alps as elevated as the Andes, all the passes across the former would be closed; and were the Scandinavian chain as high as the Alps, Sweden and Norway could only communicate by sea. Though the altitude of the Andes in Patagonia has never been measured, various circumstances show that the chain descends as it advances from the torrid zone to its southern termination. In Quito and Peru, the back or crest of the ridge is free from snow, which only rests upon isolated summits; and with the aid of such arrangements as would be created by a dense population, the means of passing from one side to the other might perhaps be found wherever they were deemed necessary. In Chili, beyond the latitude of 30°, the highest point of the most frequented pass was found by Mr Miers to be 11,920 feet above the sea; and the courier travels through it even in winter. In Peru and Quito the passes in many cases consist of deep fissures, called *quebradas*, apparently produced by earthquakes, extremely narrow, and often descending to the depth of nearly a mile.[2] In Patagonia, where the snow descends much lower, the passes must be few; but there are some—and this circumstance authorises the conclusion that the height of the chain is smaller here than in Chili.

Transverse chains.

Three branches or transverse chains proceed from the Andes, nearly at right angles to the direction of the principal chain, and pass eastward across the continent, about the parallels of 18° of south, and 4° and 9° of north latitude. The most northern of these is "the Cordillera of the coast," which parts from the main trunk near the south extremity of the lake Maracaybo, reaches the sea at Porto Cabello, and then passes eastward through Caraccas to the Gulf of Paria. Its length is about 700 miles, and its medium height from 4000 to 5000 feet; but the Silla de Caraccas, one of its summits, has an elevation of 8400 feet; and its western part, which is at some distance from the sea, contains the Sierra of Merida, 15,000 feet in height. The second transverse chain is connected with the Andes at the parallels of 3° and 4° north, and passing eastward, terminates in French Guiana, at no great distance from the mouth of the Amazon. It consists properly of a succession of chains nearly parallel to the coast, and is sometimes called the Cordillera of Parimé, but is named by Humboldt the "Cordillera of the Cataracts of the Orinoco," because this river, which flows amidst its ridges in the upper part of its course, forms the cataracts of Maypure at the point where it descends into the plains. Its mean height is estimated at 4000 feet above the level of the sea; but about 70° and 75° west longitude, it sinks to less than 1000 feet, and at other points rises to 10,000. This chain divides the waters of the Orinoco and the rivers of Guiana from the basin of the Amazon, and is covered with magnificent forests. Its breadth is supposed to be from 200 to 400 miles, and it incloses amidst its ridges the great lake Parimé, in longitude 60°, and several of smaller size. On a table-land forming part of it, about the 67th degree of longitude, the Cassiquiari forms an intermediate channel which connects the rivers Orinoco and Amazon, so that, during the annual floods, a part of the waters of the former flow into the latter. This singular phenomenon was made known long ago by the Spanish missionaries, but was thought to be a fable till the truth was ascertained by Humboldt. The length of this chain is about 1500 miles. The third transverse chain, which bears various names, and is little known, crosses the continent between the parallels of 12° and 18°, connect-

[1] *Bulletin des Sciences Géographiques*, Mars 1829; *Edinburgh Philosophical Journal*, April 1830, p. 353.
[2] Humboldt's *Researches*, vol. i. p. 53; Miers' *Travels in Chili and La Plata*, vol. i. p. 319.

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ing the Andes with the mountains of Brazil, and dividing the waters of the Amazon from those of the Plata. It is a broad plateau of elevated land rather than a distinct mountainous ridge, and consists of low hills or uneven plains, with very little wood, presenting in some places extensive pastures, and in others tracts of a poor sandy soil. Its average height probably does not exceed 2000 or 3000 feet above the level of the sea.[1]

The mountains of Brazil, which are of moderate height, and occupy a great breadth of country, form an irregular plateau, bristled with sharp ridges running in a direction approximately parallel to the eastern coast. They extend from 5° to 25° of south latitude, and their extreme breadth may be about 1000 miles. Itacolumi, about 250 miles north-west of Rio Janeiro, which is celebrated for its auriferous sands and gravel, and gives birth to three great rivers, the Parana, the St Francisco, and the Tocantin, is considered the most elevated summit, and the stem of the whole group. According to the German miner Eschwege, it rises to the height of 5710 English feet[2] above the level of the sea; and the ordinary elevation of the numerous ridges which branch off from it is supposed to be 3000 or 4000 feet. The western parts of this chain, which are near the centre of the continent, are supposed to be lower than those on the coast; but they are probably as high, if Dr Spix is correct in stating that the mean heat of the year is below 65° of Fahrenheit (15° or 16° of Reaumur).

Geology.

The geology of the South American mountains, particularly the Andes, is distinguished, like their physical form and arrangement, by some remarkable peculiarities. The chain of the Andes, as we have already stated, may be considered as an immense dike, from two to three miles in height, and from one to three hundred in breadth. The first and most peculiar feature of this chain is, that it contains within its limits thirty active volcanoes,[3] or nearly one-fifth of all that are known in the world. They are irregularly distributed in linear groups from Patagonia to New Granada. The most southerly or Chilian group extends from 43½° to 30° south latitude. After an interval of 8° without volcanoes, we have a second group, that of Bolivia in Peru, extending from the 21st to the 15th deg. of south latitude. About 14° beyond this, the third group, that of Quito appears, extending about 2° on each side of the equator. A fourth line or group, 500 miles in length, occurs in the isthmus, chiefly in the state of Guatemala; and a fifth, consisting of five vents, crosses Mexico in an east and west direction. Some of these throw out smoke merely, some mud and water, and only a few produce eruptions of lava. They are of various elevations, up to 18,800 feet. Over nearly the whole chain earthquakes are extremely frequent, and at times fearfully destructive. The fundamental rock of the Andes is granite, or a rock of kindred nature, which, from being almost peculiar to the chain, has been termed Andesite. It is a combination of albite and hornblende, often united with mica, and sometimes, though rarely, with quartz, passing on the one hand into granite, and on the other into felspar porphyry. Trachyte and syenite occur in analogous positions, that is, generally at the base, and occasionally at the summits of the chain. The fundamental rock is covered by vast masses of felspar or claystone porphyry, which had issued from below at numerous points, "studded over a breadth of 50 or 100 miles;" and being tilted, fractured, and long exposed to denudation in the sea, produced thick beds of porphyry conglomerate, which are seen in every variety of position and inclination. Incumbent on these, or mingled with them are mica slates, probably metamorphic, and clay slates, with silurians, and above these carboniferous sandstones, gypsum, and rocks of the oolite and chalk series. Tertiary deposits cover the plains at the eastern foot of the chain, forming in Patagonia a succession of terraces, one below another, extending to the Atlantic. Mr Darwin thinks that the Andes of Chili, after being raised above the sea, had subsided at least twice to the extent of six or eight thousand feet, and this conclusion applies to the whole chain. The Andes are rich in metals, abounding in mines of copper, silver, gold, &c. Crystalline schists occupy the greater part of Brazil and of Venezuela, and Guiana. A deposit of fine mud, from 20 to 100 feet thick, is found on the banks of the Parana, and covers the plains called Pampas, from Buenos Ayres, nearly as far south as the river Colorado. It is an estuary deposit, of post-tertiary or quarternary age, formed, as Mr Darwin thinks, by the Parana and its tributaries, when the land was lower "by a few fathoms" than it is now. It contains fossil remains of large mammalia in vast numbers, all of extinct species, and many of them even of extinct genera, including the Megatherium, Megalonix, Scelidotherium, Mylodon, Holofractus, Toxodon, Macrouchenia, Glyptodon, Mastodon, a great Dasypus, with a Ctenomys, Hydrochœrus, and other rodents. The horse and the elephant have been found in the fossil state from Spain to eastern Siberia, and from Russian America to Patagonia, affording a presumption, as Mr Darwin observes, that when these quadrupeds lived the two continents were connected at or near Behring's Straits.[4]

The transverse chain of the coast of Caraccas consists partly of primitive and partly of secondary formations. The Cordillera of Parimé, so far as it has been examined, is entirely composed of primitive rocks, viz., granite, gneiss, mica slate, and hornblende; the Cordillera of Chiquito, which divides the Plata from the Amazon, is only known at its eastern extremity, where it joins the mountains of Brazil. These last consist of a great number of ridges, running in general south and north. Granite abounds in those nearest the Atlantic, but the prevailing rock everywhere else, as far westward as the mountains of Cujaba, in longitude 55°, is a quartzy mica slate, intermixed however with granite, gneiss, and quartz rock, and having portions of secondary sandstone resting on its sides or in its low valleys. This quartzy mica slate, in Brazil, is the matrix of the gold and diamonds; and the former is generally accompanied with platinum and iron. The direction of the strata approaches to north-east and south-west, and the dip, where observed, is from 50° to 70° to the south-east. These mountains, like the Andes, are in many parts covered with a stratum of clay.[5] The rocks of the plains have been but partially examined. Humboldt thinks that the northern Llanos of Caraccas are of old red sandstone.

Climate.

The latitude and elevation of the land in each country, its position in reference to the sea, with the direction of the prevailing winds, are the chief circumstances which determine the nature of the climate. We have already mentioned that three-fourths of South America lie within the tropics, and the remaining fourth in the temperate zone; but, in both divisions, it might be naturally inferred that a huge wall like the Andes, rising into the atmosphere to the height of two or three miles, and running across the course of the tropical and extra-tropical winds, would exert a powerful influence on the temperature, humidity, and the distri-

[1] *Travels of Spix and Von Martius, in Brazil*, vol. ii. p. 144. Eng. edit.

[2] Spix's *Travels*, vol. ii. p. 269.

[3] On some maps 40 are marked, but erroneously. See Memoir on Active Volcanoes, in the French *Annuaire* for 1824.

[4] C. Darwin's *Geological Observations on South America*, p. 106, 237, 248. *Journal*, p. 150. Humboldt's *Personal Narrative*, vol. iv. p. 308.

[5] Spix and Von Martius, vol. ii. p. 142, &c.

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bution of the seasons. This is actually the case; and it is this vast chain of mountains, with its prolongation in North America, which affords a key to the most remarkable peculiarities in the climate of the whole continent. The subject, we think, has not been hitherto well understood, but admits of being explained in a very simple manner.

The trade-winds blowing from the east occupy a zone 60 degrees in breadth, extending from 30° of south to 30° of north latitude. Beyond these limits are variable winds; but the prevailing direction in the open sea, where no accidental causes operate, is well known by navigators to be from the west. Now these winds are the agents which transport the equable temperature of the ocean, and the moisture exhaled from its surface, to the interior of the great continents, where it is precipitated in the shape of rain, dew, or snow. Mountains attract the moisture which floats in the atmosphere; they obstruct also the aerial currents, and presenting great inequalities of temperature, favour precipitation. Rain, accordingly, in all countries falls most abundantly on the elevated land. Let us consider, then, what will be the effect of a mural ridge like the Andes in the situation which it occupies. In the region within the 30th parallel, the moisture swept up by the trade-wind from the Atlantic will be precipitated in part upon the mountains of Brazil, which are but low, and so distributed as to extend far into the interior. The portion which remains will be borne westward, and, losing a little as it proceeds, will be arrested by the Andes, and fall down in showers on their summits. The aerial current will now be deprived of all the humidity which it can part with, and arrive in a state of complete exsiccation at Peru, where no rain will consequently fall. That even a much lower ridge than the Andes may intercept the whole moisture of the atmosphere, is proved by a well-known phenomenon in India, where the Ghauts, a chain only 3000 or 4000 feet high, divide summer from winter, as it is called; that is, they have copious rains on their windward side, while on the other the weather remains clear and dry; and the rains regularly change from the west side to the east, and *vice versa*, with the monsoons. In the region beyond the 30th parallel, this effect will be reversed. The Andes will in this case serve as a screen to intercept the moisture brought by the prevailing west winds from the Pacific Ocean; rains will be copious on their summits, and in Chili on their western declivities, but none will fall on the plains to the eastward, except occasionally, when the winds blow from the Atlantic. The phenomena of the weather correspond in a remarkable manner with this hypothesis. On the shore of the Pacific, from Coquimbo, at the 30th parallel, to Amotape, at the 5th of south latitude, no rain falls; and the whole of this tract is a sandy desert, except the narrow strips of land skirting the streams that descend from the Andes, where the soil is rendered productive by irrigation. From the 30th parallel southward the scene changes. Rains are frequent; vegetation appears on the surface, and grows more vigorous as we advance southward. "At Conception," says Captain Hall, "the eye was delighted with the richest and most luxuriant foliage; at Valparaiso the hills were poorly clad with a stunted brushwood and a poor attempt at grass, the ground looking starved and naked; at Coquimbo the brushwood was gone, with nothing in its place but a vile sort of prickly pear bush, and a thin sprinkling of gray wiry grass; at Guasca (latitude 28½°) there was not a trace of vegetation, and the hills were covered with bare sand."[1] It follows from the principle we have laid down, that in this southern part of the continent the dry tract should be found on the east side of the mountains, and such is the fact. At Mendoza, in latitude 30°, rain scarcely ever falls, and the district along the east foot of the Andes is known to consist chiefly of parched sands, on which a few stunted shrubs grow, and in which many of the streams that descend from the mountains are absorbed before they reach the sea. The whole country, indeed, south of the Plata, suffers from drought; but on the eastern side this is remedied to some extent by winds from the east or south-east, which bring occasional rains to refresh the soil. From Amotape northward, on the other hand, the west coast is well watered and fruitful; and this is easily accounted for. The line of the coast here changes its direction, and trends to the north-east as far as the Isthmus of Panama, where the mountains sink to a few hundred feet in height, and leave a free passage to the trade-wind, which here often assumes a direction from the north-east, or even the north. The exhalations of the Atlantic are thus brought in abundance to the coast of Quito, which is in consequence well watered; while the neighbouring district of Peru suffers from perpetual aridity.

Our principle applies equally to the explanation of some peculiar facts connected with the climate of North America. The western coast of Mexico, as far as St Blas or Mazatlan, in latitude 23°, is well watered, because, *first*, the continent here is narrow; *secondly*, the table-land of Mexico, which is much lower than the Andes of Chili, is not so effectual a screen to intercept the moisture; and, *thirdly*, there is reason to believe that a branch of the trade-wind, which crosses the low part of the continent at Panama and Nicaragua, sweeps along the west coast during part of the year, and transports humidity with it. But beyond the point we have mentioned drought prevails. Sonora, though visited occasionally by rains, consists of sandy plains without herbage, where the streams lose themselves in the parched soil without reaching the sea; and even Old California, which has the ocean on one side, and a broad gulf on the other, and ought apparently to be excessively humid, is covered with sterile rocks and sandy hills, where the vegetation is scanty, and no timber is seen except brushwood.[2] This dry region extends as far as 33° or 34°; but immediately beyond this we have another change of scene. New California is described as in all respects a contrast to the Old. It is rich, fertile, and humid, abounding in luxuriant forests and fine pastures; and the American possessions to the northward preserve the same character. How can we account for this singular diversity of climate, except upon the principle which has been explained, namely, that in all regions where ranges of mountains intersect the course of the constant or predominant winds the country on the windward side of the mountains will be moist, and that on the leeward dry; and hence parched deserts will generally be found on the west side of countries within the tropics, and on the east side of those beyond him? Our hypothesis applies equally to the country east of the Rocky Mountains. For the space of about 3000 miles from the foot of this chain the surface consists of dry sands or gravel, sometimes covered with saline incrustations, almost destitute of trees and herbage, and watered by streams flowing from the mountains, which are sometimes entirely absorbed by the arid soil.[3] The central and eastern part of the basin of the Mississippi would in all probability have been equally barren had the configuration of the land been a little different in the south. A tract of country extremely low and level extends along both sides of this river; and a portion

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1 Hall's *Extracts from a Journal*, vol. ii. p. 12.

2 Shelvock's *Voyages*, in Harris's *Collection*, vol. i. p. 232; Hardy's *Travels in Mexico*, pp. 128, 163, 300.

3 James's *Expedition from Pittsburg to the Rocky Mountains; Supplement* by Major Long, in vol. iii.

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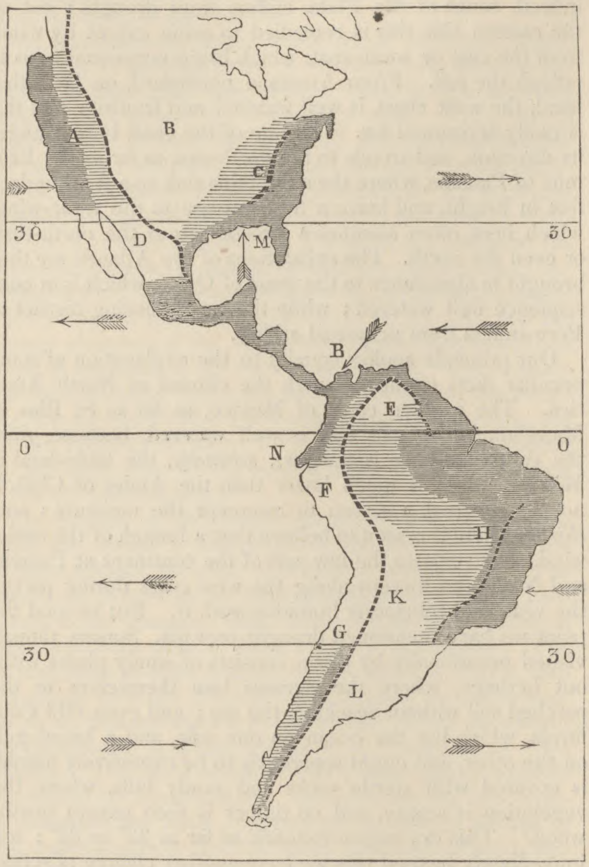
of the trade-wind blowing from the Mexican Gulf, finding its motion westward obstructed by the high table-land of the Cordillera, is deflected to the right, and ascends the valley of the Mississippi and Ohio. This wind, whose course was first traced by Volney, bears with it the humidity of the torrid zone, and scatters fertility over a wide region that would otherwise be the abode of barrenness.




The views on the subject of climate we have been unfolding will enable us to throw some light on an interesting point—the distribution of forests. We are induced to think, that in all countries having a summer heat exceeding 70°, the presence or absence of natural woods, and their greater or less luxuriance, may be taken as a measure of the amount of humidity, and of the fertility of the soil. Short and heavy rains in a warm country will produce grass, which, having its roots near the surface, springs up in a few days, and withers when the moisture is exhausted; but transitory rains, however heavy, will not nourish trees, because after the surface is saturated with water, the rest runs off, and the moisture lodged in the soil neither sinks deep enough, nor is in sufficient quantity to furnish the giants of the forest with the necessary sustenance. It may be assumed that 20 inches of rain falling moderately, or at intervals, will leave a greater permanent supply in the soil than 40 inches falling, as it sometimes does in the torrid zone, in as many hours. It is only necessary to qualify this conclusion by stating, that something depends on the subsoil. If that is gravel, or a rock full of fissures, the water imbedded will soon drain off; if it is clay or a compact rock, the water will remain in the soil. It must be remembered, also, that both heat and moisture diminish as we ascend in the atmosphere, while evaporation increases; and hence that trees will not grow on very high ground, though its position in reference to the sea and the prevailing winds should be favourable in other respects. In speaking of the *region of forests*, we neither restrict the term to those districts where the natural woods present an unbroken continuity, nor extend it to every place where a few trees grow in open plains. It is not easy to give a definition that will be always appropriate; but in using the expression, we wish to be understood as applying it to ground where the natural woods cover more than one-fourth of the surface.

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The small map of America prefixed will enable the reader to follow our statements with ease. The long hatched lines show the positions of the chains of mountains; the shading represents the regions of forests; the dense forests being marked by the double shading, and the thinner ones by the open lines. The white spaces represent the lands on which little or no wood grows. The equator and the parallel of 30° on each side are indicated by the horizontal lines marked 0 and 30. The arrows show the direction of the prevailing winds; but it must be remembered that, though the intertropical wind is assumed to have its course right from the east, this is only true at the equator, its direction inclining to north-east as we approach the northern tropic, and to the south-east as we approach the southern. In North America A is the woody region on the west coast, extending from latitude 35° to about 58°, and of unknown breadth. B the region on the east side of the Rocky Mountains, partly a bare desert, partly covered with grass and dotted with trees. C the forests of the Allegany chain, thick on the east and south, and thin on the west; bounded by a curved line passing from St Luis, in Mexico, through Lake Huron, to the mouth of the St Lawrence, in latitude 50°. The arrow at M points out the direction of the wind, which ascends the valley of the Mississippi, and nourishes the western part of these forests; and the arrow at R that which blows across the isthmus of Panama. D is the table-land of Mexico, graduating on the north-west into the dry plains of Sonora and California, all bare, or nearly bare, of wood. E is the Llanos or bare plains of Caraccas, nearly fenced round with mountains. F G is the long strip of bare dry sands on the west side of the Andes which constitutes Lower Peru and the north part of Chili; and N is Amotape, its northern boundary. H is the great region of forests which constitutes the basin of the Amazon, and occupies all the rest of Brazil. Near the equator the moisture is so excessive, that after 150 or 200 inches of rain[1] have fallen on the east coast, there is still sufficient humidity in the atmosphere to afford copious showers to all the country up to the Andes. Here, therefore, the woods reach from side to side of the continent. But as we recede from the equator the humidity diminishes rapidly; and though the continent becomes narrower towards the south, the supply of rain falls off in a still greater proportion, and the forests extend over a much smaller space. At the foot of the Andes, the forests extend to 16° or 18° of south latitude; on the east coast to 25° or probably 30°. K L are the *Pampas* or open lands of Buenos Ayres, extending on the east side of the Andes, from Cape Horn to the latitudes just mentioned. If we divide this region into three parts, the eastmost, refreshed by occasional rains from the Atlantic, is covered with a strong nutritive herbage; the second, which is drier, displays a thin coarse wiry grass; and the third portion, which extends to the Andes, receiving little or no rain, is nearly a desert: all the three are destitute of timber, but the surface of the third is dotted with dwarfish shrubs.[2]

[1] Humboldt's *Personal Narrative*, vol. vi. p. 277.

[2] See Mr Miers' Journey to Chili, in the first volume of his *Travels*, chap. i. and ii.; and Captain Head's *Rough Notes*, p. 2.

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I is the southern part of Chili. Here the prevailing winds, which are from the west, coming loaded with the moisture of the Pacific Ocean, produce copious rains to nourish the herbage and the forests. This applies, however, chiefly to the country south of the 35th parallel. From that to Coquimbo, in latitude 30°, the wood is scanty. Beyond 50° on the east coast of North America, and 55° or 58° on the west, very little wood grows, in consequence of the rigour of the climate.

Climate.

Great misapprehensions have arisen with regard to the climate of America, from comparisons being drawn between the east side of the new continent and the west side of the old. We have already pointed out the influence of winds blowing from the sea, in modifying the state of the atmosphere over the land, both as to heat and humidity. When this circumstance is attended to, and when the east and west sides of the old and the new continents are respectively compared with one another, the difference is found to be small, and easily accounted for. In the torrid zone, and on the sea-shore, the temperature of both continents is found to be the same, viz., 82°; but in the interior the difference is rather in favour of America. There is no counterpart in the new world to the burning heats felt in the plains of Arabia and Gedrosia. Even in the western and warmest part of the parched steppes of Caraccas, the hottest known region in America, the temperature of the air during the day is only 98° in the shade, which rises to 112° in the sandy deserts which surround the Red Sea. At Calabozzo, farther east in the Llanos, the common temperature of the day is only from 88° to 90°; and at sunrise the thermometer sinks to 80°.[1] The basin of the Amazon is shaded with lofty woods; and a cool breeze from the east, a minute branch of the trade-wind, ascends the channel of the stream, following all its windings, almost to the foot of the Andes. Hence this region, though under the equator, and visited with almost constant rains, is neither excessively hot nor unhealthful. Brazil, and the vast country extending westward from it between the Plata and the Amazon, is an uneven table-land, blest with an equable climate. At Rio Janeiro, which stands low, and is exposed to a heat comparatively great, the temperature in summer varies from 16° to 22° of Reaumur, and the mean is only about 19° (74° Fahr.) Farther north, and in the interior, the Indians find it necessary to keep fires in their huts; and in the country near the sources of the Paraguay, hoar-frost is seen on the hills during the colder months, and the mean temperature of the year falls below 65° or 67°.[2] On the declivities of the Andes, and on the high plains of Upper Peru, the heats are so moderate that the plants of Italy, France, and Germany, come to maturity. Lower Peru, though a sandy desert, enjoys a wonderful degree of coolness, owing to the fogs which intercept the solar rays. At Lima, which is 540 feet above the sea, the temperature varies from 53° to 82°, but the mean for the whole year is only 72°. In the plains of La Plata, the mean temperature of the year is very nearly the same as at the corresponding north latitudes on the east side of the Atlantic. At Buenos Ayres, for instance, the mean annual heat is 19° 7′ of the centigrade thermometer (68° Fahr.), while that of places on the same parallel in the old world is 19° 8′. The range of temperature is probably greater in the basin of the Plata; but as we advance southwards, the diminishing breadth of the continent makes the climate approximate to that of an island, and the extremes of course approach each other. In the Straits of Magellan the temperature of the warmest month does not exceed 43° or 46°; and snow falls almost daily in the middle of summer, though the latitude corresponds with that of England. But the inference drawn from this, that the climate is unmatched for severity, is by no means just, for the winter at Staten Island is milder than in London. In point of fact, the climate of Patagonia is absolutely colder than that of places in the same latitude in Europe; but the difference lies chiefly in the very low temperature of the summer. This peculiarity no doubt results chiefly from the greater coolness of the sea in the southern hemisphere; far beyond the parallel of 48°, the difference of temperature in the North and South Atlantic amounts, according to Humboldt, to 10° or 12° of Fahrenheit's scale.[3] If we push our researches a step farther, and inquire what is the cause of the great warmth of the Northern Sea, we shall be forced to admit that a very satisfactory answer cannot be given. Something may be due to the influence of the Gulf Stream, a minute branch of which is supposed to carry the waters of the torrid zone to the shores of Shetland and Norway; but such an agent seems too trifling to account for the phenomenon. The sum, then, of the peculiar qualities which distinguish the climate of South America may be briefly stated. Near the equator the new continent is perhaps more humid than the old; and within the tropics generally, owing to its vast forests, the absence of sandy deserts, and the elevation of the soil, it is cooler. Beyond the tropics the heat is nearly the same in the southern temperate zone of Amercia and the northern one of the old continent, till we ascend to the neighbourhood of Cape Horn, where we have cold summers, and a very limited range of the thermometer in the western hemisphere.

North America.

Nine-tenths of North America lying under the temperate zone, the climate follows a different law from what is observed in the southern peninsula, and presents more striking contrasts with that of the best known parts of the old world. The long narrow region now denominated Central America, which connects the two great divisions of the continent, stretching from Panama to Tehuantepec, has in general a very humid atmosphere; but, for a tropical country, it must be only moderately hot, as every part of it is within a small distance of the sea. At Vera Paz the rains fall during nine months of the year. Mexico is hot, moist, and unhealthy on the low coasts; but two-thirds of its area, comprising all the populous districts, consist of table-land, from 5000 to 9000 feet in height. In consequence of this singular configuration of its surface, Mexico, though chiefly within the torrid zone, enjoys a temperate and equable climate. The mean heat at the capital, which is 7400 feet above the sea, is 62½°, and the difference between the warmest and coldest months, which exceeds 30° at London, is here only about 12°; but the atmosphere is deficient in moisture, and the country suffers from drought. Beyond the parallel of 24° the western shores are hot and arid.

In the extensive region lying between the parallels of 30° and 50°, which comprehends three-fourths of the useful soil of North America, we have three well-marked varieties of climate, that of the east coast, the west coast, and the basin of the Mississippi. On the east coast, from Georgia to Lower Canada, the mean temperature of the year is lower than in Europe by 9° at the latitude of 40°, and by 12½° at the latitude of 50°, according to Humboldt's calculation. In the next place, the range of the thermometer is much greater than in Europe, the summer being much hotter and the winter much colder. At Quebec the temperature of the warmest month exceeds that of the coldest by no less than 60½° of Fahr.; while at Paris, which is nearly under the

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[1] Humboldt's *Personal Narrative*, vol. iv. pp. 315–325.

[2] Spix's *Travels*, vol. ii. p. 145.

[3] *De Distributione Geographica Plantarum*, p. 82; *Pers. Nar.* vol. ii. p. 85

North America.

same latitude, the difference is only 31°. In the third place, the climate undergoes a more rapid change in America as we proceed from south to north, a degree of latitude in the middle of the temperate zone producing a decrease of annual temperature of 1·13° in Europe, and of 1·57° in America. The comparison is greatly to the disadvantage of America when made in this form; but when the east coasts of the two continents are compared, the case is altered: the old world is found to have no superiority over the new, for Pekin has still colder winters and warmer summers than Philadelphia, which is under the same latitude. It is the west coast of the new continent which ought to exhibit the climate of Europe; and from the few facts known, we have reason to believe that it is quite as mild and equable. At the mouth of Columbia River, in latitude 46½°, Captain Lewis and Clarke found the rains to be copious and frequent; but they had very little frost, and saw no ice even in the depth of winter. From observations made in 1822–3–4, it appears that the mean heat of the warmest month was about 62°, of the coldest about 36°, and of the whole year 51°.[1] Now, the place is under the same latitude with Quebec, where the snow lies five months, and the mean temperature during the three winter months is 18° below the freezing point. This single circumstance marks emphatically the contrast in the climate of the east and west coasts of North America. But the mouth of Columbia River is also under the same parallel with Nantes at the mouth of the Loire, where snow and ice are no strangers in the cold season of the year. We have therefore, good grounds to conclude that the west coast of America, in the middle latitudes, has nearly as mild and equable a climate as the west coast of Europe. The climate of the great central valley, or basin of the Mississippi, has a considerable affinity to that of the east coast. It was long a matter of dispute in what the difference between the two consists; but this seems at last to have been clearly settled, by the meteorological registers kept at the military posts of the United States. From a comparison of four of these registers, from posts near the centre of this great valley, with others kept on the Atlantic coast in the same latitudes, it appears that in the hottest month the temperature is from 5° to 6° higher, and in the coldest month as much lower, in the basin of the Mississippi, than on the coasts of New England. The proportion of fair weather to cloudy is as 5 to 1 in favour of the east coast.[2] The climate of the interior, therefore, exhibits in still greater excess those extremes of temperature which distinguish the eastern coast of this continent from the western, and from the shores of Europe. The fourth region of extra-tropical America includes the parts beyond Mount St Elias on the west coast, and, in the interior, the plains extending from the 50th parallel to the Polar Seas. The intensity of the cold in this tract of country is scarcely equalled by any thing that is known under the same parallels in Northern Asia. The northernmost spot in America where grain is raised is at Lord Selkirk's colony, on Red River, in latitude 50°. Wheat, and also maize, which requires a high summer heat, are cultivated here.[3] Barley would certainly grow as far north as Fort Chippewyan, in latitude 58¾°, where the heat of the four summer months was found by Captain Franklin to be 4° higher than at Edinburgh. There is even reason to believe, that both this species of grain and potatoes might thrive as far north as Slave Lake, since the spruce fir attains the height of 50 feet three degrees farther north, at Fort Franklin, in latitude 65°. These, however, were low and sheltered spots; but in this dreary waste generally, it will not be found practicable, we suspect, to carry the arts of civilized life beyond the 60th parallel; and the desirable country, capable of supporting a dense population, and meriting the name of temperate, can scarcely be said to extend beyond the 50th parallel. At 65° the snow covers the ground in winter to the depth of only two feet, but small lakes continue frozen for eight months. The sea is open only for a few weeks, fogs darken the surface, and the thermometer in February descended, in one instance to *minus* 58°, or 90° below the freezing point. At Melville Island, under the 75th parallel, such is the frightful rigour of the climate, that the temperature of the year falls 1° or 2° below the zero of Fahrenheit's scale. It is a peculiarity in the climate of America, that beyond the parallel of 50° or 52°, it seems to become suddenly severe at both extremities. At the one, summer disappears from the circle of the seasons; at the other, winter is armed with double terrors.

The mountains of North America will not detain us long. The branch of the Andes which divides the seas at the isthmus of Panama is very low, the highest point of the railroad now in progress (1852) is only 300 feet above the sea. At the isthmus of Tehuantepec, a route has been traced whose most elevated point is 702 feet. The most considerable elevations are on the south-west side of the isthmus; and twenty-one volcanoes, scattered over this limited space, afford proof that the sources of internal fire exist here in unexampled abundance. From Puebla to Durango the Mexican mountains no longer present the appearance of a chain, but spread out to a table-land or elevated plain, from 5000 to 9000 feet in height, and from 100 to 300 miles in breadth. Across this plain, exactly at the 19th parallel, five volcanoes are distributed in a line running east and west, as if a vast rent, extending from the Atlantic to the Pacific, had opened a passage for the internal fires of the globe at this spot. Two of these on the east side of the continent, with a group of four or five other cones lying between Jalapa and Cordoba, have an elevation exceeding 17,000 feet, and are the only mountains in New Spain that rise to the region of perpetual snow, which commences here at 15,000 feet above the level of the sea. Jorullo, the lowest of the five volcanoes, rose suddenly in the middle of a plain, in September 1759, after fearful concussions of the ground, continued for fifty or sixty days. It is 1600 feet high, and is surrounded by a number of smaller cones or burning masses, all resting on a portion of the plain four square miles in extent, which was heaved up in the form of a tumefied dome. Near the tropic the Mexican Cordillera divides into three parts. One runs parallel to the eastern coast at the distance of thirty or forty leagues, and terminates in New Leon. Another proceeds in a north-western direction, and sinks gradually as it approaches the Californian Gulf in Sonora. The third or central Cordillera traverses Durango and New Mexico, divides the sources of the Rio Gila from the Rio Brava del Norte, and forms the eastern ridge or main trunk of the Rocky Mountains, which terminates at the Arctic Ocean about 140° of west longitude. From the southern point of California, a lower chain skirts the coast as far as the volcano of Mount St Elias, in latitude 60°; and between this chain and the eastern several intermediate ones occur, the whole forming apparently an elevated plateau from 200 to 800 miles in breadth. Many of the summits of the Rocky Mountains are within the regions of perpetual snow; and several of their peaks have been found to measure 11,000, 11,320, 13,538, and 16,000 feet.[4] In one of the valleys included in the plateau of the Rocky Mountains, is situ-

[1] *Edinburgh Journal of Science*, April 1827.
[2] Keating's *Account of Major Long's Second Expedition*, 1824, vol. ii. p. 417.
[3] *Ibid.* vol. ii. chap. ii.
[4] See Major Long's *Memoirs*, and the sections in James's *Account of an Expedition to the Rocky Mountains*.

North America. ated the great salt lake Utah, in west longitude 112° and north latitude 41°. The lake, whose waters are intensely saline, is nearly 300 miles in circumference, and its shores, for a breadth of several miles, are covered with an incrustation of very pure salt. In this valley or basin, which measures about 500 miles each way, and contains much fertile soil, the Mormons, a new religious sect of very peculiar tenets, established themselves in 1847. It is a convenient halting station for the American emigrants who pass by land to California.

If we run a line westward across the continent of North America at the latitude of Delaware Bay (38°), the geological formations present themselves in the following order:—1. Tertiary and cretaceous strata on the shores of the Atlantic; 2. Gneiss underlying these strata, and presenting itself on the eastern slope of the Allegany or Appalachian mountains, but covered at parts by New Red Sandstone; 3. Palæozoic rocks, consisting of Silurian, Devonian, and carboniferous strata, curiously bent into parallel foldings, with synclinal and anticlinal axes, the crests of the latter forming the ridges of the Allegany Mountains, which in this region rise to the height of 2500 feet. Upon these palæozoic rocks rest three great coal-fields—the Appalachian, that of Illinois, and that of Michigan, covering a large portion of the space between the Alleganies and the Mississippi, and embracing collectively an area equal to the surface of Great Britain. From the Mississippi westward the country has not been thoroughly explored, but the Silurian, carboniferous, and secondary rocks, are said to extend to the base of the Rocky Mountains. Here the crystalline schists again present themselves, and not only form the crests of the two chains, but extend to the shores of the Pacific. Both in Oregon and California they have been greatly disturbed by eruptive rocks of many varieties. Among these Mr Dana names traps, porphyries, serpentines, hypersthenes, trachytes, and cellular lavas. Sandstones of the Silurian or carboniferous age are mingled with these, and along with the mica and chlorite schists (perhaps metamorphic), were no doubt the matrix of the gold found in the gravel. It is generally in such situations—that is, among the crystalline and palæozoic strata, where they have been penetrated by intrusive masses of igneous rock, that the precious metals have been found.[1]

The Ozark mountains resemble the Alleganies in their mineral structure, containing the same rocks from the granite to the carboniferous, and probably upwards to the chalk. In British America, and the desolate country northward to the Arctic Ocean, there is no considerable chain east of the Rocky Mountains, and the rocks, so far as known, consist chiefly of crystalline and palæozoic schists.

Rivers. In no single circumstance is the superiority of America over the old world so conspicuous as in the number and magnitude of its navigable rivers. The Amazon alone discharges a greater quantity of water than the eight principal rivers of Asia, the Euphrates, Indus, Ganges, Oby, Lena, Amour, and the Yellow River and Kang-tse of China.[2] The Mississippi, with its branches, affords a greater amount of inland navigation than all the streams, great and small, which irrigate Europe; and the Plata, in this respect, may probably claim a superiority over the collective water of Africa. But the American rivers not only surpass those of the old world in length and volume of fluid, but they are so placed as to penetrate everywhere to the heart of the continent. By the Amazon, a person living at the eastern foot of the Andes, 2000 miles of direct distance from the Atlantic, may convey himself or his property to the shores of that sea in forty-five days, almost without effort, by confiding his bark to the gliding current. If he wishes to return, he has but to spread his sails to the eastern breeze, which blows perennially against the stream. The navigation is not interrupted by a single cataract or rapid, from the Atlantic to Jaen, in west longitude 78°, where the surface of the stream is only 1240 feet above the level of its estuary at Para. The remotest and least accessible part of North America is the great interior plain extending from the Rocky Mountains to the Alleganies and the lakes, between the parallels of 40° and 50°; but the Mississippi, Missouri, and St Lawrence, with their branches, are so wonderfully ramified over this region, that when it is filled with civilised inhabitants, two centuries hence, those who dwell in its inmost recesses, at the falls of the Missouri, for instance, 1700 miles from the Atlantic, will have a more easy communication with the ocean than the population of the interior of Spain and Hungary. It is only necessary to cast the eye over a map of South America, to see that all the most sequestered parts of the interior are visited by branches of the Plata and the Amazon. These streams, having their courses in general remarkably level, and seldom interrupted by cataracts, may be considered without a figure, as a vast system of natural canals, terminating in two main trunks, which communicate with the ocean at the equator and the 35th degree of south latitude. Since the invention of steam navigation, rivers are, in the truest sense of the term, Nature's highways, especially for infant communities, where the people are too poor, and live too widely dispersed, to bear the expense of constructing roads. There is little risk in predicting, that in two or three centuries the Mississippi, the Amazon, and the Plata, will be the scenes of an active inland commerce, far surpassing in magnitude anything at present known on the surface of the globe. The Mississippi is navigable for boats from the sea to the falls of its principal branch the Missouri, 1700 miles from the Mexican Gulf in a direct line, or 3900 by the stream; and the whole amount of boat navigation afforded by the system of rivers, of which the Mississippi is the main trunk, has been estimated as equal to 40,000 miles in length, spread over a surface of 1,350,000 square miles. Perhaps this is rather beyond the truth; but let us call the navigation 35,000 miles, and the following table will exhibit the lengths, size of the basins, and probable extent of the navigable waters of the greater rivers of America.

| | Length, miles. | Area of basin, sq. miles. | Navigable waters, miles. |
|---|---|---|---|
| Mississippi to source of Missouri | 4300 | 1,350,000 | 35,000 |
| St Lawrence through the lakes | 2200 | 600,000 | 4,000 |
| Orinoco | 1800 | 400,000 | 8,000 |
| Amazon, not including Araguay | 4000 | 2,100,000 | 50,000 |
| Plata, including Uruguay | 2400 | 1,200,000 | 20,000 |

The Amazon contains many islands, is broad, and in the upper part so deep, that on one occasion Condamine found no bottom with a line 103 toises long. At its mouth, two days before and after the full moon, the phenomenon called a *Bore* occurs in a very formidable shape. It is a wave of water rushing from the sea, with its front as steep as a wall

[1] Memoirs of W. B. Rogers and H. D. Rogers *On the Coal Rocks of Eastern Virginia, and on the Origin of the Appalachian Coal Strata*, 1840. Lyell's *Travels in North America*, 1845, and Wilkin's *Account of Western America*, 1849.

[2] See article PHYSICAL GEOGRAPHY.

Rivers.

and as high as a house. No small vessel can encounter it without certain destruction.

The estuaries of all these great American rivers open to the eastward; and thus Providence seems to have plainly indicated that the most intimate commercial relations of the inhabitants of America should be with the western shores of the old world. It should at the same time be observed, that this position of the great rivers of America is but one example of a physical arrangement which is common to the whole globe; for it is remarkable that, in the old world as well as in the new, no river of the first class flows to the westward. Some, as the Nile, the Lena, and the Oby, flow to the north; others, as the Indus and the rivers of Ava, to the south; but the largest, as the Wolga, Ganges, Great River and Yellow River of China, the Euphrates, and the Amour, have their courses to the east or south-east. This arrangement is not accidental, but depends most probably on the inclination of the primary rocks, which, in all cases where their *direction* approaches to the south and north, seem to have their steepest sides to the west and the longest declivities to the east. We have examples in the Scandinavian Alps, the mountains of Britain, the Ghauts of India, the Andes, and the Rocky Mountains.

Physical regions of North America.

North America, like the Southern peninsula, naturally divides itself into five physical regions: 1. The table-land of Mexico, with the strip of low country on its eastern and western shores; 2. The plateau lying between the Rocky Mountains and the Pacific Ocean, a country with a mild and humid atmosphere as far north as the 55th parallel, but inhospitable and barren beyond this boundary; 3. The great central valley of the Mississippi, rich and well wooded on the east side, bare but not unfertile in the middle, dry, sandy, and almost a desert on the west; 4. The eastern declivities of the Allegany Mountains, a region of natural forests, and of mixed but rather poor soil; 5. The great northern plain beyond the 50th parallel, four-fifths of which is a bleak and bare waste, overspread with innumerable lakes, and resembling Siberia both in the physical character of its surface and the rigour of its climate.

Numbers.

The origin, history, languages, and condition of the American nations present ample materials for speculation; but before touching on these subjects, the question presents itself, What is the amount of the indigenous population? Humboldt, in a later edition of his work on Mexico, published in 1823, estimates the whole number of Indians in the New World as follows:—

| | |
|---|---|
| Civilised or settled Indians of Spanish America | 7,530,000 |
| Ditto in Brazil | 260,000 |
| Independent Indians to the east and west of the Rocky Mountains, on the frontiers of Mexico, and in Central America | 400,000 |
| Independent Indians of South America | 420,000 |
| Total Indian population of America | 8,610,000 |

Indigenous population.

The indigenous population of America presents man under many aspects, and society in various stages, from the regular but limited civilisation of Mexico and Peru, to savage life in its most brutal state of abasement. At one extremity of the country we find the pigmy Esquimaux of four feet and a half in height, and at the other the Patagonian giants of seven feet. In complexion the variety is great, and may be said to embrace almost every hue known elsewhere on the face of the earth, except the pitchy black of the negro. About one-half of all the known languages belong to America; and if we consider every little wandering horde a distinct community, we have a greater number of nations here than in all the rest of the world. Amidst all this diversity, philosophers have thought they were able to discover certain general characters, sufficiently marked to distinguish the American nations from those of the old continent. It is foreign to our purpose to inquire whether the varieties of form, stature, and complexion, in the human species, are modifications produced by external causes operating differently on distinct portions of the progeny of one primitive pair, or whether several races were originally created, and have given birth, by their mixture, to the amazing varieties we witness. We assume the former opinion as true, because the probabilites seem to be in its favour; but the phenomena present themselves to us in the same light in whichever way they originated.

Aborigines

Physiologists are not at one in their accounts of the characteristics of the aborigines of the new world, nor are they agreed as to whether they should be considered one race or several. Blumenbach places them all under one class, except the Esquimaux. Bory St Vincent, an ingenious but fanciful writer, in a recent work,[1] divides them into four races, or into five if we include the Esquimaux, under the following designations:—1. The *Colombian*, which comprehends the tribes formerly inhabiting the Allegany Mountains, Canada, Florida, the eastern coasts of Mexico, and Central America; and the Caribs, who occupied the West India Islands and Guiana. 2. The *American*, embracing the tribes which occupy all the other parts of South America east of the Andes, except Patagonia. 3. the *Patagonian* race, inhabiting the south extremity of the continent. 4. The *Neptunian*, inhabiting the western coasts of both divisions of the continent, from California to Cape Horn, and which he considers as essentially the same with the race spread over the Malay Peninsula and the Indian Archipelago. With this race he classes the Mexicans and Peruvians. By another writer[2] the species are reduced to two, the *Colombian* and the *American;* the former including all the North American tribes, with the Caribs, the Mexicans, and Peruvians, and other inhabitants of the Cordillera; and the latter the Brazilian Indians and Patagonians. None of these systems, when compared with facts, is very satisfactory. Dr Prichard thinks that the mutual resemblance among the American nations has been exaggerated by some writers; yet it is certain that there is more of a common family character in their organisation than in that of the indigenous population of Asia or Africa. "The Indians of New Spain," says Humboldt, "bear a general resemblance to those who inhabit Canada, Florida, Peru, and Brazil. We have the same swarthy and copper colour, straight and smooth hair, small beard, squat body, long eye, with the corner directed upwards towards the temples, prominent cheek-bones, thick lips, and expression of gentleness in the mouth, strongly contrasted with a gloomy and severe look. Over a million and a half of square leagues, from Cape Horn to the river St Lawrence and Behring's Straits, we are struck at the first glance with the general resemblance in the features of the inhabitants. We think we perceive them all to be descended from the same stock, notwithstanding the prodigious diversity of their languages. In the portrait drawn by Volney of the Canadian Indians, we recognise the tribes scattered over the Savannahs of the Apure and the Carony. The same style of features exist in both Americas."

Form of skull.

The American race is distinguished by the form of the skull, which strongly resembles the Mongol type. The forehead recedes more than in any other variety of the

[1] *L'Homme, Essai Zoologique*, vol. ii. Paris, 1827.
[2] *Histoire Naturelle des Races Humaines*, par A. Desmoulins. Paris, 1826.

Aborigines

human species; the cheek-bones are prominent, but not so angular, as in the Mongol head; the occiput is rather flat, the cavity for lodging the cerebellum small, the orbits large and deep. The nose is generally aquiline, but in some tribes flat; and the nasal cavities are large. Compared with the head of the Negro, that of the American is much broader, and the teeth are less prominent: when placed by the side of the Caucasian head, it is seen to be smaller in size, less rounded and symmetrical, and less developed in the part before the ear. The skull is generally thin and light. There are, however, many deviations from this central form. The Carib skull, and the Araucanian, are large; the Peruvian small, and singularly flattened behind, so as to present a short line from the forehead to the occiput.

Complexion.

The colour of the Americans, though it includes a considerable diversity of shade, is more uniform than that of the inhabitants of Asia or Africa; and, what is more remarkable, its varieties do not bear any visible relation to the temperature of the climate. A brownish yellow, or copper colour, as it has been called, pervades nearly all the numerous tribes from the Arctic Ocean to Cape Horn, but still with many different degrees of intensity. The eastern nations of Chili have but a slight tinge of the brown colour, and the Boroanes are said to be as white as the northern Europeans. On the north-west coast, from latitude 43° to 60°, there are tribes who, though embrowned with soot and mud, were found, when their skins were washed, to have the brilliant white and red which is the characteristic of the Caucasian race. But within the tropics, the Malapoques in Brazil, the Guayanis in Paraguay, the Guiacas of Guiana, the Scheries of La Plata, have tolerably fair complexions, sometimes united with blue eyes and auburn hair; and, in the hot country watered by the Orinoco, Humboldt found tribes of a dark, and others of a light hue, living almost in juxtaposition. It is remarkable, too, that the nations whose colour approaches nearest to black are found in the temperate zone, namely, the Charruas of the Banda Oriental, in latitude 33° south, and the Cochimies, Pericus, and Guaycurus, spread over the peninsula of California. These people have skins of a very deep hue, but are not absolutely black; and they have neither the woolly hair of the negroes, nor their social and good-humoured disposition. The Charruas especially are distinguished by a high degree of that austerity and stern fortitude which are common to the American nations.[1] The Caribs and some Brazilian tribes have the yellowish hue of the Chinese, and the same cast of features. Among the nations dwelling on the west side of the Alleganies, and near the northern lakes, there is also a considerable variety of complexion; but the brown or copper shade is found more or less in them all. It may be said, then, of the American nations, that, with the exception of two or three tribes on the north-west coast, who probably arrived from Asia at a later period than the others, the two extremes of complexion, the white of Northern Europe and the black of Ethiopia, are unknown amongst them; and that, when compared with the Moors, Abyssinians, and other swarthy nations of the Old World, their colour inclines less to the yellow, and more to the reddish brown. In stature the variety is great. The North American tribes are generally above the middle size, and of a slender shape. The Brazilian nations and the Peruvians are short and squat. The Caribs of the Orinoco, and the Abipones, Mocoby, and other tribes which rove over the Pampas west of the Plata, are tall and strong; and the Patagonians, a Chilian tribe, exceed in strength and stature all the other races in the known world.

Dr Morton, a recent authority, says that the most natural division of the Americans is into two families, the *Toltecan* and the *American;* the former of which bears evidence of centuries of half-civilisation, while the latter embraces all the barbarous nations of the new world, with the exception of the Polar tribes, which are evidently of Mongolian origin. In each of these, however, there are several subordinate groups, which may be distinguished as the *Appalachian*, the *Brazilian*, the *Patagonian*, and the *Fuegian.* The Appalachian branch includes all the nations of North America, except the Mexicans, together with the tribes of South America north of the River Amazon and east of the Andes. In this race the head is rounded, the nose large, salient, and aquiline: the eyes dark brown, with little or no obliquity of position; the mouth large and straight; the teeth nearly vertical; and the whole face triangular. The neck is long, the chest broad, but rarely deep, the body and limbs muscular, and seldom disposed to fatness. In character these nations are warlike, cruel, and unforgiving; they turn with aversion from the restraints of civilised life, and have made but little progress in mental culture or the useful arts. The Brazilian branch is spread over a great part of South America, east of the Andes, including the whole of Brazil and Paraguay, between the River Amazon and 35° south latitude. Their physical characteristics differ but little from those of the Appalachian branch; they possess, perhaps, a larger and more expanded nose, with larger mouths and lips. The eyes are small, more or less oblique, and far asunder; the neck short and thick; the body and limbs stout and full, even to clumsiness. In character also, they differ little. None of the Americans are less susceptible of cultivation; and what they are taught by compulsion seldom exceeds the humblest elements of knowledge. The Patagonian branch includes the nations to the south of the Plata, as far as the Straits of Magellan; including also the mountain tribes of Chili. They are chiefly distinguished by their tall stature, handsome forms, and indomitable courage. The Fuegians, who call themselves *Yacannacunnee*, rove over the sterile wastes of Tierra del Fuego, which is computed to be half the size of Ireland, and yet their whole number has been computed by Forster at only 2000. The physical aspect of the Fuegians is altogether repulsive. They are of low stature, with large heads, broad faces, and small eyes. Their chests are large, their bodies clumsy, with large knees, and ill-shaped legs. Their hair is lank, black, and coarse, and their complexion a decided brown, like that of the more northern tribes. Their expression of face is vacant, and their mental operations are to the last degree slow and stupid; they are almost destitute of the usual curiosity of savages, caring little for anything that does not minister to their present wants.

Long, black, lank hair is common to all the American tribes, among which no traces of the frizzled locks of the Polynesian, or the woolly texture of the African negro has ever been observed. The beard is very deficient, and the little that nature gives them assiduously root out. A copper-coloured skin has been also assumed by most writers as a characteristic distinction of the Americans; but their real colour is in general brown, of the hue most nearly resembling that of cinnamon; and Dr Morton coincides in opinion with Dr M'Culloch that no epithet derivable from the colour of the skin so correctly designates the Americans as that of the brown race. There are, however, among them occasional and very remarkable deviations, including all the varieties of tint from a decided white to an unequivocally black

[1] *Mithridates Einleitung Amerikanischen Sprachen*, p. 313; Prichard's *Researches*, vol. ii. pp. 396, 492.

Aborigines

skin. That climate has a very subordinate influence in producing these different hues must be inferred from the fact that the tribes which wander in the equinoctial regions are not darker than the mountaineers of the temperate zone. The Puelches, and other tribes of the Magellanic regions, beyond 55° south latitude, are darker than the Abipones, Mocobies, and Tobos, who are many degrees nearer the equator; and the Botecudos are of a clear brown colour, sometimes approaching nearly to white, at no great distance from the tropic; while the Guyacas under the line are characterised by a fair complexion; the Charruas, who are almost black, live at the 50° south latitude; and the still blacker Californians are 25° north of the equator. Everywhere, indeed, it is found that the colour of the American depends very little on the local situation which he actually occupies; and never, in the same individual, are those parts of the body which are constantly covered of a fairer colour than those which are exposed to a hot and moist atmosphere. Children are never white when they are born, as is the case among even the darkest of the Caucasian races; and the Indian caçiques, who enjoy a considerable degree of luxury, and keep themselves constantly dressed, have all parts of their body, except the palms of the hands and the soles of the feet, of the same brownish-red or copper colour. These differences of complexion are, however, extremely partial, forming mere exceptions to the general tint which characterises all the Americans, from Cape Horn to Canada. The cause of such anomalies is not easily ascertained; that it is not climate is sufficiently obvious; but whether or not it arises from partial immigrations from other countries remains yet to be decided. The Americans might also be divided into three great classes distinguished by the pursuits on which they depend for subsistence, namely, hunting, fishing, and agriculture. The greater number of them are devoted to hunting; the fishing tribes are not numerous, and are wholly destitute of the spirit of maritime adventure, and even of fondness for the sea. A few tribes were strictly agricultural before the arrival of Europeans, but a much greater number have become so since. Many tribes regularly resort to all these modes of subsistence, according to the seasons; employing the spring in fishing, the summer in agriculture, and the autumn and winter in hunting.

The intellectual faculties of this great family appear to be decidedly inferior, when compared with those of the Caucasian or Mongolian race. The Americans are not only averse to the restraints of education, but are for the most part incapable of a continued process of reasoning on abstract subjects. Their minds seize with avidity on simple truths, but reject whatever requires investigation and analysis. Their proximity for more than two centuries to European institutions has made scarcely any perceptible change in their mode of thinking or their manner of life; and, as to their own social condition, they are probably in most respects exactly as they were at the earliest period of their national existence. They have made few or no improvements in constructing their houses or their boats; their inventive and imitative faculties appear to be of very humble capacity, nor have they the smallest taste for the arts and sciences. One of the most remarkable of their intellectual defects is the great difficulty they find in comprehending the relations of numbers; and Mr Schoolcraft, the United States Indian agent, assured Dr Morton that this deficiency was one cause of most of the misunderstanding in respect to treaties entered into between the United States Government and the native tribes. The natives sell their lands for a sum of money, without having any conception of the amount; and it is only when the proceeds come to be divided, that each man becomes acquainted with his own interest in the transaction. Then disappointment and murmurs invariably ensue.

The Toltecan family embraces the civilised nations of Mexico, Peru, and Bogota extending from the Rio Gila in 33° north latitude along the western shore of the continent to the frontiers of Chili; and on the eastern coast, along the Gulf of Mexico, in North America. In South America, on the contrary, this family chiefly occupied a narrow strip of land between the Andes and the Pacific Ocean, bounded on the south by the great desert of Atacama. Farther north, however, in New Granada, were the Bogotese, a people whose civilisation, like their geographical position, was intermediate between that of the Peruvians and the Mexicans. But, even before the Spanish conquest, the Toltecan family were not the exclusive possessors of the regions which we have assigned to them; they were only the dominant race or caste, while other tribes of the American race always constituted a large mass of the population. The arrival of the Spaniards reduced both classes alike to vassalage; and three centuries of slavery and oppression have left few traces of Mexican and Peruvian civilisation, except what may be gleaned from their history and antiquities. These nations can no longer be identified in existing communities; and the mixed and motley races which now respectively bear the name, are as unlike their predecessors in moral and intellectual character, as the degraded Copts are unlike the ancient Egyptians. It is in the intellectual faculties that the great difference between the Toltecan and the American families consists. In the arts and sciences of the former we see the evidences of an advanced civilisation; their architectural remains everywhere surprise the traveller and confound the antiquary. Among these are pyramids, temples, grottoes, bas-reliefs, and arabesques; while their roads, aqueducts, and fortifications, and the traces of their mining operations, sufficiently attest their attainments in the practical arts of life.[1]

Languages.

It is the absence of civilisation which has broken human speech into such a countless variety of dialects; and the lower any race of people have sunk in the abasement of savage life, the more languages multiply amongst them. Every unwritten tongue is subject to continual fluctuations, which will be numerous and rapid in proportion as the tribe using it is exposed to frequent vicissitudes of fortune, and the individuals composing it have little intercourse with one another. When the population of one of these societies increases, it splits into several branches; and if these have little intercourse, the original language divides by degrees into as many dialects. These smaller societies subdivide in their turn with the same effects; and, in such continual subdivisions, the dialects of the extreme branches deviate farther and farther from one another, and from the parent tongue, till time, aided by migrations and wars, producing mixtures of different hordes, obliterates all distinct traces of a common origin. The cause of these changes becomes more obvious when we reflect on the principles which give stability to a language. These are, 1. the abundant use of writing; 2. the teaching of a language as a branch of education; 3. frequency of intercourse among all the people speaking it; 4. the existence of an order of men, such as priests or lawyers, who employ it for professional purposes; 5. stability of condition in the people, or exemption from vicissitudes and revolutions; 6. a large stock of popular poetry, which if universally diffused, may almost become

[1] *Crania Americana*, &c., by Samuel George Morton, M.D., 1 vol. 4to, published at Philadelphia in 1839, pp. 62 to 86.

Aborigines. a substitute for writing. All these conditions were wanting (with some trifling exceptions) in the whole of the wandering tribes of America. The great multiplication of languages, therefore, proves two things; first, that the people are in the lowest state of savage life; and, secondly, that they have been for many ages in this condition; for time is a necessary element in the process of splitting human speech into so many varieties. Now, it is a remarkable fact, that there were as many languages spoken among a population of two or three millions of American savages, as among the six hundred millions of human beings scattered over the old continent! We call them two or three millions, because we exclude the civilized inhabitants of Mexico and Peru, and because a considerable number of the facts collected by Hervas and Vater relate to a period from 50 to 100 years back, since which, some of the tribes they allude to have become extinct. Balbi, in his Ethnographical Atlas, has enumerated 423 languages, which are, or at no distant period were, spoken in America by the indigenous population. Of these, 211 belong to North, 44 to Central, and 168 to South America; but as the list includes only those tongues of whose structure something is known, it does not embrace more than one or two of the 116 dialects noticed by the missionaries in Quito, some of which have ceased to exist; and many others, unknown, or known imperfectly, are also left out. There cannot be a doubt that the greater multiplicity of tribes in South America is accompanied with a corresponding multiplicity of languages, and that we may add at least 100 for omissions in this section of the continent. Vater says expressly that the number of languages in America "exceeds five hundred." As a general result, then, we may state, that there are (or *were* within a century past) from 500 to 600 distinct dialects in the new world, without including in our enumeration any which do not differ from one another as widely as the Spanish from the Italian, or the German from the Dutch.[1]

Under this prodigious diversity of dialects, a remarkable analogy of structure has been detected in all those which are well known, and is believed to pervade the whole. The American languages are extremely complicated and artificial, and have extraordinary powers of combination. The verb, besides inflections applicable to the varieties of time, has numerous moods, which may be described as reflected, transitive, compulsive, applicative, meditative, communicative, reverential, frequentative; and forms which indicate by suffixes and affixes whether the object be animate or inanimate, male or female, &c.[2] "From the country of the Esquimaux to the straits of Magellan," says Humboldt, "mother tongues entirely different in their roots have, if we may use the expression, the same physiognomy. Striking analogies of grammatical construction are discovered, not only in the more perfect languages, as that of the Incas, the Ayemara, the Guarani, the Mexican, and the Cora, but also in languages extremely rude. It is in consequence of this similarity of structure that the Indians of the missions could learn the tongue of a different tribe much more easily than the Spanish; and the monks had hence adopted the practice of communicating with a great number of hordes through the medium of one of the native languages." The complication of grammatical forms which these dialects display has induced Mr Duponceau of Philadelphia to give them the name of *Polysynthic*. Now the remarkable facts are, first, that this characteristic should not be found in any of the known languages of the old world, except in a faint degree in the Basque, and the dialect of Congo; Aborigines. and, next, that it should belong, not to one or two, but with slight exceptions, so far as is known, to all the languages of America, so extremely numerous, and many of which have nothing else in common. How is this diffusion of a peculiar and common character over materials so dissimilar to be accounted for? To us it seems to imply a community of origin in the tribes, whether few or many, which peopled the continent. As no person has the full command of all the vocables in his native language, individual terms must be continually dropping out of dialects preserved by oral communication; and new ones will be introduced as new wants and new objects solicit attention. But during the gradual change which thus takes place, the new words will be combined and modified according to the rules which belong to the genius of the spoken dialect with which they are incorporated; and thus it may happen that the grammatical forms of an ancient language may live, while its materials perish. The changes of structure which present themselves in the history of European languages, it must be remembered, took place in *progressive* communities. Among nations like the American Indians, whose barbarism, we may suppose, remained almost stationary, the forms of speech might be more permanent, though its substance was in a state of slow but constant mutation. We do not mean, however, that the community of origin alluded to was entire and absolute among the American nations. Since weak tribes are often incorporated with strong ones in the present times, it might happen that small parties of separate and dissimilar races might be blended by conquest or treaty with the larger nations of the American stock, and in a generation or two lose their distinctive character, by adopting the language and manners of their new confederates or masters. Neither must it be imagined that there is an entire absence of mutual affinities among the 423 tongues enumerated by Balbi. On the contrary, six, eight, or more, are sometimes united in one family by analogies, in their roots and grammatical forms, as strong as those which obtain among the languages of the Teutonic stem in Europe, the Icelandic, Swedish, Danish, German, Dutch, and English. If philologists had complete vocabularies of them all, it might probably be found that the 500 or 600 American languages could be arranged into eight or ten "reigns," to use Balbi's term, or into forty or fifty families, each characterized by affinities sufficiently clear to prove that its component members had sprung from a common parent. On the other hand, the complete absence, in so many instances, of common roots in the dialects of contiguous tribes,—the fading and almost obliterated traces of resemblance in languages which had once been identical,—are very remarkable phenomena, and prepare us for a result which could not have been anticipated otherwise—that none of all the American tongues has any distinct marks of a common origin with any one of those of Asia, Africa, Europe, or Polynesia. The sole exception is the Esquimaux idiom, which belongs to the same family with that of the Tschutskoi, a people having the same physical aspect, who inhabit the extreme north-eastern parts of Asia. Upon a painful comparison of the known languages of the new world with those of the old, only 170 words have been found in the former which have a distinct resemblance to words of the same signification in the latter. These are derived from 83 American tongues; three fifths of them have a resemblance to words in the Mantchou, Tonguse, Mongol, and Samoiede

[1] *Mithridates Einleitung Amerikanischen Sprachen*, p. 373. Balbi, *Atlas Ethnographique du Globe*. Paris, 1826.
[2] See Prichard's *Researches*, vol ii. p. 341; and Tables 26, 27, and 29 of Balbi's *Atlas*.

Aborigines.

dialects, and two fifths to words in the Celtic, Tschoud, Biscayan, Coptic, and Congoese. This number is too small to prove any thing by itself; but it is not entirely to be disregarded when taken in connection with the analogies which have been traced in the physical character, customs, superstitions, and monuments, of the people of the two continents. And if we admit, on the ground of their similarity of organization, that the greater number of the American languages have had a common origin, even in those cases where coincident terms are no longer to be discovered, perhaps it ought to be acknowledged that the affinity between the languages of the two continents is as great as could be expected. In this, as in many questions connected with geology, *time* is the element which solves the difficulty; and when a longer course of observation has enabled us to detect the laws which govern the changes of oral language among barbarous and savage nations, the facts will probably speak to us in clearer terms.[1]

Though any attempt to reduce the American population under a few general classes, either on physical or ethnographical grounds, would be idle, a brief survey of the most remarkable nations, or families of nations, will enable us to form a more distinct idea of the whole.

Esquimaux.

All the northern coast of the new continent is tenanted by the Esquimaux, a dwarfish race, rarely exceeding five feet in height, and of the same stock with the Greenlanders, the Tschutskoi, the Samoiedes, and the Laplanders. Near Mackenzie's River their territories commence at the 68th parallel, and extend to the Arctic Ocean. They occupy all the northern Archipelago, the shores of Hudson's and Baffin's Bays, of Labrador, and of Russian America, round by Behring's Straits, to the peninsula of Alyaska. They live entirely by fishing, the whale and the seal being their most common food; they inhabit skin tents during their short summer, and in winter caves or houses built with snow in the shape of domes, within which a single rude lamp is kept perpetually burning. They are crafty and dirty, but appeared to Captain Franklin more intelligent and provident than the northern Indians. There is a wide diversity in their dialects, which still display decided marks of identity in their roots. They are the only American race whose Asiatic origin is indisputable.

The north-west coast of Russian America, from Cook's Inlet to the 48th parallel, is inhabited by four tribes, of whom the Kaluschi are the most remarkable. These people are distinguished from all the native races of America by having as fair a complexion when their skins are washed as the inhabitants of Europe; and this distinction, accompanied sometimes with auburn hair, has been considered as indicating an origin different from that of the copper-coloured tribes who people all the rest of the continent.

Allegany Indians.

The Indians of the east coast belong almost entirely to three stems; and, before the arrival of the English colonists, occupied both sides of the Allegany Mountains, from the Gulf of Mexico to Canada and New Brunswick. 1. The Delaware or Algonquin Indians, comprehending the Ottogamies, Shawanese, Naragansets, Chippeways, Knisteneaux, Delawares, and other nations, to the number of thirty or forty, were spread over the space between the Mississippi and the Atlantic, as far north as Hudson's Bay; and all spoke dialects of one language. They preserved a tradition, to which some credit has been given, that they had migrated from the west many centuries before the white men crossed the Atlantic, and gained possession of their country by expelling the Allegewis (or Alleganies), its former occupants. The latter nation, it is said, lived in towns; and it has been conjectured that they were the race who had constructed the long mounds and walls, and the circular and polygonal inclosures, like fortresses, which are scattered in great numbers over the region between the Ohio and the lakes. 2. The Iroquois, often called the "Five Nations," and the "Six Nations," but comprehending 15 tribes or more, among whom were the Mohawks, Oneidas, Hurons, and Senecas, all spoke dialects of one language. They lived on the south side of the great lakes, and finally obtained a complete ascendency over the Algonquin race. 3. The Florida Indians, including the Creeks, Seminoles, Choctaws, Chickasaws, Natches, and Mobiles. The Cherokees and Creeks, two of these nations, who dwell in Alabama and Georgia, have made greater advances in agriculture and the useful arts than any of the other tribes within the territories of the United States. They not only cultivate maize, potatoes, and cotton, but raise cattle and hogs for the market. The former, who have some hundreds of negro slaves, have established schools, set up a newspaper, and even adopted a political constitution, modelled on those of the Anglo-Americans. It has been recently discovered that the

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[1] Vater remarks, in the introduction to his account of the American languages, that they have, comparatively speaking, a considerable number of words in common with the Finnish. He finds, however, only 51 similar words where the affinity should be most distinct, namely, in all the languages of North America and Northern Asia. We subjoin a tabular view of the number of words he has detected in the American languages agreeing in sound and sense with words in some of the principal tongues of the old continent and its islands.

| | | | | |
|---|---|---|---|---|
| 8 words picked from | 7 American languages, | resemble the same number of words in the | | *Coptic.* |
| 8 words in | 8 American languages | | do | *Japanese.* |
| 11 do. in | 8 | do | do | *Malay.* |
| 4 do. in | 1 | do. (Quichua) | do | *Sanscrit.* |
| 20 do. in | 16 | do. (chiefly from eastern and tropical parts of America) | do | in 13 languages of *Western Africa.* |
| 8 do. in | 6 | do. (chiefly from the east side) | do | *Basque.* |
| 18 do. in | 10 | do | do | *Celtic.* |

Vater admits that many of these resemblances may be accidental; and some of them are evidently too faint to be of any value. We must at the same time keep in view, that philologists have rarely the means of making a complete and satisfactory comparison. In general they are furnished with only 40 or 50 words, significant of the most common objects, out of some thousands constituting the dialect of a tribe or people; and these few words are taken down hastily by travellers, mariners, or missionaries, of different nations, who are often betrayed into errors by imperfect means of communication, and must in their turn mislead the philologist by their dissimilar systems of orthography. To enable the reader to judge of the sort of resemblances collected by Vater, we give his comparison of six Irish words with six Algonquin, remarking, however, that this is decidedly the most favourable specimen in his tables:—

| | *Irish.* | *Algonquin.* |
|---|---|---|
| Island | inis | inis |
| Falsehood | gai | ga |
| Water | uisce | isca |
| Soft | bog | boge |
| All | cac-uile | kak-eli |
| Each thing | cac-eini | kak-ina |

(*Einleitung Amerikanischen Sprachen*, p. 332–351.)

Aborigines. Osages, Missouris, Kanses, and some other tribes inhabiting the country beyond the Mississippi, as far as the Rocky Mountains, speak dialects which are allied to those of the Iroquois; a fact which tends strongly to confirm the opinion entertained by the latter, that their original residence was far in the west. The Natches, near the Mississippi, had a monarchical government, and a class of nobles like the Mexicans. They had temples in which the sun was worshipped, and a perpetual fire kept up. Traces of this superstition existed also among the Gaspes, in New Brunswick. Tribes belonging to these three families, with the Wocons and Katawbas, now almost extinct, occupied nearly all the region east of the Mississippi, from the Gulf of Mexico to Hudson's Bay, comprising more than a million of square miles. The Katawbas alone, however, are said to have included 20 tribes, and nearly as many dialects. The Powhattans were a confederacy of 33 tribes, comprehending 10,000 persons. It is probable that when the English settlers landed in the country, the region mentioned was inhabited by a quarter of a million of Indians, divided into many tribes, and speaking dialects belonging to half a dozen of radically distinct languages. These nations have furnished brilliant models of the most shining qualities of savage life—a high sense of honour, according to their perceptions of duty, mutual fidelity among individuals, a fortitude that mocks at the most cruel torments, and a devotion to their tribe which makes self-immolation in its defence easy. On the other hand, they treat their wives cruelly, and their children with indifference. The apathy under the good and ill of life which the Stoic affected, is the grand element of the Indian's character. Gloomy, stern, and severe, he is a stranger to mirth and laughter. All outward expression of pleasure or pain he regards as a weakness; and the only feeling to which he ever yields, is the boisterous joy which he manifests in the moment of victory, or under the excitement of intoxication. He is capable of great exertions in war or the chase, but has an unconquerable aversion to regular labour. He is extremely improvident; eats enormously while he has abundance of food, without thinking of the famine which may follow; and, when liquors are supplied to him, wallows in the most beastly intoxication day after day. Most of the Indians believe in the existence of a supreme being, whom they call the Great Spirit; and of a subordinate one, whose nature is evil and hostile to man. To the latter their worship is principally addressed, the Good Spirit, in their opinion, needing no prayers to induce him to aid and protect his creatures. In some cases, however, as when influenced by a dream, they offer sacrifices to the Good Spirit. These consist generally of part of an animal taken in the chase, which is stuck upon the head of a high pole set vertically in the ground, and left in this situation to decay by the action of the elements. The remainder of the carcass is boiled and eaten; and the feast is accompanied with prayers, dancing, and singing. Human sacrifices are not unknown amongst them, but are rare. In their fasts, which are long and severe, they smear the face and other visible parts of the body with charcoal, and abstain from food till the sun has gone down; and this is practised day after day for one or two weeks. Some of them believe in tutelar spirits; and in most of the tribes there are jugglers or soothsayers, who pretend to discover lost property, and foretell the issue of hunting or warlike expeditions. By some tribes, deities are supposed to reside in the sun and moon. They generally believe in a future state, in which the souls of brave warriors and chaste wives enjoy a tranquil and happy existence with their ancestors and friends, spending their time in those exercises in which they delighted when on the earth. The Dacotas believe that the road to these "villages of the dead" leads over a rock with an edge as sharp as a knife, on which only the good are able to keep their footing. The wicked fall off, and descend to the region of the Evil Spirit, where they are hard worked, and severely flogged by their relentless master. Suicide is common among the women of this tribe, in consequence of the cruel treatment they are exposed to; but the practice is viewed as immoral. It is commonly effected by the woman hanging herself upon a tree; and as the popular belief is, that she is doomed to drag this tree after her for ever in the land of spirits, it is said to be usual for a female in committing the act to select as small a tree as will bear her weight.

Customs. Polygamy is allowed; and a number of wives is considered as adding to a man's consequence. When a young man has formed an attachment to a girl, he throws a deer, a gun, or some valuable article, into her father's hut. This is repeated for several days, till the father asks the young man what his object is, and whether he wishes to obtain his daughter. The young man having answered in the affirmative, the relations of the girl, if they approve of his suit, signify their consent by preparing a dress for the youth, which they carry to his house, and put upon his person. The young man's friends then prepare presents for the girl's family, into which he goes to reside, serving his father-in-law for a year, during which he gives him all the produce of his hunting. At the end of this period the youth takes his wife home to his own house, and treats her as he pleases, his power over her being unlimited. This is the custom of the Potowatomies. Other tribes have modes of courting and marrying which are very different; but among all the Indians, the presenting of gifts to the girl's father is an essential feature of the transaction, and shows that the wife is considered as procured by purchase. Deformed children, and lame or decrepit old persons, are sometimes destroyed; but the practice is uncommon. Incest and unnatural vices are practised in some tribes, but they are always viewed as matters of reproach. The Indian funerals are conducted with much decorum. The deceased is dressed in his best clothes, and laid in a grave, in a vertical, horizontal, or inclined position, according to his own previous directions, with his mocassins, knife, money, and silver ornaments beside him, and a small quantity of food near his head. Some prefer having their bodies sewed up in a blanket, and suspended from the branches of a tree. In this position the corpse is frequently visited by the friends of the deceased, until they observe that it is in a state of decay. They then shake hands with it and bid it farewell; but this does not prevent them from paying a yearly visit to the spot, and leaving some food at the place. It is usual to mark the graves with a post, on which figures are carved expressive of the nature of the pursuits and achievements of the deceased.

Clothes. Some nations of Indians wear little or no clothing; but the general dress of the men in the temperate and cold parts of the country, previous to the arrival of the Europeans, consisted of three articles: a cloak of buffalo-skin hanging from the shoulders, a piece of skin used as an apron, and a pair of mocassins or loose boots, made of undressed skin also. The women wore a long robe of the same material, which was fastened round the waist; but among the tribes living near the whites, coarse woollens are now frequently substituted for the hides of wild animals, except for the mocassins. Houses. The habitations of the Indians are huts or cabins, generally of a circular form and small size, but sometimes of 30 or 40 feet in diameter, formed by stakes fixed in the ground, and covered with

Aborigines. the bark of trees. Sometimes the spaces between the stakes are filled up with twigs, grass, and mud, and the roof is covered nearly in the same way. A hole in the top serves for the escape of the smoke, and the skins of wild beasts form the beds and seats. When they go to a distance to hunt, they erect for temporary use large tents, which are covered with skins. On the west side of the Mississippi, where the ground is open, many of the tribes make use of horses, which are seldom employed amidst the woods covering the territories east of that river. The custom of painting their bodies is nearly universal. They introduce the colours by making punctures on their skin; and the extent of surface which this ornament covers is proportioned to the exploits they have performed. Some paint only their arms, others both their arms and legs, others again their thighs; while those who have attained the summit of warlike renown have their bodies painted from the waist upwards. This is the heraldry of the Indians, the devices of which are probably more exactly adjusted to the merits of the persons who bear them than those of more civilized countries. Besides these ornaments, the warriors also carry plumes of feathers on their heads, their arms, or ancles. Their arms are the tomahawk, the war-club, knife, the bow and arrow; and, since they had intercourse with Europeans, many of them have muskets. Each tribe or community is governed by a chief and council, who are elective; but in matters of importance the whole warriors are consulted; and Mr Keating informs us that questions are not decided by the votes of a majority, but the resolution adopted must have the consent of every individual warrior. Their assemblies are conducted with much formality and decorum. The eldest chief commences the debate, which is often carried on by set speeches, abounding in bold figures and metaphors, and bursts of a rude but impassioned eloquence. The young are permitted to be present, and to express their approbation by cries, but not to speak. In their wars the object commonly is, to secure the right of hunting within particular limits, to maintain the liberty of passing through their accustomed tracts, and to guard from infringement those lands which they consider as their own tenure. War is declared by sending a slave with a hatchet, the handle of which is painted red, to the nation they intend to break with. They generally take the field in small numbers. Each warrior, besides his weapons, carries a mat, and supports himself till he is near the enemy by killing game. From the time they enter the enemy's country, no game is killed, no fires lighted, or shouting heard, and their vigilance and caution are extreme. They are not even permitted to speak, but must communicate by signs and motions. Having discovered the objects of their hostility, they first reconnoitre them, then hold a council; and they generally make their attack just before day-break, that they may surprise their enemies while asleep. They will lie the whole night flat on their faces without stirring, and, at the fit moment for action, will creep on their hands and feet till they have got within a bow-shot of those they have doomed to destruction. On a signal given by the chief warrior, which is answered by the yells of the whole party, they start up, and, after discharging their arrows, they rush upon their adversaries, without giving them time to recover from their confusion, with their war-clubs and tomahawks. If they succeed, the scene of horror which follows baffles description. The savage fury of the conquerors, the desperation of the conquered, the horrid yells of both, and their grim figures besmeared with paint and blood, form an assemblage of objects worthy of pandemonium. When the victory is secured, they select a certain number of their prisoners to carry home: they kill the rest in cold blood, take their scalps, and then march off with the spoil. The prisoners destined to death are soon led to the place of execution, where they are stripped, have their bodies blackened, and are bound to a stake. In this situation, while the burning faggots embrace his limbs, and the knives of his revengeful enemies are inflicting a thousand tortures, it is common for the warrior to recount his exploits, boast of the cruelties he has committed upon his enemies, and to irritate and insult his tormentors in every way. Sometimes it happens that this has the effect of provoking one of the spectators to dispatch him with a club or tomahawk. Sometimes the male adult prisoners are given as slaves to women who have lost their husbands in the war, and by whom they are often married. The women taken are distributed among the warriors; the boys and girls are considered as slaves.

Subsistence. Nearly all the Indian tribes raise maize, beans, and pumpkins, by the labour of their women, but only to a small extent, and as a resource against famine, their chief reliance being upon the chase. The buffaloes which wander over the prairies of the west, in herds of tens of thousands, are their great support; but deer, bears, and in time of need otters, beavers, foxes, squirrels, and even the most disgusting reptiles, are devoured. And last and worst, there is the horrid banquet of human flesh, which is still in use among some tribes, and to which, at one period of their history or another, perhaps few or none of them have been strangers. The fact has been doubted; but the decided testimony given by Major Long and his party, who all started on their journey with a disinclination to admit it, must be considered as setting the question at rest. After alluding to the incredulity which many felt on the subject, the narrator says,—"With such feelings the gentlemen of the expedition first heard the reports of the anthropophagy of the Potowatomies, and yielded but an unwilling ear to every thing that could induce a belief in the existence of this disgusting trait in the character of the North-West Indians. Truth compels them, however, to assert, that the reports which they have received on this subject were so frequent, so circumstantial, and derived from such respectable sources, that any concealment of it, or any apparent incredulity on their part, would be a dereliction of duty. Even the most incredulous of the party, or those disposed to entertain the most favourable opinion of the Indians, were at last compelled to acknowledge that all doubt on the subject had been removed from their minds."[1] The practice seems to have its origin sometimes in famine, which drives the Indians to this resource, and sometimes in hatred or revenge towards a hostile tribe; for it is only enemies that are thus devoured; and the Indians have a superstitious idea, that the flesh of a brave man, when eaten, especially the heart, imparts a portion of his courage to the individual who consumes it. We have described the manners and dispositions of these nations at some length, because the lights and shadows of savage life, its grand features and marked peculiarities, in that state in which a brutal ferocity has not obliterated every generous quality, are more strongly depicted in their character than in that of any other American race. For the sake of distinction, they may be denominated the Allegany Indians.

[1] *Narrative of Major Long's Expedition to St Peter's River*, vol. i. p. 101. Philadelphia, 1824.

Aborigines. The Caribs, who have been compared to them, had the same courage and fierceness, but were more gross and brutal; and the Araucanians, who surpassed all the independent tribes of America in intrepidity, intelligence, and generosity, had a slight tincture of civilisation. In speaking of those other nations which make the most considerable figure in the new continent, our limited space will not permit us to do more than to describe very briefly the leading traits of their character.

American civilisation. It has been generally admitted by physiologists, that the temperate regions of the globe are best fitted to develope all the powers of our nature; and it is a fact in accordance with this opinion, that among the aborigines of America, civilisation followed very closely the chain of the Andes, and was found either upon their sides or the table-land of their summits, where the elevation of the ground moderates the heat of the tropical sun, and produces a climate analogous to that of Central and Southern Europe. This civilisation did not exist merely at the two distant and isolated points of Mexico and Peru, but presented itself at intermediate places, and may be said to have formed a continuous line from lat. 35. N. to lat. 35. S., with few interruptions, except at those parts where the mountainous chain disappears, or sinks down to a trifling elevation. Some large buildings near the Rio Gila, in lat. 33. N., with fragments of porcelain, indicate the existence of a people here who had some knowledge of the arts. These were most probably a branch of the Aztecks or Toltecks, who afterwards occupied Mexico, as the annals of this country tell. Though some pursued their march southward, it may be reasonably supposed that a part remained in the district; and the Indians living here, who cultivate corn, weave cloth, and live in villages consisting of houses built of solid materials, sometimes two stories in height, may either be their descendants, or have borrowed from them the improvements they possess. Next in order as we proceed southward, are the various nations of Mexico, of whose condition we shall speak by and by. In Chiapa were the Zapotecks, in Yucatan the Mayas, in Guatemala the Quiches and Kachiquels, all nearly as much advanced in civilisation as the Mexicans, and probably of the same primitive stock. From this point, where the Andes lose their elevation, or break into isolated cones, no distinct traces of civilisation appear till we enter the southern continent. Here were found the Muyscas or Moscas, on the table-land of Bogota, a nation consisting of several tribes, who worshipped the sun and practised some of the useful arts. To these succeeded the nations of Peru, living under the Incas, whose dominion extended from the equator to the 35th degree of south latitude. Beyond this boundary were the Chilian tribes, who, though inferior to the Peruvians, had made some advances beyond the rudeness of the savage state. It is proper to mention that some of the nations named were extinct before the arrival of the Spaniards; but the degree of civilisation they had attained is attested by the monuments they have left behind them. There were no other tribes in the new continent which had made any progress in social improvement. We would not except the Guaranis of Brazil, and a few others, who derived their subsistence chiefly from agriculture, but were in other respects savages. We place among the exceptions, however, the extinct race of the Allegewis, or whatever was the name of the people, who erected the military works existing between the Ohio and the northern lakes; but they also, it must be remembered, inhabited a temperate climate, though not a mountainous country. It may be affirmed, then, as a general proposition, that from 35° of north to 35° of south latitude, the sides and summits of the Andes were the exclusive seats of American civilisation. We admit that some of the tribes in Chiapa, Oaxaca, and Yucatan, inhabited low districts; but they were still near the Cordillera, and may be fairly considered as offsets from the nations dwelling upon it. The fact is important, as marking the effect of climate on the active energies of our species. There is no doubt that, with the improved arts of modern times, civilisation can subsist under the burning sky of the torrid zone, but not in such vigour as in countries which enjoy a more moderate temperature. Perhaps it will be found that the moral and physical powers of man attain their highest perfection in those regions where he is accompanied by *wheat* and the *vine*. The zone occupied by the former extends from the 30th to the 57th or 58th parallel; and within the tropics the corresponding climate is found on the flanks or summits of mountains, from 4500 to 10,000 feet above the level of the sea.

Mexico. It is remarkable that the Mexican annals reach to a more remote date than those of any of the nations of northern Europe, though they were preserved merely by an imperfect species of hieroglyphics, or picture-writing. We do not pretend to enter into the question which may be raised, both as to the authenticity of the records themselves, and their susceptibility of a correct interpretation. It is enough that they have received credit from Humboldt, Vater, and other men of learning and judgment who have examined into their nature and origin. From the annals thus preserved, we learn that several nations belonging to one race migrated in succession from the north-west, and settled in *Anahuac* or Mexico. The Toltecks, the first of these, left their original seat, far to the west, in 544 of our era, and after a long journey invaded Mexico, then occupied by wandering hordes, in 648. This people, who penetrated to Nicaragua, if not to South America, were nearly destroyed after the lapse of some centuries; but were followed by the Chichimeks, a half-savage tribe, about 1170, and these a few years afterwards by the Anahuatlels, or seven tribes, including the Acolhuans, Tlascalteks, and the Aztecks or proper Mexicans. All these people spoke dialects of one language, and had similar arts, customs, and institutions. The town of Mexico or Tenochtitlan was founded in 1325, and the series of Mexican kings which commenced in 1352 was continued through eight monarchs to Montezuma. The monarchy was small at first, and passed through many vicissitudes; but it was gradually enlarged, especially by the policy and enterprise of the later princes of the line. When Cortes arrived, it embraced what are now the provinces of Vera Cruz, Oaxaca, Puebla, Mexico, and part of Valladolid, a surface of 130,000 square miles; but within this were comprehended three small independent states, Tlascala, Cholullan, and Zapeaca. The pastoral state, which forms the intermediate stage between savage and civilized life, had never existed in Mexico; for the native wild ox had not been tamed, and the use of milk as food was unknown. The Mexican nations derived their subsistence from agriculture, which, however, was conducted in the rudest manner, with very imperfect instruments. They cultivated maize, potatoes, plantains, and various other esculent vegetables. They raised cotton, and understood the art of spinning and weaving it into cloth, of a texture which excited the admiration of the Spaniards. They had no iron, but showed considerable skill in fashioning the gold, silver, and copper found in a native state, into domestic utensils and ornamental articles. In some of their buildings the stones were hewn into regular forms, and accurately joined; and from the ruins of the palace of Mitla, in Oaxaca, still existing, it appears that they had the art of designing ornaments like arabesques, in paste, Aborigines. with great neatness, and attaching them to the walls; but solid structures of masonry evincing any considerable skill are extremely rare in the country. Their carvings in wood were tolerably well executed, but the figures were disproportioned and uncouth. The same remark applies to their hieroglyphical drawings, which were far inferior in taste and design to those of the Hindoos, Japanese, and Thibetians. For paper they employed sometimes the large leaves of the aloe, sometimes cotton cloth, or the skins of deer dressed. Their books consisted of strips or webs of such materials, composed of pieces neatly joined, one or two feet broad and twenty or thirty long, which were divided into pages by folding them in a zig-zag manner; and two pieces of thin deal attached to the outermost folds served as boards, and gave these manuscripts, when closed, an appearance very much like our old folios in wooden binding. The written language of Mexico contained a few real hieroglyphics or symbols, purely conventional, to designate such objects as water, earth, air, day, night, speech, and also for numbers; but it was essentially a system of *picture-writing*, in which objects were represented by coloured figures having a resemblance more or less exact to themselves. With all its necessary imperfections, this instrument was familiarly employed to a prodigious extent in deeds and instruments for effecting the transmission and sale of property. The government kept couriers for conveying intelligence from all parts of the empire; and the capital was watched and cleaned by a sort of police establishment. This is the bright side of Mexican civilisation. On the other hand, it must be kept in view, that the Mexicans had no tame animals, no made roads, no money to serve as a universal medium of exchange in commercial transactions. The government was originally a perfect feudal monarchy, in which all power was monopolized by a numerous nobility and the priesthood. The great mass of the people were serfs, attached to the soil, and transferred with it from owner to owner by descent or purchase. The peasants or slaves of a nobleman were allowed a certain portion of land, which they cultivated in common for their subsistence: the rest of their labour belonged to their lord. The country swarmed with beggars, and thousands were swept off every few years by famine. As among the ancient Egyptians and the Chinese, immutable custom, regulating every act of civil and common life, chained up the course of improvement, and spread a languid monotony over society. The crown was elective, and the powers of the monarch small, till the privileges of the nobles were destroyed by the policy and ambition of Montezuma. The religion of the Mexicans breathed a savage spirit, which sinks them, in a moral point of view, far below the hordes of wandering Indians. Their deities, represented by mis-shapen images of serpents and other hideous animals, were the creation of the darkest passions of the human breast, of terror, hatred, cruelty, revenge. They delighted in blood, and thousands of human sacrifices were annually offered at their shrines. The places of worship, called Teocallis, were pyramids composed of terraces placed one above another, like the temple of Belus at Babylon. They were built of clay, or of alternate layers of clay and unburnt bricks, but in some cases faced with slabs of polished stone, on which figures of animals are sculptured in relief.[1] One or two small chapels stood upon the summit, inclosing images of the deity. The largest known, which is composed of four stories or terraces, has a breadth of 480 yards at the base, and a height of 55. These structures served as temples, tombs, and observatories; and it is remarkable that their sides are always placed exactly in the direction of the meridian. This leads us to the most interesting fact connected with Mexican civilisation, we mean the perfection of their calendar. The civil year was composed of 365 days, divided into 18 months of 20 days, and 5 supplementary days. The Mexicans had besides a ritual or religious year for the regulation of their festivals; and, by means of a cycle of 52 years, and a very complicated method of computation, the religious and civil periods were connected with one another, and the civil year made to correspond with the natural by the intercalation of 13 days at the end of the cycle. The month was divided into four weeks of five days, but each day of the month had a distinct name; and Humboldt has given strong reasons for believing that these names were borrowed from an ancient zodiac formed of 27 or 28 lunar Houses, which was made use of from the remotest antiquity in Tartary, Thibet, and India. The calendar of the Mexicans bespeaks a degree of scientific skill, and an accuracy of observation, which are not easily reconciled with their semi-barbarous habits, their general ignorance in other things, and the recent date of their civilisation according to their own accounts. It is here, indeed, and not in their language, that we find distinct traces of their connection with Asiatic nations. The character of the Mexicans is probably the same at this day as before the conquest, which, we are disposed to think, made less change in the situation of the people than is often supposed, though it annihilated the rank and privileges of the nobles. The Mexican Indian is grave, suspicious, and taciturn; quiet and placid in his external deportment, but rancorous in his spirit; submissive to his superiors, harsh and cruel to those beneath him. His intellect is limited, and chiefly developes itself in imitative labours and mechanical arts. Slow, cautious, and persevering, he loves, both in his acts and thoughts, to travel in a beaten track. The people, though speaking many different languages, have nearly the same physical character. The Mexicans have olive complexions, narrow foreheads, black eyes, coarse glossy black hair, and thin beards. They are of the middle size, and well-proportioned in their limbs. A person with any defect or deformity is rarely seen amongst them. They are healthy, and live to an advanced age, when life is not shortened by drunkenness. The Tolteck and Azteck races, when they established themselves in the country, diffused their own language partially from the lake of Nicaragua to the 37th parallel. They reclaimed, by degrees, many of the neighbouring savage tribes to a settled mode of life, and spread a feeble degree of civilisation over a mixed mass of nations, speaking, according to Clavigero, 35 languages, of which Humboldt tells us that 20 still exist. The Azteck language is one of the most copious and polished of the American tongues, and abounds in words of the immoderate length of 12 or 15 syllables. It is uncertain what was the number of subjects over whom Montezuma ruled. The ruins in the valley of Tenochtitlan, on which the capital stands, show that it must have been more populous before the conquest than now; but the population at present is diffused over an incomparably wider space; and, upon the whole, there are no good grounds for believing that the number of civilized Indians was much greater when Cortes landed, than in 1803, when it amounted to 2,000,000.

[1] Robertson was mistaken in believing that the Teocallis were in all cases mere masses of earth, without masonry. See Humboldt's *Researches*, vol. i. p. 111, English translation.

Aborigines.

The civilisation of Mexico, as well as Peru, owed its existence to one single cause,—the patient, submissive, and superstitious character of the people, which fitted them to be beasts of burden, under an aristocracy of priests and nobles, who were led, perhaps, partly by lights derived from abroad, partly by the instinct of self-interest, to devise means for holding the mass of the community in subjection. Many of the nations which continued savage, such as the Algonquins and Iroquois, were probably equal to the Mexicans in intellect; but their propensity to superstition was less, and their energy of character was too great to permit of their being enslaved by their chiefs. It is chiefly in the variety of their primitive character that we must seek for the cause of the diversity of manners and institutions we find among the American nations.

Peru.

The ancient empire of Peru, more extensive than that of Mexico, embraced the whole sea-coast from Pastos to the river Maule, a line of 2500 miles in length. Its breadth is uncertain; but as it included both declivities of the Andes, it must have extended in some cases to 500 miles, and the entire surface of the empire probably exceeded 500,000 square miles. It is plain, however, from the imperfect history of the Incas which has been preserved, that within this space there were many districts where their authority was feeble, and others inhabited by tribes which were entirely independent. One part of the country, besides, consisted of a sandy desert, while the most elevated tracts were uninhabitable from cold. It must not therefore be supposed that the capacity of the country to support population was commensurate with the extent of its surface. Still the magnitude of the Peruvian empire, in the midst of an immense multitude of independent savage communities, so extremely minute, that a hundred of them might have been planted without crowding, in one of its provinces, is an extraordinary phenomenon. The creating and maintaining of such an empire is a proof that the Peruvians had made no trifling progress in the useful arts and in the science of government. To keep in subjection so many remote provinces, there must have been an efficient military force, rapid means of communication, considerable revenues, an organized magistracy capable of understanding and executing the plans of rulers, who had sufficient political skill and knowledge of human nature to adapt their institutions and arrangements to the wants, habits, and character of a great variety of dissimilar nations, spread over a territory reaching as far as from Lisbon to the banks of the Wolga. It is clear that the ruling tribe, which was able to extend its dominion, and to a considerable extent its language, over a space of 2500 miles, must have possessed a marked superiority of some kind over the hordes that surrounded it. We must remember, besides, that the Peruvians lay under the disadvantage of being destitute of even such an imperfect instrument of communication as the hieroglyphical language of the Mexicans, and that they were extremely deficient in military spirit. Indeed it is one of the most singular facts connected with the history of America, that by far the largest empire it contained was formed by the most unwarlike people in it. The dominion of the Incas was founded entirely on policy, superstition, and the arts. It could only be by the intelligence and skill which civilisation developes, that the Peruvians conquered tribes superior to themselves in courage; and it was by policy and superstition that the Incas tamed the rudeness of savage tribes, and held distant countries in subjection. Robertson justly observes, that the Peruvians "had advanced far beyond the Mexicans, both in the necessary arts of life, and in such as had some title to the name of elegant." In two points only were they inferior; in their calendar or mode of computing time, and in their want of such a substitute for writing as the Aztecks possessed in their hieroglyphics.

Arts in Peru.

Agriculture was conducted with greater care and success in Peru than in Mexico. The lands capable of cultivation were divided into three shares. One was consecrated to the service of religion, the erection of temples, and the maintenance of priests; the second was set apart as a provision for the support of the government; and the third and largest share, which was reserved for the people, was parcelled out, not among individuals, but among the hamlets and villages, according to the number and rank of the inhabitants; and a new division was made every year to meet any change that might arise in the circumstances of the parties. The members of each little community went to the fields under overseers, and cultivated the land by their joint labour. The produce was distributed among the families and individuals according to their wants, while the evils of famine were provided against by storing up the corn in granaries. The Peruvians having no draught animals, and no ploughs, turned up the earth with wooden mattocks; but their skill and care were exemplified in irrigation, which they practised extensively, and in their employing the dung of sea birds as manure, of which great stores exist on the islands near the coast. Their masonry was superior to that of the Mexicans. Like the ancient Egyptians, they understood mechanics sufficiently to move stones of vast size, even of 30 feet in length, of which specimens are still existing in the walls of the fortress of Cusco. They had the art of squaring and cutting blocks for building with great accuracy; and they did not effect their purpose, as Dr Robertson supposes, merely by chipping the stones, or rubbing them together so as to fit the surface of the one to that of the other, without regard to symmetry of form. It is now known that they had hard chissels, made of copper, with a mixture of 6 per cent. of tin; a proof of considerable skill in the working of metals. With these they hewed the stones into parallelopipeds, which were disposed in "courses as regular," says Humboldt, "as those of Roman workmanship." They are joined with such nicety, that the line which divides the blocks can scarcely be perceived; and the outer surface is in some cases covered with carving. The palaces or lodges of the Incas, of which there are many remains, had doors with slanting sides like the Egyptian; sloping roofs, which, it is supposed, were covered with rushes or stone slabs; no windows, but niches symmetrically distributed.[1] Ancient stone structures, which are so rare in Mexico, are pretty abundant in Peru; a fact for which we can only account by the difficulty with which the Mexicans erected buildings, in consequence of their inferiority in the art of masonry. The architecture of the Peruvians, like every thing else connected with their social state, displays a remarkable uniformity, not only of style, but of plan. "It is impossible," says Humboldt, "to examine a single edifice of the time of the Incas, without recognising the same type in all the others which cover the ridge of the Andes, along an extent of 450 leagues."

Roads.

The ancient public roads of Peru are justly considered as striking monuments of the political genius of the go-

[1] See Humboldt's account of the ancient buildings of Callo and Cunnar, vol. i. and ii. of his *Researches.*

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vernment. One of these extended along the sides of the Andes from Quito to Cusco, a distance of 1500 miles. It is about forty feet broad, and paved with the earth and stones which were turned up from the soil; but in some marshy places it is formed, like the old Roman roads, of a compact body of solid masonry. A tolerably level line is preserved, by filling up hollows, cutting down small eminences, and winding round the sides of large ones. At proper distances zambos or storehouses were erected, for the accommodation of the Inca and his messengers. A similar road was made along the coast in the low country.

Bridges.

Fissures a few yards in breadth were passed by bridges formed of beams laid horizontally; and an invention, at once bold and ingenious, afforded the means of crossing deep ravines, or the channels of rivers, which happened to intersect the route. This consisted of a suspension bridge, perfectly analogous in its principle to those recently introduced in Britain. It was formed of half a dozen of cables of twisted osiers, passed over wooden supports, and stretched from bank to bank; then bound together with smaller ropes, and covered with bamboos. Humboldt passed over one of these pendulous bridges, of 120 feet span; and Mr Miers crossed one of 225 feet span, over which loaded animals might travel.[1] In low grounds the rivers were crossed on rafts with a mast and sail, which, by a particular contrivance, could be made to tack and veer. In this respect the Peruvians were a stage in advance of all the other American races, who had nothing superior to the canoe with paddles. The Peruvians manufactured a rude species of pottery: they understood the art of spinning, and, in an imperfect degree, that of weaving. They procured native gold by washing the gravel of rivers, and silver, and perhaps copper, by working veins downward from the outcrop. They knew how to smelt and refine the silver ore; and they possessed the secret of giving great hardness and durability to copper by mixing it with tin. Their utensils and trinkets of gold and silver are said to be fashioned with neatness and even taste. On the other hand, they had no money, no knowledge of iron or glass; and they were ignorant of the mode of mortising or joining beams, and of casting arches. They had no animals fitted for draught; but the llama, a small species of camel, which they had tamed, was employed to some extent as a beast of burden.

Laws and customs in Peru.

The political organization of Peru, which was artificial in a high degree, reminds one, in some of its features, of the old system of the Saxons in England, but bears a more general resemblance to that of the ancient Egyptians. The mass of the people were in a state of servitude, except a small number, who were free; above these in rank were the Curacas, or chiefs of districts, who formed a sort of nobility; and above the whole, the family of the Incas, the members of which, by intermarrying only with themselves, formed a numerous and distinct caste. For the purposes of police and civil jurisdiction, the people were divided into parties of ten families, like the tythings of Alfred, over each of which was an officer. A second class of officers had control over five or ten tythings, a third class over fifty or a hundred. These last rendered account to the Incas, who exercised a vigilant superintendence over the whole, and employed inspectors to visit the provinces, as a check upon maladministration. Each of these officers, down to the lowest, judged, without appeal, in all differences that arose within his division, and enforced the laws of the empire, among which were some for punishing idleness, and compelling every one to labour. It is probable that the tythings and hundreds, as in England, would lose their numerical signification in course of time, and become mere local allotments. In the hamlets and villages, a person mounted a tower every evening, and announced where and how the inhabitants were to be employed next day. The taxes were paid in the produce of the fields; and magazines for receiving them were established in every district. Such is the account given by Acosta and Garcilasso of the civil institutions of Peru, which may be correct with regard to the oldest possessions of the Incas near Cusco, where their power had been long established; but it is not probable that such a complicated system was ever fully in operation in the more distant parts of the empire.

Government.

The government of Peru was a theocracy. The Inca was at once the temporal sovereign and the supreme pontiff. He was regarded as the descendant and representative of the great deity the sun, who was supposed to inspire his counsels, and speak through his orders and decrees. Hence even slight offences were punished with death, because they were regarded as insults offered to the divinity. The race of the Incas was held sacred. To support its pretensions, it was very desirable that it should be kept pure and distinct from the people; but human passions are often too strong for the dictates of policy; and though the marriages of the family were confined to their own race, the emperor, as well as the other males of the blood royal, kept large harems stocked with beauties drawn from all parts of the empire, and multiplied a spurious progeny, in whom the blood of the "children of the sun" was blended with that of the "children of the earth." Among a simple-minded and credulous people, the claims of the Incas to a celestial origin seem to have been implicitly believed. They were blindly obeyed, and treated with a respect bordering on adoration, by the nobles as well as the common people. The Peruvians worshipped the sun, the moon, the evening star, the spirit of thunder, and the rainbow; and had erected temples in Cusco to all these deities. That of the sun, which was the most magnificent, had its walls covered with plates of gold. The sacrifices consisted of the objects most prized by the people, of grain and fruits, of a few animals, and of the productions of their own industry. Sabeism, as it is the most rational of all the forms of idolatry, so it is generally the most mild; and doubtless this results from the tendency which it has to fix the thoughts on the marks of beneficence and wisdom which are displayed in the works of nature. The Peruvian temples were accordingly never polluted, like those of Mexico, with the blood of human victims; and the Incas even went farther, and signalized their zeal against such horrid rites, by suppressing them in all the countries they conquered. Though their history exhibits some bloody deeds, the general character of their government was the reverse of cruel. The severe punishments prescribed by their laws were rarely inflicted, and rebellion was scarcely known in their dominions. The Inca not only assumed the title of the father of his people, but the vices as well as the merits of his government sprung partly from the attempt made to construct the government on the model of paternal authority, and partly from the blending of moral and religious injunctions with civil duties. Hence the idle pretension of the state to reward virtuous conduct, as well as to punish crimes; hence too the plan of labouring in common, the extinction of

[1] Humboldt's *Researches*, vol. ii. p. 72. Miers' *Travels*, vol. i. p. 334.

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Origin of Peruvian laws.

This system of the Peruvian monarchs, by which the people were kept in a state of perpetual tutelage, merits the greater attention, because it is precisely that which the Jesuits employed, in Paraguay and other districts, to reduce the natives to a settled mode of life; and it seems in fact to be the only method by which a semblance of civilisation can be introduced amongst the American nations. Two things must be supposed to account for its prevalence: first, a certain amount of timidity, passiveness, and superstition, in the body of the people, implying weak passions, but not necessarily smallness of intellect; and, secondly, a few minds of a higher class, to give an impulse to the rest, and to control and regulate their acts. In the case of Peru did these ruling intellects spring from the body of the people, and, after striking out new lights in morals and legislation for themselves, devise a complex and artificial system for establishing their power over the minds of the rest, by the help of superstition and force? Or were they strangers from another country, and imbued with the principles of a higher civilisation? If we may believe the Peruvian annals, the latter was the case. About the year 1100 of our era, or perhaps a century later, Manco Capac, with his wife and sister Mama Ocello, appeared as strangers on the banks of the lake Titiaca. They were persons of majestic appearance, and announced themselves as "children of the sun," sent by their beneficent parent to reclaim the tribes living there from the miseries of savage life. Their injunctions, addressed to a people who probably worshipped the god of day, were listened to by a few, who settled around them, and founded Cusco. By degrees, other tribes were induced to renounce their wandering habits. Manco Capac instructed the men in agriculture and the arts, and Mama Ocello taught the women to spin and to weave. Laws, institutions, and religious rites, were added. The form of a civilized society arose, which was gradually extended by persuasion or conquest; the Incas having always planted their arts and religion wherever they established their authority. Huana Capac, the twelfth in succession from the founder of the dynasty, occupied the throne when the first party of Spaniards visited Peru in 1527; and the empire was then still in a state of progress; for this prince had conquered Quito at no distant date, and nearly doubled the extent of his dominions.

Such is the account which the Peruvians give of the origin of their civilisation, which we should be disposed to reject as a fable, if there were not peculiar circumstances which give it some credibility. First, their institutions, taken in the mass, do not present what may be called the American type. The mild and paternal character which they display, the injunction to "love one another" raised to the rank of a positive precept, the preference of the useful arts to war, all breathe a spirit, not only foreign to the genius of the American tribes, but exactly opposed in character to any thing which a native self-taught legislator was likely to produce. Secondly, the artificial and systematic form of the Peruvian institutions renders it improbable that they were developed by the natural action of political causes, but strongly favours the idea, that they were framed by a few designing heads, as an instrument to tame and govern a patient, feeble, and credulous people, of rude or savage habits. A small number of Jesuits were led, by a sagacious study of the savage character, to devise a system extremely similar in its nature, which worked admirably. These missionaries were the Manco Capacs of Paraguay; and, like the Incas, might, in the course of two or three centuries, have extended their theocracy over as large a space as Peru, if their situation had permitted them to employ force. Thirdly, a million of native Peruvians yet survive, the living descendants of those who built the temples of Cusco; and their extreme stolidity, apathy, and feebleness of character, sufficiently testify that the chances were nearly as great against a legislator like Manco Capac arising amongst them, as against the Jews in the time of Augustus producing a being like Jesus Christ. They have the weakness and passiveness which fit them to receive an impression from superior directing minds; but they discover no trace of the intelligence, energy, and originality which must have been united in the persons who planned and carried into effect the political system of the Incas. We admit that oppression may have degraded their character; but it cannot have entirely changed it. Look at the Greeks of this day, who have been enslaved for a much longer period.

If, then, the civilisation of Peru was exotic, whence was it derived? To us it appears most probable, that the legislators of Peru were either Chinese, or persons who had received at second-hand a knowledge of the arts and institutions of China; and our opinion is grounded on traits of resemblance in the manners, laws, arts, and institutions of the two nations, which, in our opinion, are too numerous, striking, and peculiar, to be the effect of chance. We shall mention some of the most prominent.

Peruvians and Chinese compared.

1. The first and most obvious resemblance is in the singularly artificial frame of society in both countries. In China, as in Peru, the legislation is *directive* as well as punitive, and is distinguished by that minute and elaborate system of regulation, inspection, and control, which interferes with the most trifling actions of ordinary life, and reduces the mass of the people to the condition of automata, moved and guided in every thing by the rulers. China, says Mr Barrow, is a great school, in which the magistrates are the masters, and the people the scholars. It might be more correctly compared to a large monastic establishment, in which each person has his place and his duty assigned to him, and all his acts directed by superiors, whose wisdom and authority he is not permitted to question. The Chinese have the same immense multitude of civil officers which the Peruvians had, and the same chain of subordination from the emperor down to the petty constable. In China this system was undoubtedly the growth of many centuries; but it was too artificial to occur to the thoughts of a cazique, educated amongst a tribe of savages on the sides of the Andes. 2. In China, as in Peru, the emperor assumes the title of the "father

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of his people;" and his government is modelled upon this figure of speech. He affects to be sprung from progenitors who *descended from heaven*, like the children of the sun; and he unites the character of supreme pontiff with that of temporal prince. There are vestiges, too, of the worship of the heavenly bodies in China.[1] 3. The Chinese emperor extends an ostentatious patronage to agriculture, by celebrating an annual festival in its honour; on which occasion he proceeds to the field in great pomp, and takes a part in the labour of cultivating the ground with his own hands. This singular custom existed in Peru, where the Incas went through an annual ceremony perfectly similar. How foreign was such an institution to the spirit of the American tribes! 4. In China agriculture is in a rude state, and exhibits proofs of intelligence and skill only in two things—the use of manures, and a laborious system of irrigation. Precisely the same circumstances characterized the agriculture of Peru. 5. The internal taxes of China, like those of Peru, are paid in kind (maize, rice, silk, cotton, &c.), and stored in public magazines or granaries. 6. The Chinese government maintained public roads, even in those provinces where neither carriages nor beasts of burden were used, of course for the use of pedestrians; and storehouses or places of refreshment were built upon them at proper distances.[2] The Peruvians constructed roads on precisely the same plan, and for the same purposes; and this was done by no other people in America. 7. The Chinese do not inter the bodies of the dead, but lay them on the ground, and raise a tumulus or conical heap of earth over them. Such was also the practice in Peru. The only barbarously cruel rite practised in Peru, that of immolating the Inca's domestics at the obsequies of their master, was brought into China by the Tartars.[3] Its existence is an anomaly in each case; for the genius of both nations was peaceful and mild. 8. The architecture of the Chinese displays little taste, but is distinguished by two peculiarities—the power shown of cutting and moving immense masses of stone,[4] and the uniformity of style which pervades their structures, of every size and description. "All the buildings," says Mr Barrow, "from the meanest hut to the viceroy's palace, are upon one plan." Humboldt remarks the same adherence to a single model among the Peruvians; and the walls of Cusco show that they were acquainted with the method of moving stones of prodigious size. The Chinese were fond of covering their walls with carving; and examples of the same practice occur in Peru. If any of the Peruvian buildings had remained entire with their roofs on, it would perhaps have been found, that the type or primary architectural form employed in the two countries was not very dissimilar; and some allowance should be made for the circumstance, that Peru must have borrowed her models from China 700 or perhaps 1000 years ago. 9. The Peruvians made coarse pottery; and all the world knows that this is an art in which the Chinese excel. The Peruvians were the only American nation who had made any progress in the art of fusing and alloying metals, in which the Chinese have long been distinguished by their skill. 10. The Peruvians had dramas and dramatic spectacles. Where could a people so uninventive have caught the idea of such entertainments, if not from China, where they have been long familiar to the people? There were mimics and buffoons in Mexico, but nothing, we believe, to which the term drama could be applied. 11. But perhaps the most remarkable coincidence is found in an invention entirely confined to the two countries. We have described the suspension bridges made of ropes, employed by the Peruvians in crossing deep ravines. Now it is singular that bridges of the very same description, some of chains, and *some of ropes*, are found in the south of China, and nowhere else except in Thibet, which has interchanged arts and customs with China from time immemorial. This single fact we would consider as a proof of communication between the two countries. The Peruvians made their ropes of twisted osiers, and the Chinese had ropes also of this description.[5] 12. From what people nearer than the Chinese could the Peruvians borrow the idea of rafts with a mast and sail? These rafts, supporting covered huts, may be considered as literal copies of some that are used in China; and the peculiar mechanism employed in lieu of a rudder is no doubt borrowed from the paddles attached to the Chinese boats, fore and aft.[6] 13. The Chinese in ancient times made use of quippus or knotted cords to facilitate calculation. Is it not probable that this invention had passed from them to the Peruvians, the Mexicans, the Kaluschi, and other American nations who employed it? It would be easy to trace similar analogies in many other customs, laws, and institutions of the two nations. Both had nunneries or religious societies of women, who lived under a vow of celibacy; both had a class of literary men (the Havaracs and Amantas, or poets and philosophers, in Peru), patronised by the government; both divided the year into twelve months, and placed the beginning of it in January (a coincidence the more remarkable, as the year of the Mexicans and other northern nations consisted of 18 months); both were strangers to the use of milk, cheese, and butter.[7] These facts may suffice, for we have not room for lengthened inquiries; neither are we anxious to press our argument beyond its proper limits. Our position is, not that the Peruvians are descended from the Chinese, but simply that Peru had been inoculated with civilisation by persons who derived their ideas from China. If it is asked why these persons did not import from China the use of letters, the method of casting arches, and many other arts practised there, our answer is, that no individual, and still less any casual assemblage of individuals such as the purposes of trade or navigation might bring together, possesses a knowledge of every art and science which exists in his country. How many men are there in England at this day, who could not even carry the knowledge of the alphabet to another country? We must remember, too, that all the arts existing in China do not exist in every province of it, and have not always existed in those provinces where we now find them.[8] As to the means of

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[1] See account of the temples at Pekin dedicated to the heavens, the north star, the moon, the earth, &c., and of the festival kept at the summer solstice, like the grand solar festival in Peru. (*Hist. Gén. des Voyages*, tom. vi. p. 32–34.)

[2] *Histoire Générale des Voyages*, tom. vi. p. 170.

[3] *Ibid.* p. 391.

[4] See the account of the bridges formed of huge blocks of stone, without arching, in Prevost's *Hist. Gén. des Voyages*, tom. vi. p. 179.

[5] Prevost, *Hist. Gén. des Voyages*, tom. vi. p. 179, and tom. vii. p. 339.

[6] *Ibid.* tom. vi. p. 211, and tom. xiii. p. 583.

[7] Mr Barrow, in the article CHINA, written for this work, is our authority for this fact, which is the more remarkable, as the Mongols, the neighbours and conquerors of the Chinese, had the use of all the three articles immemorially.

[8] The uniformity and unchangeableness of customs in China have evidently been much exaggerated. The empire is formed of

Aborigines. communication, it is evident that the trade-wind renders Peru almost unapproachable from Eastern Asia, between the parallels of 30° north and 30° south latitude. But beyond these limits the west winds prevail, and hence China, in point of facility of access, is nearer to Peru than the Society or Marquesas Islands. The Chinese have long exposed themselves to the casualties of a maritime life, in vessels of large size, provisioned for many months; and at this day they perform voyages of 3000 or 4000 miles, to Ceylon and Polynesia.

The Quichua language, or that of Peru, was spread, by the care of the Incas, over all the countries which they conquered, so far at least as to be understood, if not spoken, by the great variety of tribes subject to their sway. It is understood at present as far as Santiago del Estero, 1200 miles of direct distance south-east from Cusco. This single fact proves both the long duration of their power, and the efficiency of their internal administration. It is said to be the most rich, polished, and harmonious of the South American languages, abounding in vowel sounds, but wanting those corresponding to the Spanish consonants b, d, f, g, l, x, v. Like all the other American tongues, it wants terms for abstract and universal ideas, such as *time*, *space*, *being*, *substance*, *matter*, *body*, and even such as *virtue*, *justice*, *liberty*, *gratitude*. There are five dialects of the Quichua, which are spoken in Peru proper, and in Quito, New Granada, and a considerable part of La Plata, and not only by the Aborigines, but by many Spaniards of the higher classes. The Peruvians had no alphabetic writing. They possessed a very rude species of hieroglyphics, of which little use was made, and the quippus or knotted cords of various colours; but whether these last were employed to record events, or were merely instruments of calculation, is a question which we must confess our inability to solve. The history of Peru, as it has reached us, seems to have been preserved entirely by tradition, aided perhaps by popular songs.

The Peruvians, according to Mr Stevenson, are of a copper colour, with a small forehead, the hair growing on each side from the extremities of the eye-brows; they have small black eyes, a small nose, a moderately sized mouth, with beautiful teeth; beardless chin (except in old age), and a round face. Their hair is black, coarse, and sleek, the body well proportioned, the feet small, the stature rather diminutive. Their intellectual qualities, according to M. Ulloa, are of the lowest order. The most prominent trait in their character is an imperturbable and incurable apathy. Though half-naked, they are as contented as the Spaniard in his most splendid raiment. Gold and silver have so little influence over them, that the greatest recompense will not induce them to perform the slightest service voluntarily. Neither power nor dignity moves them; and they receive with the same indifference the office of alcalde and that of executioner. They are habitually slow in their motions, and extremely indolent. When employed at any piece of labour, if the master withdraw his eye for a moment, they cease to work. They are timid, shy, secretive, and always grave, even in the dances, which are their favourite pastime. The love of intoxicating liquors is deeply rooted in their nature. They prepare a fermented beverage called chicha, from maize, by a process known to them before the conquest, and at their festivals drink till their senses fail them, day after day. This bestial habit, however, is common to all the American nations, and is confined to the men, for the women are in general strictly sober. The Peruvians are a gentle and mild people; they are fond of their dogs, and breed up hogs, geese, and chickens, for which they have so tender a regard, that they will often neither kill nor sell them. Their huts, says Mr Stevenson, consist of stones laid upon one another without any cement or mortar, thatched over with long grass or straw, affording no defence either from the wind or the rain. One small room contains the whole family; their bed a sheep-skin or two; their furniture one or two earthen pots. The principal food of the Peruvians is maize; but they raise also potatoes, wheat, beans, camates, yucas, pumpkins, and other vegetables. Christianity, imposed upon them in dogmas, by priests who take no pains to enlighten them, has scarcely gained admission to their understandings, and has no hold on their affections. They attend divine service from the dread of chastisement, and give an outward assent to whatever they are taught, but without any real religious impression being made upon their minds. They meet death with the same stupid indifference as the ordinary accidents of life, and rather decline than seek the assistance of a priest in their last hours. It ought not to be forgotten, however, that the intellectual torpor which the Peruvians display may be attributed in part to the deadening and debasing effects of three centuries of brutal oppression. They still cherish in secret a strong veneration for their ancient faith and their native government, which displays itself even in the large towns. The story of Manco Capac (whom, since numbers of our countrymen appeared in Peru, they affect to call an Englishman) and Mama Ocello, the wealth, power, and beneficence of the Incas, are still fresh in their memories, and are handed down from father to son with a degree of fond admiration which three centuries of humiliation and misfortune seem only to have rendered more intense. The barbarous murder of the Inca Atahualpa by Pizarro is annually represented in the form of a tragedy. "In this performance," says Mr Stevenson, "the grief of the Indians is so natural, though excessive, their songs so plaintive, and the whole is such a scene of distress, that I never witnessed it without mingling my tears with theirs. The Spanish authorities have endeavoured to prevent this exhibition, but without effect. The Indians in the territory of Quito wear black clothes, and affirm that it is mourning for their Incas, of whom they never speak but in a doleful tone."

The oppression of the *mita*, or forced labour in the mines, with the introduction of the small-pox and the use of spiritous liquors, has destroyed prodigious multitudes of the Indians since the conquest. What their number was before that event it is impossible to tell; but, judging from the extent of the Inca's dominions, he probably had not less than three or four millions of subjects. A pretended Spanish account, assigning a population of eight millions to Peru shortly after the conquest, is known to be fictitious. According to General Miller, there were 998,000 Indians in Peru about 1826; but he does not include those in Quito or Bolivia.[1]

Chili. In Chili there were several tribes who possessed near-

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an assemblage of small states, conquered one after another, each of which must have had its peculiar laws, manners, and superstitions; and common sense tells us, that to blend these into one perfectly homogeneous mass, must have required a much longer period than has elapsed since the empire attained its present magnitude. It would be easy, too, to find instances of the Chinese having changed their customs, both in matters of business and matters of domestic economy.

[1] In this account of the Peruvians we have chiefly followed Garcilasso, Acosta, Frezier, and Ulloa, of whose statements a copious digest is given by Prevost, in the 13th volume of his *Histoire Générale des Voyages*. We have also taken some facts from Humboldt's

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ly all the arts known to the Peruvians, but were distinguished from them by a finer physical constitution, and an unconquerable spirit. When the Spaniards arrived, Chili, according to Molina, was inhabited by fifteen tribes independent of each other, who were spread over the country on both sides of the Andes, from latitude 30° to the Straits of Magellan. They all spoke dialects of one language, which is described as rich, harmonious, abounding in compound words, and having, like the other American tongues, very complicated grammatical forms. It has no affinity to the Quichua or Peruvian. The inhabitants of the plains are a stout people, of middle stature; those of the mountains are tall; and one tribe, the Tehuels or Patagonians, surpass in size every other nation in the world. All the tribes inhabiting the plains, except those of the extreme south, now make use of horses. The complexion of the Chilian tribes is, like that of the other American nations, a reddish brown; but one tribe is said to be of a clear red and white. They do not paint their bodies. The Chilians lived partly by hunting, but chiefly by agriculture, before they had any intercourse with Europeans. They cultivated maize, magu, guegen, tuca, quinoa, the potato, pumpkins, and some species of pulse; and to these they added, as food, the flesh of a small rabbit, and of the Chilihueque or Araucanian camel, of whose wool they are said to have manufactured cloth. Like the Peruvians, they understood the use of manure, practised irrigation with considerable skill, and turned up the ground with a wooden spade or mattock. They boiled their grain in earthen pots, or brayed it into meal after roasting it in hot sand; of the meal they made puddings or bread, which they knew how to leaven, and various species of fermented drink. They had gold, silver, copper, tin, and lead, procured probably by washing; but they had few or no edge-tools of metal, as those found are almost always of basalt. They made baskets and mats, extracted salt from sea-water, and were able to give various dyes to their cloths. They used *quippus* or knotted cords for calculation, and, according to Mr Stevenson, for the transmission of intelligence and for recording events. They lived in villages formed of houses standing at a distance from one another, under hereditary chiefs, but whose power was limited. It is remarkable that the Chinese mode of catching wild ducks on the rivers, by covering the fisher's head with a gourd, was practised in Chili.

Araucanians.

The Araucanians, the most intelligent, improved, and warlike of the Chilian tribes, occupy about 200 miles of the sea-coast, between the 37th and 39th parallels. They are of ordinary stature, but vigorously formed; bold, hardy, hospitable, faithful to their engagements, generous to a fallen enemy, ardent, intrepid, and enthusiastic lovers of liberty. Their vices are drunkenness, and a contempt of other nations, springing from pride. Their government, in the regularity of its form, and its sub-division of authority, has an outward resemblance to the Peruvian; but the spirit of the two systems differs as widely as the genius of the two nations. Araucania contains four tetrarchies, under four toquis or princes, who are independent of one another, but confederated for their joint security against foreign enemies. Each tetrarchy is divided into five provinces, ruled by five chiefs called *Apo-Ulmen;* and each province into nine districts, governed by as many *Ulmen,* who are subject to the Apo-Ulmen, as the latter are to the toquis. These various chiefs (who all bear the title of ulmen, as our nobility of all orders are barons) compose the aristocracy of the country. They hold their dignities by hereditary descent in the male line, and in the order of primogeniture. The supreme power of each tetrarchy resides in a diet or great council of the ulmen, who assemble annually in a large plain, like the Poles and Germans in old times; but as the people are all armed, and have a high love of liberty, no resolution of the diet is of any avail if it has not their hearty concurrence. The chiefs, indeed, are little more than leaders in war; for the right of private revenge, which is fully admitted, limits their authority in judicial matters; and they receive no taxes. Their laws are merely primordial usages. The Araucanians can raise altogether 6000 or 7000 men, besides a body of reserve. When war is declared by the great council, messengers bearing "arrows dipt in blood" are sent to all parts of the country, to summon the men to arms. Unlike many barbarous nations, which are immovably attached to their ancient customs, the Araucanians were not slow in copying the military arts and tactics of the Spaniards. Their troops now consist of infantry and cavalry; the former armed with pikes or clubs, the latter with swords and lances. The infantry are formed into regiments of ten companies, each company containing a hundred men. When they take the field, they carry parched meal with them for provisions; they station sentinels, send out scouts, and have advanced guards preceding their main body. When necessary for their security, they dig ditches, and plant stakes along their sides, and throw up mounds of earth. They advance to battle in lines well formed, and fight with intrepidity. Their history affords a brilliant example of what a brave nation, animated by an enthusiastic love of liberty, can accomplish under the greatest disadvantages. After resisting the best troops and the best generals of Spain for two hundred years, they at last compelled their proud enemies to acknowledge their independence. The Araucanians were indebted for their success to a deliberate species of courage, to which even the bravest of the North American tribes are strangers; and they combined with it a degree of sagacity and intelligence, which led them to adapt their mode of fighting to the new circumstances in which they were placed. Experience having taught them the inefficiency of their old missiles when opposed to musket balls, they soon laid aside their bows, and armed themselves with spears, swords, or other weapons fitted for close combat. Their practice was to advance rapidly within such a distance of the Spaniards as would not leave them time to reload after firing. Here they received without shrinking a volley, which was certain to destroy a number of them, and then rushing forward in a close column, fought their enemies hand to hand. In this way they gained many victories, and impressed the Spaniards with such a respect for their courage, that an individual of this nation made their achievements the subject of an epic poem. Combining the moral, intellectual, and physical qualities of the Araucanians, they were certainly the finest native race in the new world. They had nearly all the germs of civilisation which belonged to the Mexicans and Peruvians; without the ferocity of the former, the apathy of the latter, or the slavish habits common to both; and without having their minds stupified by that grovelling superstition which the rulers of these two nations seem to have considered as the only secure foundation of their authority. In true courage, in manliness and energy

*Researches*, Balbi's *Ethnographical Atlas*, and W. B. Stevenson's *Narrative of Twenty Years' Residence in South America*, a useful work, but in which the author has shown rather too great an anxiety to exalt the character of the Indians.

Aborigines.

of character, they take precedence of all the American nations.

The Araucanians believe in a supreme being, and in many subordinate spirits, good and bad. They believe also in omens and divination, but they have neither temples nor idols, nor religious rites; and discover upon the whole so little aptitude for the reception of religious ideas, that the Catholic missionaries who are settled among them have had very little success in imbuing their minds with a knowledge of Christianity. They believe in a future state, and have a confused tradition respecting a deluge, from which some persons were saved on a high mountain. They divide the year into twelve months of 30 days, which have significant names, and add five days by intercalation. They esteem poetry and eloquence, but can scarcely be induced to learn reading or writing. Chess, a game of Chinese origin, is said to have been known among them from time immemorial;[1] and it may be further observed, that the numbers 5 and 9, employed in their geographical and civil divisions, are favourite numbers in China.

The other Chilian tribes are all much behind the Araucanians in civilisation; but some, as the Puelches and the Tehuels, surpass them in strength and stature. Part of them live on horse flesh, part by keeping sheep and cattle, and part by hunting. Some of these tribes paint their faces.[2] With regard to the height of the Patagonians, M. Lesson, an eminent French naturalist, has collected the authorities on the subject, in a note published by Balbi in his Ethnographical Atlas; and they appear to us to remove every rational doubt as to the fact of a race of men existing there, whose average stature is about six feet, and among whom men seven feet high are perhaps as common as men of six feet two or three inches in England. We cannot help regarding the scepticism in which many writers have indulged upon this question, as unphilosophical. The diversities of size in the human race are innumerable, and stature, like other physical qualities, is hereditary. We form in our minds, indeed, an idea of a standard size for man; but this is merely the mean of all the varieties which come under our notice; and till we know all these, our estimate cannot have any exactness. There are scarcely two nations perhaps whose average height is the same, and who can pretend to such a knowledge of the causes producing these varieties as to fix their precise limits? That individuals seven feet high, free of weakness or defect, have existed among ourselves, is a proof that there is nothing in such stature inconsistent with the physical laws on which human life depends. And since nobody denies that the dwarfish size which we witness occasionally in our own country, as a deviation from the common type, becomes generic and universal among the Laplanders and Esquimaux, why should the natural causes which produce tall men at intervals among ourselves not be rendered equally fixed and permanent in other cases? But the chief source of the incredulity of many persons is obvious. Only one of the fifteen tribes who inhabit the south extremity of the American continent is distinguished by the very tall stature which is ascribed to the Patagonians; and as these tribes probably migrate from place to place, from the coast, for instance, to the interior, and *vice versa*, a navigator touching at a bay where some of his precursors profess to have met with the giants, may find no inhabitants at all, or only men of ordinary size, and in either case may attribute to false reports what is really the consequence of a change of habitation.

Patagonians.

Guaranis.

Of the numerous nations which inhabited Brazil, there is only one to whom we can afford any special notice in this article. The Guaranis had at one time formed a numerous people, which seems to have been spread over a larger surface than any other now existing in America. Tribes, or remnants of tribes, whose relationship to the Guaranis is attested by the strong evidence of their language, are found diffused over the wide space between the Orinoco and the embouchure of the Plata, over more than the half of South America. They are met with among the Andes of Peru, in the province of Chiquitos, in Mattogrosso, in Paraguay, in Minas Geraes; and the Omaguas, in the province of Quito, who, from their nautical habits, and the influence they obtained on the upper part of the Amazon, have been called the Phœnicians of the new world, are believed to be of the same race. They constituted the bulk of the native population of Brazil when the Portuguese gained possession of it, but were divided into many distinct tribes, quite independent of one another, and living, not in contiguity, but mixed with other nations. They are of low stature, two inches shorter than the Spaniards, according to Azara, of a square form, fleshy, and ugly. Their colour has a strong shade of the copper red, while that of the other Brazilian tribes inclines generally to the tawny or black. Their character, like their physical form, resembles that of the Peruvians. They are patient, torpid, silent, downcast in their mien, mild, and passionless. Nearly all the Indians whom the Portuguese have civilized or converted belong to this race. It is difficult to account for their dissemination through the southern continent, amidst nations much more brave and powerful than themselves. May we suppose that, like the subjects of the Incas, they had been at one time the dominant tribe of an extensive empire, which derived its force from union and civilisation? But if such a state did exist, its date cannot be very ancient; for the identity or close resemblance of the dialects spoken by the scattered portions of the Guaranis, shows that their dispersion from a common point did not happen at a very remote period.[3] Yet no memorial of its existence survives, either in traditions or monuments. The supposition, therefore, that the Guarani tribes are the remnants of a once powerful and united people, is scarcely admissible; and Azara thinks it more probable that they have crept gradually from north to south. Their dispersion is the more remarkable, as they are not a wandering but an agricultural people. They live in the woods, or in small open spaces in the forests; cultivate maize, beans, gourds, yams, mandioc; and eat also wild honey, and the flesh of monkeys and various small quadrupeds.

Paraguay Indians.

The Indians whom the Jesuits civilized and collected into communities in the celebrated settlements of Paraguay belonged chiefly to the nation of the Guaranis. These missionaries are said to have borrowed the plan of the theocracy which they established here from that which the Incas had introduced into Peru. There is no doubt that the spirit of their system was the same; and, considering that they were precluded from any other means of extending and supporting their authority than persuasion, their success was remarkable. The settlements were commenced about 1610, and were gradually extended over the country watered by the Parana and Uruguay, between the 27th and 30th degrees of south

[1] Molina's *History of Chili*, vol. ii. p. 125.

[2] *Ibid.* vol. ii. book i. and ii. Stevenson's *South America*, vol. i. chap. iii.

[3] Dr Prichard's *Researches*, vol. ii. p. 487.

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latitude, till the order of the Jesuits was suppressed in 1767. The plan of the government may be called *parochial*, for it was administered entirely by the parochial clergy. The Indians were collected into villages. Each village had its church, and its curate, who was assisted by one, two, or more priests, according to the number of Indians under his charge. The curate and assistant priests were nominated, not by the Spanish authorities, but by the father superior, also a Jesuit, who exercised a vigilant superintendence over the whole. Indians were appointed in each village with the titles of regidors and alcaldes; but they were merely instruments in the hands of the curate and his assistants, in whom all power was lodged. The curate gave his whole attention to religious offices, saying mass in the church, and visiting the sick; while the assistant priests managed all secular matters, directing the labour of the Indians who cultivated the ground, and training others to the crafts of the weaver, mason, carpenter, goldsmith, painter, and sculptor; for the fine arts were by no means neglected. Private property did not exist. The produce of the labour of the community was stored in magazines, from which each family was supplied according to its wants, special provision being made for aged persons, widows, and orphans. The surplus was sold by agents at Buenos Ayres, and the proceeds employed in paying the taxes to the king, in procuring ornaments for the churches, and various articles which the colonists could not manufacture for themselves. The religious instruction was of the most simple kind; but the service of the church was conducted with a well-trained choir, a pompous ceremonial, and every accessory calculated to strike the senses. The punishments were mild, and they were always accompanied with such admonitions as a parent would address to a child whom he was chastising. Crimes, in truth, were rare. The Indians, who regarded their spiritual chiefs with the veneration due to beneficent beings of a superior order, scarcely felt humbled in confessing their misdeeds; and offenders may have solicited correction, as Raynal says, for the quieting of their consciences. The incursions of the Portuguese compelled the Jesuits to take means for repelling force by force. All the male Indians of the proper age were accordingly armed with muskets, and disciplined as a militia. In 1732, according to Dobrizhoffer, the thirty villages or parishes under the care of the missionaries contained a population of 141,000 souls. The Jesuits had another establishment of the same kind among the Chiriguas, a branch of the Guaranis, in the province of Chiquitos, containing 30,000 or 40,000 Indians; a third, of smaller size, in the province of Moxos; a fourth in California; and probably others. After the suppression of the order, all these were committed to the care of friars of other descriptions; and we believe they have universally fallen into a state of decay. The social system established in Paraguay was the most effectual ever contrived for reclaiming the Indians from their savage mode of life; but even its success shows how hopeless the attempt is to raise the American tribes to the rank of thoroughly civilized nations. The Jesuits were able to introduce settled habits and a slight knowledge of religion and the arts among the Indians only by means of the personal ascendency they acquired over them. It was a few superior minds gaining the respect and confidence of a horde of savages, then employing the influence they acquired to lead them as children; giving them such portions of instruction as taught them to trust implicitly in their guides, working alternately on their fears, their pride, their kind affections, but never fully unveiling to them the springs of the machinery by which they were governed. The incurable indolence of the savages rendered it necessary to prescribe the labour as task-work, and to carry it on under the constant inspection of the missionaries. The plan of cultivating the ground in common, and of storing the produce in magazines, out of which the wants of each family were supplied, was resorted to as a check upon their improvident habits. In short, the eye and the hand of the missionaries were everywhere; and the social system was held together entirely by their knowledge and address. When these were withdrawn, the fabric soon fell into ruins, and the Indians relapsed into their idolatry and savage habits, just as boys drop their tasks the moment they are liberated from school.

Conversion and civilisation of the Indians.

We have dwelt a little upon this topic, because we think the experiment made by the Jesuits in Paraguay and Chiquitos is almost an *instantia crucis* with regard to the capacity of the American tribes for receiving Christianity and civilisation. From the moment that the Europeans landed in the new world, benevolence has been at work to instruct some portions of these tribes in religion and the arts; and flattering accounts have been published from time to time of the success of those humane persons who dedicated their lives to the task. But, after three centuries of incessant exertion, what is the result? Is there one tribe that exhibits the steady industry, the provident habits, the spirit of improvement, and the rational views of religion, which are to be found in any parish of England? We cannot find that there is. Many tribes, living near the whites, have adopted their habits and ideas to a certain extent, but merely under the influence of imitation. While missionaries and teachers are among them, every thing wears a favourable aspect; but their civilisation is never self-sustained. It is created by the agency of men of higher natural endowments; and when this is removed it moulders away, because it has no foundation in their character. Many parties of Indians, remnants of tribes once powerful, have lived peaceably on reserves of land, inclosed amidst the population of the United States, for more than a century. No situation can be imagined better fitted to promote their improvement; but in no one instance, so far as we know, have they melted into the mass of the white population, or risen to any thing near their level in knowledge and the useful arts. They live in huts in no material degree better than the wigwams of their wandering brethren. They are generally honest, but drunken, indolent, and ignorant, though teachers and missionaries are employed by the government to instruct them. Basket-making is almost the only trade they ply, and in their habits and character they may be aptly compared to the gypsies of Europe, who exist in the midst of civilisation, without partaking of its spirit or its benefits. It should be observed that there is not the same reluctance in the whites to mingle their blood with the red men, as with the blacks.[1] Much has been recently said of the progress made by the Cherokees; but we suspect that what is witnessed there is but a flimsy veil of improvement, spread over habits which are essentially savage. We are convinced, in short, that the Indian is truly the man of the woods; and that, like the wild animals he lives upon, he is destined to disappear before the advancing tide of civilisation, which falls upon him like a blight, because it supplies new food to nourish his vices, while it demands intellectual and moral faculties in which he is deficient, and renders useless

[1] See, on the habits and character of the Indians, Cooper's *Notions of the Americans*. vol. ii. letter 17.

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those qualities which predominate in his character. We would not discourage the attempt to meliorate the lot of the Indians; but this will succeed best when it is grounded on a true knowledge of their natural capacities. Some of them are much more susceptible of moral and religious improvement than others; but, to instruct and reclaim them effectually, our belief is, that the system of the Jesuits is the only one that holds out a chance of success. They must not merely be taught and preached to, but they must be retained in a state of pupilage, trained to their duties, controlled and directed in all their proceedings by intellects superior to their own; and there are many tribes too ferocious and intractable for even this method of tuition. We do not maintain that the character of the Indian nations is indelible; but to effect any considerable change in it, the lapse of a longer period would be required than the existence of these tribes is likely to extend to. Neither do we think that there is any thing in the extinction of these people by natural means which humanity should mourn over. In every state of life man has but a brief span of existence allotted to him. Successive generations fall like the leaves of the forest; and it should be remembered that the extinction of a race of men by natural causes, means merely its non-renewal, or the suspension of those circumstances which enabled it to continue its existence.

To complete our general view of the aboriginal races, a few particulars remain to be mentioned. Many of the tribes who inhabit the Pampas of South America make use of horses. Dobrizhoffer enumerates eight equestrian tribes in the province of Chaco, on the west side of the river Paraguay, who are generally distinguished by tall and vigorous forms, and a bold and active character. The Abipones and Mbayas are the most celebrated of these. The woods of Brazil are too dense for equestrians; but horses are used by a few hordes in the great plain of the Mississippi and in the north of Mexico. The American tribes in general either kill their prisoners or adopt them; but a few retain them as slaves, and compel them to work. The Guaycurus of Brazil are an example. The food of different tribes is extremely various. Maize, beans, pumpkins, and mandioc, are raised in small quantities by some; natural fruits, berries, bulbous roots, and bananas, are gathered by others. Those who dwell on the sides of rivers live greatly on fish; in the plains, buffaloes, horses, and sheep, are killed. In the forests of Brazil, monkeys, pigs, armadillos, pacas, agoutis, and tapirs, are the favourite food; but birds, turtles, deer, and the coati, are also taken; and in an emergency the Indians do not scruple to feed on serpents, toads, and lizards, the larvæ of insects, and other disgusting substances.[1] Salt is used where it can be easily obtained, and some season their food with capsicum. Some roast their meat, others boil it; and not only several savage tribes, but even the civilized Peruvians, ate their flesh raw. The Ottomaques, a tribe near the Orinoco, eat a species of unctuous clay; and this strange diet, which no doubt owed its introduction to the stern monitor, famine, is probably not extremely rare; for Drs Spix and Martius noticed a similar practice in Brazil, and Captain Franklin found the same food in use among an Indian tribe near the Frozen Ocean. The clay is stated by this traveller to have a milky and not disagreeable taste.[2] A great proportion of the tribes in Brazil and the basin of the Orinoco, and some in all parts of America, indulge in the horrid banquet of human flesh. Shame, in our sense of the term, is nearly a stranger to the breasts of these savages. In the warm regions of Brazil, men and women go entirely naked, except in the neighbourhood of the Portuguese settlements, where some wear a band of cloth round the loins.[3] In such situations, where the want of shelter is little felt, their dwellings are often nothing more than a sort of arbour formed by interlacing the open space between two or three trees with twigs, and covering it with leaves so as to form a screen on the windward side, while it is left entirely open on the other. The manufacture of bows and arrows, war-clubs, baskets, mats (which, swung from a tree, serve them both as seats and hammocks), and in some cases a coarse pottery, comprises the sum of their practical skill in the arts. It has long been the practice of bands of Portuguese, consisting chiefly of outlaws and vagabonds, to make marauding expeditions among the Indians living near the great rivers, and to carry them off and sell them clandestinely for slaves. This infamous trade is carried on in despite of the orders of the government, which has issued many decrees for the protection of the Indians, and, besides employing missionaries to convert them, enjoined the governors of provinces to furnish them with hoes and other agricultural implements. Wherever the negroes are introduced in great numbers, as in the Capitanias of Santa Paulo and Rio Janeiro, and in the whole of the West India islands, the red men rapidly disappear, the former being more intelligent, more tractable in their habits, and more active and industrious. The negroes are indeed a superior race to the Indians; and the existence of one or two hundred blacks, as slaves, among some thousands of the Cherokees, does not detract from the accuracy of this opinion. Missions for the conversion of the Indians have been supported for more than two centuries by the governments of Spain and Portugal. They are thinly spread over those parts of Mexico, La Plata, Peru, Brazil, and Colombia, which are still occupied by the savages; but there are extensive districts in all these provinces in which they have never been established, owing to the fierce character of the tribes, or the remote and inaccessible nature of the country. A mission consists in general of one or two friars or priests, who settle among the savages, learn their language, and, besides teaching them the elements of Christianity, always endeavour to instruct them in the more simple and useful arts, and to train them to settled habits. We have seen many scattered notices of these establishments, but we have not met with any work that gives a distinct account of them collectively to a recent period. We believe, however, that many of them have been abandoned, owing to the failure of the funds with which they were supported; and that the success of the others has been extremely trifling. The late revolutions in these countries, by liberating the Indians from their ancient state of tutelage under the whites, has in many cases broken up the little settlements which the missionaries had formed. This has been the result even in Brazil, where the political changes have been least felt.[4]

Origin of American population.

The problem as to the source whence America derived its population presents no difficulty now, when the contiguity of the old and the new continent at Behring's Straits is known. The breadth of the sea here (latitude 66°) is only forty-five English miles; the transit across is facilitated by two islands placed almost exactly midway between Asia and America; and in severe winters a firm body of ice joins the two continents. The climate, though rigorous, does not prevent the country on each side from

[1] Spix's *Travels*, vol. ii. p. 260.
[2] Franklin's *Second Journey*, p. 24.
[3] Spix's *Travels*, vol. ii. p. 220.
[4] *Ibid.* vol. i. p. 302, vol. ii. p. 261.

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being inhabited. The Aleutian Isles, besides, at the latitude of 53°, which run in a line like the piers of an immense bridge, from one continent to the other, present such easy means of communication, that few savage tribes a little familiar with sea-life could be long in Kamtschatka without threading their way across the Pacific to the peninsula of Alyaska. Indeed, if a doubt could exist, we have positive proof that America received part of its population from the north-east extremity of Asia; for the Esquimaux, living on the east side of Behring's Straits, speak a language which is radically the same with that of the Tschutskoi on the opposite shores. Two other questions however present themselves. Did all the tribes which inhabit America pass into it through this one channel? And from what nation or nations of the old world are these tribes descended? Now, it appears to us probable, that inhabitants may have been conveyed to America by other routes besides that of Behring's Straits and the Aleutian Isles. We may form some idea of the chances of human beings from other climes being cast on the shores of America, from the countless accidents which must have scattered inhabitants over the thousands of islands on the Pacific Ocean. Take the case, for instance, of Easter Island, which is within the zone of variable winds for half of the year, and is 1500 miles from the nearest known land whence it could receive inhabitants. This island is a mere speck in the ocean, 10 miles in diameter; and supposing that it could be seen by an Indian in his canoe from a distance of 25 miles on each side, a space of 60 miles in the circumference of a circle of 1500 miles radius would thus represent the probability of a canoe carried away by a storm coming within sight of it. If then we suppose the wind to blow from any westerly point between north and south, we shall find that the probability of a drifted canoe reaching the island is only as 1 to 75. If we add the chances of the isle being passed in the night-time, when it could not be seen, the probability will be only as 1 to 150. But, further, to plant a breeding population on the isle, the canoe must have carried women in it; and as the savages have not women with them in their canoes perhaps more than once in three or four of their voyages, the probability is thus diminished to 1 in 500. In other words, the peopling of an island in such a situation as Easter Island may be considered as representing the result of 500 accidents, in which canoes were drifted to sea and wrecked. This single example may give us an idea of the myriads of casualties which must have been instrumental in dispersing the human species over the isles of Polynesia,—casualties so numerous and so various, that they may be compared to the chance sowing of the volatile seeds of plants by the winds. If we neglect distance, it will be seen at once that the probability of a canoe reaching any land in such circumstances, is in proportion to the angle the land subtends on the horizon. In the extra-tropical regions the prevailing winds are from north-west to south-west. The part of South America accessible with such winds from Gambier's Islands subtends an angle of about 40°, or ten times as great as the angle subtended by a space of 25 miles on each side of Easter Island from the same station. If we throw *distance* out of view, therefore, the chances of a boat drifted with any wind between north-west and south-west reaching the coast of Peru or Chili, would be ten times as great as of its reaching Easter Island. But from this latter well peopled island the accessible coast of Peru subtends an angle of 60°, and the chances are so much higher in proportion. Easter Island is about 2800, and Gambier's Island 3600 miles from the American coast; and the question is, whether, of many hundred canoes drifted off in this direction in the lapse of ages, it is improbable that one or two carrying persons of both sexes might reach America. We may allow an unrigged boat to make 100 miles a day with a strong wind. From 28 to 36 days, then, would suffice for the voyage; and though savages often go to sea with little provisions, we must remember that they have a horrid resource in their cannibal habits. There are besides, we think, well-attested cases of the South Sea Islanders surviving a storm which has kept them a month at sea. Many of these islanders have boats capable of carrying 20 or 30 persons; and their ferocious wars are continually creating emergencies which compel crowds of males and females to take suddenly to the water to save their lives.

We have referred to Easter Island merely as an example, to illustrate causes which have been in operation in all parts of the maritime world. Setting aside Behring's Straits and Greenland, there are four points from which, according to the principles we have explained, there is a possibility that inhabitants might be transported to America. These are, first, Gambier's Isles and Easter Island, of which we have already spoken. Secondly, Southern Africa: from Congo, Benguela, and the Cape, to the coast of Brazil, the distance is from 3700 to 4100 miles; and a boat abandoned to itself, favoured at once by the tropical current, which sets north-westward, and by the trade-wind, might perform the voyage in 30 or 40 days. Thirdly, the north-west coast of Africa, and the Canary and Cape Verd Islands. From the latter (which were inhabited when discovered by the Portuguese) the distance to Brazil is only about 2000 miles, and the motion of a boat would be aided both by the trade-wind and the returning great current of the North Atlantic. The voyage might occupy from 20 to 30 days. The possibility of men being carried to America is shown by the stern of a vessel, such as the American nations could not build, which Columbus found on one of the Caribbean Islands on his second voyage.[1] It is true that both Madeira and the Azores, though nearer the old world, were uninhabited when discovered in the 15th century; but we must remember that these isles are but specks in the wide ocean, compared with America; and, further, that the mariners accidentally cast upon them might have no females with them, and would find none there. The Azores had been the residence of some luckless shipwrecked Europeans, as the figures found carved on the rocks proved. The fourth channel through which inhabitants might reach America is the Sandwich Islands. The distance is 3000 miles; and when the sun is at the southern tropic, it is probable that the western winds may blow for a time in their vicinity.

In a comprehensive view of all the causes which, in the lapse of ages, have contributed to spread the human race over the new world, the conjectures we have hazarded are not without value. There are, for instance, two parts of the new continent in which nations almost black are found, namely, California and Paraguay. In the latter

[1] Washington Irving's abridged *Life of Columbus*, p. 130. Vater has discussed this subject in his *Untersuchungen über Amerikas Bevolkerung aus dem alten Continent*: Leipsic, 1810. We have not been able to procure a sight of the work; but we find, from the introduction to the section on the American languages in the *Mithridates*, that he speaks in decided terms of the possibility, or rather the probability, of the western coasts of Europe and Africa contributing, as well as the east coast of Asia, to people the new continent.

Aborigines.

the Charruas, Minuanes, Bohanes, and Yaros, are of this complexion,[1] and seated amidst tribes of a much lighter hue. Is it unreasonable to suppose, that a few persons belonging to a South African tribe had been cast ashore at an early period on the north banks of the Plata, the district to which the natural motion of the winds and waves would most readily waft them, and had grown up into a tribe before they mixed with any other race? The Californians may be descended from the Papuas or black race inhabiting New Guinea, and who are supposed to constitute the swarthy people of the Sandwich Isles.[2] At any rate it is remarkable that the only race of a very dark complexion in North America should be found exactly at the part of the coast nearest to these isles, and to which the agency of the extra-tropical wind would conduct any object left to its guidance. We admit, however, that they might come from the Kurile Isles, where the same black race is found. By the mixture of persons belonging to tribes of this hue with others of the copper colour, the varieties of complexion found among the American nations may be accounted for. It affords a slight corroboration of this idea, that among the scanty affinities traced between the languages of the old and new world, there are some few which connect certain American dialects with that of Congo. The superior intelligence, great stature, light complexion, and personal beauty of some of the Chilian tribes, on the other hand, favour the supposition that they are of the same race with the tall, fair, handsome people of the Society and Marquesas Isles, who have displayed so great an aptitude for civilisation.[3] That individuals of European birth also had been carried to America by the accidents of maritime life, is rendered probable by physical causes; and it is singular that traditions, describing the arrival of a white or bearded man from an unknown country, and his teaching them to build houses and cultivate the ground, are preserved in three other parts of America besides Peru. Such is the Quetzalcoatl of the Mexicans, the Bochica of the Muyscas in New Granada, the Camararu of the Brazilians, who were all said to come from the east.[4] Manco Capac alone, the Peruvian legislator, made his appearance on the west coast of the continent. The story of a sword with a legible Greek inscription being found under the soil at Monte Video in 1826, is, we fear, a fiction. (*Bulletin Historique*, Août 1828.)

Affinity of Mexicans and Asiatics.

Attempts to trace the descent of the American tribes from any particular people of the old world have not succeeded. We except the Esquimaux, who are distinct from all the other nations of the new continent, and clearly of the same race with the Tschutsko of north-eastern Asia. Many analogies, however, in the physical character of the people, their rites, monuments, and superstitions, establish a connection between the Mexicans and some Asiatic nations. A general resemblance has been observed between the American nations and some tribes of Mongols and Mantchous, in the form of the skull, the brown colour of the skin, the thinness of the beard, and the oblique position of the eye. Humboldt has shown that the Mexican calendar is identical in its principles, which are very artificial and complicated, with that which was in use among the Chinese, Japanese, Thibetians, Hindoos, and Tartars; and he has rendered it probable that the names of their days are borrowed from an extinct zodiac of 27 or 28 houses anciently familiar to the same nations. The cosmogony of the Mexicans has too many analogies with that of the Jews to admit of the coincidence being accidental. Their traditions speak of the serpent woman or the mother of mankind falling from a state of innocence, of a great inundation from which a single family escaped, of a pyramid raised by the pride of man, and destroyed by the anger of the gods; they practised the ceremony of ablution upon children at their birth; they had the rite of confession for penitents; and religious societies like those of monks existed among them. Now, we know that the Nestorians about the seventh century carried the rites and doctrines of Christianity into China and Tartary, where they were found by Carpini, Rubruquis, and Marco Polo, in the thirteenth, mixed with many strange corruptions. There is little doubt that the traditions and customs alluded to reached Mexico through this channel. Further, a species of picture-writing like the Mexican was practised in China about the year 1325. Vestiges of the same art are found among the Kaluschi or Yucuatl, tribes inhabiting the north-west coast between the latitudes of 50° and 60°, and whose languages bear a resemblance to that of the Mexicans. Finally, the records of this people speak distinctly of their ancestors migrating from a distant country in the north-west; and the traditions of the Muskogees, Chickasas, Mohicans, Iroquois, and the tribes of Cinaloa, point to the same region as their original seat.[5] The facts, taken collectively, leave no doubt that more than one of the American nations were somehow connected with the people of eastern Asia; but they scarcely authorize the conclusion, that the one were a colony directly sent off from the other. The Chinese, Mongols, Tartars, and Mantchous, have cultivated the cerealia, employed horses, and tamed cattle, from very remote times. It was scarcely possible that such necessary arts should be entirely lost by a colony sprung from any of these people; yet the Mexicans were unacquainted with wheat, oats, and barley; they had no horses (which a migrating Tartar tribe might probably have carried across Behring's Straits); and they had never attempted to tame the native ox of America, nor to use the milk of its female. There is perhaps only one hypothesis by which these diverging facts can be reconciled. Tribes belonging to the races of eastern Asia had separated from them while they were still living in the state of hunters, and, crossing Behring's Straits, had spread themselves by degrees over America. Among some of these tribes, dwelling probably north of Columbia River, a few emigrants from China, Japan, or Chinese Tartary, at a comparatively late period, had been thrown by some of the accidents to which a seafaring life is liable, and bringing with them picture-writing, the art of building and weaving, a few mystical rites and traditions, and the calendar which was in use in their native country, had established their influence among the savages by address or force, and sown the seeds of civilisation. After social life had made a few advances, the increasing numbers and power of the people would enable them to send off several swarms in succession to the eastward, and dispossess the earlier and ruder inhabitants of Anahuac and the plains of the Mississippi. The Toltecks were perhaps the first of these colonists; the Hurons, Iroquois, Chichi-

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[1] Prichard's *Researches*, vol. ii. p 495. [2] *Ibid.* p. 424. [3] *Ibid.* vol. i. p. 418, 422; vol. ii. 471, 473.

[4] Humboldt's *Researches*, vol. i. p. 29–74. Stevenson's *Narrative*, vol. i. p. 396.

[5] Humboldt's *Researches*, vol. i. p. 276, &c. Prichard's *Researches*, vol. i. p. 167–169, vol. ii. p. 378. Travels of Ibn Batuta, Travels of Marco Polo and Rubruquis, in tom. vii. *Hist. Gen. des Voyages.* *Mithridates, Einleit. Amer. Sprach.* p. 357.

America. mecks, and Aztecks (all of whom had hieroglyphics), must have been separated from the parent stock at a later period, probably two or three centuries after the Nestorians had spread some knowledge of the Christian rites and the Hebrew cosmogony among the people of eastern Asia. To all appearance there was no race in America anterior to the Toltecks who possessed any germs of civilisation; for the military works in Ohio can scarcely be referred to a period farther back than 800 or 1000 years from the present day. But for 2000 or 3000 years anterior to this the new continent had been overrun by tribes of hunters. This, we think, is clear; for while the analogies of physical character observed in the American nations, and in the structure of their dialects, show, on the one hand, that nine-tenths of them had sprung from one tribe, or a few tribes of one stock; the existence of 500 of these varieties of speech proves, on the other hand, that a very long period must have elapsed to admit of the subdivision of one, two, or even half-a-dozen of mother tongues into such a prodigious number of dialects. That the original seat of Tolteck and Azteck civilisation was not in Asia, but in the north-west parts of America, results, we think, from the non-existence of the cerealia and of tame cattle in the new world; and that the glimmering of knowledge which these people possessed had been kindled by the arrival of a few chance emigrants, perhaps at different periods, from China, Japan, or Chinese Tartary, seems equally certain, from the resemblances formerly noticed in the calendars, the superstitions, and the cosmogonical traditions of the Asiatic and American races.

Indian Antiquities. In the great valley of the Mississippi and its mighty tributaries, the Ohio and Missouri, are the remains of the works of an extinct race of men, who seem to have made advances in civilisation far beyond the races of *red men* then discovered by the first European adventurers. These remains consist chiefly of tumuli and ramparts of earth, inclosing areas of great extent, and much regularity of form. Some of them recal the barrows of Europe and of Asia, or the huge mounds and ramparts of Mesopotamia, as displayed at Babylon and Nineveh; while others remind us of the ruined hippodromes and amphitheatres of the Greeks and Romans. In that part of North America, the barrows are usually truncated cones; but in advancing farther south, they often assume the figure of four-sided pyramids in successive stages, with flattened tops, like the *Teocallis*, or temples of Mexico and Yucatan. The earliest accurate notice of them, published in England, is contained in the *Letters from America* of Adam Hodgson, in 1820 and 1821, published in 1829. Since that time they have been admirably described, and many of them delineated in the splendid work, *The Smithsonian Contributions to Knowledge*, vol. i.; from the researches of Messrs Squier and Davis, which appeared in 1848, at New York.

The barrows and ramparts are constructed of mingled earth and stones; and from their solidity and extent, must have required the labour of a numerous population, with leisure and skill sufficient to undertake combined and vast operations. The barrows often contain human bones, and the smaller tumuli appear to have been tombs; but the larger, especially the quadrangular mounds, would seem to have served as temples to the early inhabitants. These barrows vary in size, from a few feet in circumference and elevation, to structures with a basal circumference of 1000 or 2000 feet, and an altitude of from 60 to 90 feet, resembling, in dimensions, the vast tumulus of Alyattes near Sardis. One in Mississippi is said to cover a base of six acres. The ramparts also vary in thickness, and in height from 6 to 30 feet, and usually inclose areas varying from 100 to 200 acres. Some contain 400; and one on the Missouri has an area of 600 acres. The inclosures generally are very exact circles or squares, sometimes a union of both; occasionally they form parallelograms, or follow the sinuosities of a hill; and in one district, that of Wisconsin, they assume the fanciful shape of men, quadrupeds, birds, or serpents, delineated with some ingenuity, on the surface of undulating plains or wide savannahs.

These ramparts are usually placed on elevations or hills, or on the banks of streams, so as to show that they were erected for defensive purposes, and their sites are judiciously chosen for this end. The area inclosed, therefore, bears no proportion to the relative labour bestowed on such ramparts: thus, in Ohio, an area of not more than 40 acres is inclosed by mounds of a mile and a half in circumference; and on the little Miami, in the same state, is found an inclosure fully four miles round, that contains an area of about 100 acres.

These remains are not solitary and few, for in the state of Ohio they amount to at least 10,000.

The inclosures in the form of animals are more rare than those now noticed, and seem nearly confined to Wisconsin. One of those represents a gigantic man with two heads, the size of which may be estimated, by the body being 50 feet long, and 25 feet across the breast. Another on a slope near Bush Creek, represents a tolerably designed snake, with an oval ball in its mouth; the undulating folds of its body and spiral of its tail extending to a length of 700 feet. The forms of quadrupeds and birds are also characteristically represented in these works. Those that have been explored contain human bones; and though the Indians deposit their dead within them occasionally, they have no tradition of their having belonged to their ancestors. The most probable supposition respecting them is that of Mr R. C. Taylor, that each was the sepulchral monument of a different tribe, who have all disappeared from America.

The question immediately suggests itself, to what people must we ascribe those vast works? They can scarcely be the works of the ancestors of the red men discovered by Europeans in North America. Neither can we ascribe them to the early Greenland and Iceland colonists, who never seem to have passed westward of the Alleganies. We can scarcely attribute them to the somewhat apocryphal followers of the Welsh Madoc. Can their authors be the people obscurely mentioned in the Icelandic *sagas*, as the inhabitants of *New Iceland?*

A curious tradition of the present Iriquois records, that when the *Lenni Lenapi*, the common ancestors of the Iriquois and other tribes, whose language is still widely spread among the Indians, advanced from the north-west to the Mississippi, they found on its eastern side a great nation more civilised than themselves, who lived in fortified towns and cultivated the ground. This people at first granted the Lenni Lenapi leave to pass through their territories to seek an eastward settlement; but treacherously attacked them while crossing the river. This conduct gave rise to inveterate hostilities, that terminated in the extermination or subjugation of their opponents, and the establishment of the red men in those regions. This not improbable, though imperfect account of such rude communities, where neither letters nor hieroglyphics existed, is probably all that we shall ever learn of the people who executed those works that now excite our surprise.

As we advance southward, we find proofs of still greater refinement on the table-land of Anahuac or Mexico; and on descending into the humid valleys of Central America, the peninsula of Yucatan, and the shores of Honduras, we find striking remains of the semi-civilisation of the races that inhabited those countries before the Spanish invasion. The barbarous policy of Cortez and other invaders, was to eradicate every trace of the former grandeur of the native races, thereby to inure them to a degrading servitude. The systematic destruction of the native works of art and gorgeous buildings in Mexico was relentlessly carried on for ages, to the infinite regret of the modern ethnographical inquirer. Little positive information on these subjects can be gleaned from the early Spanish historians of the conquest; and it was not until the publication of Humboldt's *Researches*, that Europe knew anything of the state of the Great Mexican pyramid, or of the wonderful remains of Palenque and Papantla.

In the middle of the last century, however, some Spanish adventurers penetrated with difficulty the dense forests of the Mexican province of Chiapas, in which they discovered the remains of an ancient city, of which all memory had been lost, and to which they gave the name of PALENQUE, from a poor adjacent village. Stimulated by their report, the Spanish government some years afterwards despatched two intelligent travellers to explore those wilds; but the report of Del Rio and Du Paix, from the commotions that agitated Europe and convulsed Spain, remained unpublished until a few years ago. It has since appeared with very interesting designs of the ruins they explored. Our knowledge of such remains, however, has been greatly enlarged by the labours of an enterprising North American traveller, Mr Stephens, given to the world in four volumes, entitled *Incidents of Travel in Central America, Chiapas, and Yucatan*, 1838, and *Incidents of Travel in Yucatan*, 1842. This gentleman has discovered, in the almost impenetrable forests of those regions, the remains of no less than 44 towns, some of them with extensive and highly decorated structures. These exhibit walls of hewn stone, admirably put together with mortar, often enriched by sculptures in bold relief, and hieroglyphical inscriptions, exactly resembling the Azteck MSS. in the museums of Europe, and in the publications of Humboldt; well-executed *vaulted* roofs, and obelisks covered with mythic figures, and pictorial or hieroglyphical inscriptions. These curious remains have been concealed for ages by a luxuriant tropical vegetation, so dense that they seem to have been unknown to people living within half a mile of their site.

The most conspicuous ruins seem to have been temples or palaces, and almost invariably have a pyramidal form, in several stages, with wide intervening terraces, the ascent to which is by grand flights of steps. The chambers in those buildings have generally a length disproportioned to their width; they have no windows, but receive their light from the doors; just as the rooms do at this day in Barbary and some other eastern countries. The apartments are in two parallel rows, a narrow corridor or series of chambers runs along the front, and the apartments behind this receive their light only from the front rooms into which they open. Yet these interior apartments are often richly decorated with sculptures, ornamented with stuccos, and gaily painted red, yellow, white, and black.

The ruins of Palenque, as may be seen in the researches of Humboldt, have the characters just mentioned. They are covered with hieroglyphics, and sculptures in relief, with ornamental cornices. The largest building stands on a terrace, faced with stone, measuring 310 by 260 feet; the building itself is 200 by 180 feet; its walls are 25 feet high. The stone has been originally covered with painted stucco; fronts the east, and contains 14 doors, separated by piers ornamented with stucco figures. In this building some of the figures are erect, while others sit cross-legged, in what we term the oriental fashion; one statue, $10\frac{1}{2}$ feet high, was found at Palenque; and two fragments of two *torsos* and a head were also discovered that exhibited a severe but fair style of sculpture, that recals somewhat of the early style of Greek art.

The ruins at Copan, in Honduras, are of vast extent. Here a pyramidal structure remains, with an elevation of 150 feet measured along its slope, and this appears to be a principal temple, included with several smaller structures within a *sacred inclosure*, in the manner of the temples of ancient Egypt. On its walls are many skulls of a quadrumanous animal, well executed in high relief; a large figure of a baboon was discovered among the ruins, bearing no inconsiderable resemblance to the cynocephalus of the Egyptians. Here also several sculptured obelisks occur, from 11 to 13 feet in height, and from 3 to 4 feet wide, which, as well as the walls of the temple, were highly ornamented with sculptures in bold relief.

The similarity between the ruins at Copan and Palenque, and the identity of the hieroglyphic tablets in both show that the former inhabitants of Chiapas and Honduras had the same *written* language, though the present Indians of those provinces do not understand each other.

At Labphak, but more especially at Uxmal, both in Yucatan, are very magnificent ruins of the same kind. Several sculptured obelisks are here, also bearing on their principal face a figure of some deity probably, with a benignant countenance represented in full, and the hands applied to the breast. The other sides of the obelisks are covered with hieroglyphical tablets, proving that the same race once inhabited the plains of Honduras, and the tableland of Anahuac. The principal building at Uxmal seems to have been a very magnificent pyramid in three stages or terraces, faced with hewn stone, and neatly rounded at the angles. The first terrace is 575 feet long, 15 feet broad, and 3 feet high, serving as a sort of plinth to the whole; the second terrace is 545 feet long, 250 feet wide, and 20 feet high; the third terrace is 360 feet long, by 30 feet wide, and 19 feet in height. From the centre of the second terrace, the upper part is gained by a vast flight of well-constructed steps 130 feet wide. This leads to the temple, the façade of which is no less than 322 feet long, but has not had a greater elevation than 25 feet; yet its grandeur is enhanced by the rich sculpture that covers the upper part above a fillet, or cornice, that surrounds the whole building at about half its elevation. The interior consists of two parallel ranges of chambers, 11 in each row. The front apartments are entered by 11 doorways, enriched with sculpture, this gave sufficient light to those rooms; but the posterior row receives no light except what enters by their doors from the exterior rooms. The roofs here, unlike those of Palenque and Copan, are not stone arches, but are supported on bearers of a very hard wood that must have been brought from a distance of some hundred miles; and these beams too are covered with hieroglyphics. The flat roof of this building has been externally covered with a hard cement. In a building placed on a lower level, is a rectangular court, which has been once wholly paved with well-carved figures of tortoises in demi-relief. These are arranged in groups of four, with their heads placed together; and from the dimensions of the court, this *sala de las Fortugas* must have required 43,660 of such carved stones for its pavement.

The ruins of Chichen, also in Yucatan, extend over an area of two miles in circumference. One of the best preserved buildings with an ambit of 638 feet, is constructed in three terraces, which give it an apparent altitude of 65 feet. The buildings here, on the second terrace, have the façades highly sculptured, both above and below the horizontal fillet; and the doorways are enriched with mouldings, and *truss*-like ornaments supporting a drip-stone. The staircase here is 56 feet wide. The front apartments are 47 feet long and only 9 wide. There are three doors in the front, and in the central apartment are nine niches. The roofs are stone arches; and all has been once painted of various

America.

colours. A curious adjoining structure consists of two parallel stone walls, 274 feet long, and 30 feet apart. The walls are 30 feet thick. It has been conjectured to have been connected with the celebration of some public games, like the *palæstræ* of the Greeks.

In several of the ruins now noticed are found buildings to which there is no access. They have doorways, but these seem to have been walled up when the buildings were erected. Their use is unknown; they are named *casas cerradas*, or "shut up houses." Their interior does not differ from the other apartments above described.

It is worthy of notice, that the builders of those cities took great pains to supply them with one of the prime essentials of human comfort—abundance of good water, by means of wells and cisterns of excellent construction.

The remains, in all the 44 ancient towns visited by Stephens, have a similar character; so that we can have no hesitation to ascribe them to the same nation, or to kindred races of men, who had certainly attained no inconsiderable civilisation, although unacquainted with the use of iron, or even of bronze. They seem to have been farther advanced in the arts than even the inhabitants of the table-land of Mexico at the period of the Spanish conquest. Can we assign these ruins to the *Toltecks*, a people whom the Mexican annals represent as inhabiting the table-land before the Azteck invasion.

America discovered by Norwegians.

The discovery of a continent so large that it may be said to have doubled the habitable world, is an event so much the more grand and interesting, that nothing parallel to it can ever occur again in the history of mankind. America had of course been known to the barbarous tribes of eastern Asia for thousands of years; but it is singular that it should have been visited by one of the most enterprising nations of Europe five centuries before the time of Columbus, without awakening the attention of either statesmen or philosophers. Iceland was discovered about 860, and colonized by the Norwegians in 874. About 50, or, according to other accounts, 100 years later, the same people planted colonies in Greenland. Into the disputes respecting the situation of these colonies we have not room to enter. Sir Charles Giescke, a good authority, states that their ruins exist near the southern point of the peninsula. It is obvious that the same adventurous spirit which enabled these northern mariners to discover the southern extremity of the country, would not permit them to stop short without visiting what is now known to be the most habitable part of it—the western coast; and the fact has been established by an inscription in *Runic* characters, found on a stone four miles beyond Upernavik, at the 73d parallel, intimating that "Erling, the son of Sigvat, and Enride Oddsoen, had cleared that place and raised a hillock on the Friday after Rogation day." The marking of the date is indistinct, but it is supposed by Professor Rask, the translator, to be either 1135 or 1170; and the Runic characters show at any rate that it was anterior to the Reformation, when this mode of writing was prohibited.[1] Whoever looks at the map of Greenland, and reflects on the fact that the Norwegians must have been ascending through Davis' Straits as high as the latitude mentioned, annually, perhaps for two or three centuries, will admit that, with half the spirit of enterprise which had carried them so far, the discovery of some portion of the west coast of these straits was almost unavoidable. Now, the position and direction of this coast once known, it required no great effort to trace it southwards to Labrador and Newfoundland. We mention these particulars, because Mr Murray, one of the few who now deny the discovery of America by the Norwegians, grounds his disbelief chiefly on the hypothesis that the colonies and the navigation of this people at the period alluded to were confined to the east coast of Greenland.

In 1001 an Icelander sailing to Greenland, was driven away by a tempest far to the south-west, where he saw a level country covered with wood. The wind abating, he turned his course homeward, and on his arrival gave such a flattering account of the country he had seen, as induced Lief, the son of the founder of the Greenland colony, to undertake a voyage thither. Lief and Biorn, who sailed together, first reached a rocky island, to which they gave the name of Helluland; then a low country, thickly wooded, which they called Markland; and some days afterwards they found trees loaded with fruits on the banks of a river. They spent the winter in the country; and one of them, who was a German, having found wild vines growing, they called it Vinland. They had some intercourse, and traded for furs, with a people who came in leathern boats, and were called *Skrælings*, from their dwarfish size. A colony was planted and remained for many years in the country, the situation of which is indicated by a fact casually mentioned, that the sun remained nine hours above the horizon at the shortest day. It should of course have been under the 41st parallel; and this is the actual latitude of Rhode Island, the country which every collateral circumstance would lead us to fix upon as the seat of the colony. The Skrælings were of course the Esquimaux.[2] The *vine* appears to be the fox grape (*Vitis vulpina*), which grows wild in that part of America. Only a few unimportant particulars respecting the settlement are preserved; but it was probably abandoned or destroyed, like the Greenland colonies, of which it was an offset. The account, though meagre, is distinct and consistent. Its authenticity can scarcely be disputed; and it is almost equally obvious that the country it refers to under the name of Vinland is in the vicinity of Rhode Island. A conclusion resting on such strong grounds scarcely requires to be supported by the high authority of Humboldt and Malte-Brun. That the colony disappeared, and that the discoveries made were not prosecuted farther, are not circumstances which will shake the credit of the narrative in the minds of those who know the numerous reverses which befell the early colonies in New England and other parts of America. The hostilities of the Skrælings was no doubt the principal cause of the abandonment of the colony. The Norsemen describe Vinland as a rich country, with a delightful climate. Helluland, Markland, and Vinland, were no doubt regarded as countries either connected with or similar to Greenland, the flattering descriptions of which given by the first discoverers were sadly belied by later experience.[3] The interest excited by the obscure accounts

[1] Ferussac, *Bulletin des Sciences Historiques*, Juillet 1828.

[2] See the curious works of Torfæus called *Vinlandia Antiqua*, Hafn, 1705; and the valuable *Antiquites Americanæ*, published at Copenhagen in 1827. Also Humboldt's *Cosmos*, vol. ii. p. 233; Sabine's Transl. 1848.

[3] M. Rafn, a Dane, who has been engaged in researches respecting these early voyages, announces that he has ascertained, from original documents, various facts previously unknown; among others, that America (first discovered in 985) was repeatedly visited by the Icelanders in the 11th, 12th, and 13th centuries; that the embouchure of the St Lawrence, and in particular the bay of Gaspe, was their principal station; that they had penetrated along the coast as far south as Carolina; and that they introduced a knowledge of Christianity among the natives. The announcement is contained in a letter addressed to a person in Washington, and published in Nile's *Register* (Baltimore), in November 1828. But M. Rafn has since found reason to change his opinion as to the site of the Icelandic colony; and he now considers that it was at the mouth of the River Taunton, which falls into the sea in Narragansit Bay, at the north end of Rhode Island.

of these countries was probably such as the announcement of a new island eastward of Spitzbergen would produce at the present day. No reasonable doubt can exist, however, that the north-eastern portions of America (considering Greenland as a distinct country) were familiarly known to the Norwegians in the eleventh century.

The obscure allusions of Aristotle, Plato, and Seneca, to a country hid in the Western Ocean, must have derived fresh importance from the discovery of the Canary Isles, Madeira, and the Azores, in the early part of the fifteenth century. The love of maritime adventure was excited by these events; and among the active spirits who were attracted to nautical life by the career of distinction which was then opened up, was Christopher Columbus. Our limits do not permit us to enter into details respecting this great man, an outline of whose life will be found under the proper head. Having received a learned education, the study of the geographical systems then in vogue impressed him with a strong conviction that a voyage to India by a course directly westward was quite practicable, with the degree of nautical science which his contemporaries possessed. From the old and imperfect maps of Ptolemy, he was led to believe that the parts of the globe known to the ancients embraced 15 hours, or 225 degrees of longitude, which exceeds the truth by more than one third. The discovery of the Azores on the west side had lengthened the space by one hour; and the accounts gleaned by Marco Polo in Asia, induced him to think that the isles connected with this continent stretched out so far to the eastward that their distance from Europe could not be great. Columbus was, however, without the fortune necessary to fit out ships; and when he attempted to interest some of the princes of those times in his project, he encountered neglects and difficulties which would have exhausted the patience of any mind less ardent than his own. At length, after many delays and discouragements, Ferdinand and Isabella of Spain supplied him with three small vessels, two of them only half-decked; and in this little armament, accompanied by 120 men, he set sail from the port of Palos on the 3d of August 1492. He proceeded first to the Canary Isles, where he was detained three weeks in repairing one of his vessels. On leaving these isles he entered on an unknown sea, where all was chaos and mystery. The trade-wind, however, bore him steadily along, and the labour of the ships proceeded cheerfully, till the increasing length of the voyage, the failure of prognostics which had from time to time kept alive the hopes of the crew, and various circumstances interpreted by their superstition as evil omens, produced a mutinous spirit, which all the address and authority of Columbus would not have been able to quell, had the discovery of land happened one day later than it did. Columbus, says Humboldt, on sailing westward of the merdian of the Azores, through an unexplored sea, sought the east of Asia by the western route, not as an adventurer, but according to a preconceived and stedfastly pursued plan. He had on board the sea chart which the Florentine astronomer, Toscanelli, had sent him in 1477. If he had followed the chart, he would have held a more northern course, along a parallel of latitude from Lisbon. Instead of this, in the hope of reaching Zipangu (Japan), he sailed for half the distance in the latitude of Gomera, one of the Canary Islands. Uneasy at not having discovered Zipangu, which, according to his reckoning, he should have met with 216 nautical miles more to the east, he after a long debate yielded to the opinion of Martin Alonzo Pinzon, and steered to the south-west. The effect of this change in his course curiously exemplifies the influence of small and apparently trivial events on the world's history. If Columbus, resisting the counsel of Pinzon, had kept his original route, he would have entered the warm current of the Gulf Stream, have reached Florida, and thence perhaps been carried to Cape Hatteras and Virginia. The result would probably have been, to give the present United States a Roman Catholic Spanish population, instead of a Protestant English one, a circumstance of immeasurable importance. Ponzen was guided in forming his opinion by a flight of parrots towards the south-west. Never, says the Prussian philosopher, had the flight of birds more important consequences. It may be said to have determined the first settlements on the new continent, and its distribution between the Latin and Germanic races. It was on the 12th of October that the western world revealed itself to the wondering eyes of Columbus and his companions. What a triumph for this extraordinary man, who had treasured in his breast for twenty years, amidst neglect, discouragement, and ridicule, the grand truth, which his own incomparable skill, wisdom, and firmness, had now demonstrated in the eyes of an incredulous world! The spot which he first touched was Guanahani, or San Salvador, one of the Bahama Islands, 3650 English miles from Teneriffe. After spending nearly three months in visiting Cuba, Hispaniola, and other isles, he returned to Spain. He made three other voyages, and in the second coasted along a part of South America, which he rightly judged to be a continent, from the volume of water poured into the sea by the Orinoco; but he died ignorant of the real extent and grandeur of his discoveries, still believing that the countries he had made known to Europe belonged to that part of Eastern Asia which the ancients called India. Hence the name of West Indies, which the tropical islands and part of the continent have ever since received.

Discoveries and colonies.

We should extend this article to an unreasonable length were we to describe in detail the discoveries and settlements made by the several nations of Europe in America. We shall therefore confine ourselves to a very brief chronological notice of the more important events.

1495. The first place in which the Spaniards established their power was the large island of Hayti or Hispaniola, which was inhabited by a numerous race of Indians, of a mild and gentle character, a third part of whom are said to have perished within two or three years after the Spaniards conquered them.

1497. John Cabot, in the service of Henry VII. of England, discovered Newfoundland, and coasted along the shores of North America to Florida.

1500. Cabral, a Portuguese, visited the coast of Brazil, and discovered the mouth of the Amazon. It was probably colonised before 1515, as the first cargo of wood was sent from it to Portugal in that year.

1508. Vincent Pinzon is said to have entered the Rio de la Plata. It was in the same year that the Spaniards, finding the aborigines too weak for the labour of the mines in Hayti, first imported negroes from Guinea, and thus laid the foundation of a traffic which continues to this day to disgrace the civilisation of Europe.

1511. Diego Columbus conquered the island of Cuba, with 300 soldiers, of whom he did not lose one.

1513. Balboa crossed the isthmus of Darien with 290 men, and discovered the South Sea.

1519. Hernando Cortes sailed from Cuba with 11 ships and 550 men, and landed on the coast of Mexico, which had been discovered in the previous year. The conquest of the empire was finished in 1521 by 950 Spaniards, assisted by a vast number of the Indians of Tlascala.

1531. Peru invaded by Pizarro, and conquered in little more than one year, with a force of 1000 men.

1534. James Cartier, a Frenchman, discovers the Gulf of St Lawrence.

1535. Mendoza, a Spaniard, with 2000 followers, founds Buenos Ayres, and conquers all the country as far as

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Potosi, at which silver mines were discovered nine years after.

1537. Cortes discovers California.

1541. Chili conquered; Santiago founded; Orellana sails down the Amazon to the Atlantic from the sources of the Rio Napo.

1578. New Albion on the north-west coast of America discovered by Sir Francis Drake.

1586. The Spaniards found St Thomas's Island, in Guiana.

1587. Davis' Straits and Cumberland Islands discovered by John Davis.

1604. De Monts, a Frenchman, founded the first settlement in Nova Scotia, then called Acadie.

1607. After many ineffectual attempts during more than twenty years, the first permanent settlement of the English in North America was made this year, on the banks of James' River, in Virginia.

1608. Quebec founded by the French, who had had a small neglected colony in Canada since 1542.

1611. Newfoundland colonized by the English; a Dutch colony established at Hudson's River. New York was founded in 1614.

1618. Baffin penetrates to the 78th degree of latitude, in the bay which bears his name.

1620. The first English colony established in New England at Plymouth. It was in this year that the first negroes were imported into Virginia. They were brought by a Dutch vessel.

1635. A French colony established in Guiana.

1655. Jamaica conquered by the English.

1664. The Dutch colonies on Hudson's River capitulate to the English.

1666. The Buccaneers begin their depredations on the Spanish colonies.

1682. William Penn establishes a colony in Pennsylvania. La Salle takes possession of Louisiana, in the name of the French king.

1698. A colony of 1200 Scots planted at Darien, and ruined in the following year, in consequence of the miserable jealousy of the English.

1733. Georgia colonized by the English.

1760. Canada, and all the other French settlements in North America, conquered by the English.

We must pause at this point to give a very short account of the colonial system introduced by the principal European nations who occupied extensive tracts of the new world. The English settlements extended from the 31st to the 50th degree on the east coast, and were divided into 15 or 16 provinces. The colonists had carried the love of liberty characteristic of their countrymen with them; and after many struggles with their British rulers, all the provinces, with one or two exceptions, were permitted to enjoy a form of government extremely popular. The executive power was vested in a governor appointed by the king. He was assisted by a council, which sometimes conjoined the functions of a privy council and a house of peers. The people were represented by a house of assembly, consisting of persons chosen by the freeholders in the country parts, and the householders or corporations of towns. The governor could levy no money without the consent of the house of assembly: the British parliament, however, claimed, but scarcely ever exercised, the privilege of imposing taxes upon the colonists, without consulting them. Against this assumption of power the local legislatures always protested as an infringement of their rights. The vessels of foreign states were not permitted to trade with the colonies; but the colonists were allowed to trade in their own ships with one another, with the mother country, and, to a limited extent, with foreign states. Their taxes, which were always small, were all consumed in defraying internal expenses; and, compared with any other people in the new world, they enjoyed an unexampled degree of commercial and political liberty. It was the growing prosperity of the colonies, and the increasing debt of the mother country, which induced the British ministers, for the first time, in 1764, to attempt raising a revenue in America, for purposes not colonial. The experiment was made by imposing a stamp-duty on newspapers and commercial writings. The sum was trifling; but the Americans, long-sighted and jealous of their rights, saw in it the introduction of a principle which deprived them of all security for their property. The people declared themselves against it as one man, in local assemblies, and by petitions and publications of all kinds. The ministers became uneasy, and repealed the tax; but, as a salvo to the pride of the mother country, a declaratory act was passed, asserting her right "to bind the colonies in all cases whatsoever." The idea of raising a revenue in America was not renounced, but another mode was to be tried. Duties were laid on glass, colours, paper, and tea, and were met by an opposition in the colonies still more zealous and determined. The British ministers, irritated, but wavering in their purpose, dropped all the taxes but that on tea, and commenced at the same time a series of alarming innovations. They closed the port of Boston, changed the charter of the province, placed judges and juries on a footing to render them more subservient to the views of the government, and introduced a strong military force to overawe the people. On the other side, the colonists passed resolutions not to import or consume any British goods, and hastened to supply themselves with powder and arms. Blood was at length drawn in April 1775, at the village of Lexington; and in the following year the American congress published their celebrated declaration of independence. We shall not enter into the details of the war, which was closed in 1782. Suffice it to say, that, on the part of the Americans, it rested on high grounds; it was a war to vindicate a principle—for the practical grievance was admitted to be slight; and it was conducted with a regard to humanity, of which there are few examples in history.

British colonies.

Spanish colonies.

The Spanish possessions in America, before the revolution, formed nine distinct governments, all constructed on the same plan, and independent of one another. Four of these, of the first rank, were vice-royalties, viz. Mexico, Peru, La Plata, and New Granada; and five were captain-generalships, viz. Yucatan, Guatemala, Chili, Venezuela, and the island of Cuba. The government was vested in the viceroy or captain-general, who was held to represent the king, and to enjoy all his prerogatives within the colony. But in these countries, as in others where the supreme power is apparently unlimited, it was indirectly restrained by the influence of the courts of justice, corporations, and other public bodies. The royal audiencias or supreme courts, consisting of Spaniards nominated by the crown, had extensive judicial powers, and were independent of the viceroys. The cabildos or municipalities, and the fueros or corporations (similar to our guilds), also possessed considerable privileges, which derived security and importance from long prescription. Lastly, the clergy, who were numerous and rich, necessarily possessed great influence among a superstitious people. The vices inherent in the colonial system existed in their utmost rankness in the Spanish American dominions. There was tolerable security for all classes except the miserable Indians, who were regarded and

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treated precisely as beasts of burden, out of whose toil and sufferings a provision as ample as possible was to be extracted, first to supply the wants of the royal treasury, and next to feed in idleness, and to satisfy the cupidity of a countless shoal of public officers and priests. Edicts were indeed issued for the protection of the Indians, and persons appointed to enforce them; but these were feeble correctives to the evils rooted in the system, and not unfrequently increased their weight. The Indians, after the conquest, were at first slaves; they paid a capitation tax to the crown, and their labour was entirely at the disposal of their lord. This system was modified from time to time; but all the changes introduced down to the revolution did not release them from their state of vassalage. They still continued subject, in a less or greater degree, to the performance of compulsory labour, under the orders of persons over whom they had no control. This was an enormous grievance; but, what was equally bad, being held incompetent in law to buy or sell, or enter into any pecuniary engagement beyond the value of a few shillings, without the agency of white men, the swarm of public functionaries had an unlimited power of interfering in their concerns, of vexing, harassing, and plundering them, under the forms of law. The memoir of Ulloa, long buried amidst the Spanish archives, with various other documents published since the revolution, depicts acts of extortion, perfidy, cruelty, and oppression practised upon the Indians which have rarely been paralleled. Men rose to affluence in offices without salaries; and the priests rivalled the laymen in the art of extracting money from those whom they ought to have protected. As the sole aim of the Spaniards in the colonies was to enrich themselves, so the government at home made all its acts and regulations subordinate to the grand object of raising a revenue. Spain retained in her hands the whole trade of the colonies, and guarded her monopoly with the most severe penalties. The price of all European commodities was enhanced three, four, or six fold, in America. The colonists were not allowed to manufacture or raise any article which the mother country could supply; they were compelled to root up their vines and olives; and for a long period one colony was not even permitted to send a ship to another. To support such a system it was necessary to keep the people in profound ignorance, and to cherish prejudices and superstition. The schools were extremely few, and permission to establish them was often refused, even in towns where the Spaniards and Creoles were numerous. The importation of books, except books of Catholic devotion, was rigorously prohibited. Even the more grave and dry sciences, such as botany, chemistry, and geometry, were objects of suspicion. And the more effectually to crush all mental activity, natives of America could rarely obtain leave to go abroad, to seek in foreign countries what was denied them in their own. On the other hand the priests, sharing in the spoil, filled the minds of the people with childish superstitions, as a means of confirming their own power; and employed the terrors of religion to teach them patience under oppression. To create a race of servants devoted to its purposes, the court bestowed all offices, from the highest to the lowest, on natives of the peninsula exclusively. The wisdom of the plan seems questionable; but that it was adhered to with wonderful pertinacity is certain. "It was the darling policy of Spain," says Mr Ward, "to disseminate through her American dominions a class of men distinct from the people in feelings, habits, and interests, taught to consider themselves as a privileged *caste*, and to regard their own existence as intimately connected with that of the system of which they were the principal support." With all those means and appliances, it is extraordinary that Spain should have been able to uphold, for three centuries, a system in which the interests of so many millions of human beings were so habitually and unrelentingly sacrificed. It was the course of events, much more than its own inherent weakness, which ultimately caused its subversion.[1]

Revolutions.

Revolution in Chili and La Plata.

After the seizure of Ferdinand, and the elevation of Joseph Buonaparte to the throne of Spain, orders were dispatched to all the colonies with the view of securing their obedience to the new dynasty. The men in office were generally disposed to submit, but the treacherous conduct of the French excited a universal hatred of their cause among the people; and when the regency established in Spain presented the semblance of a patriot government, the loyalty of the Americans blazed forth, and poured large contributions of money into the hands of Ferdinand's adherents. The weak and suspicious conduct of the regency, however, and its subserviency to the grasping spirit of the merchants of Cadiz, at length alienated the colonists, and roused them to take measures for their own security. But the diversity of views and interests among the colonists rendered the course to be adopted a matter of some delicacy. Ferdinand, being a prisoner, was, politically speaking, a nonentity. Napoleon's brother was clearly an usurper, odious to, and rejected by, the mass of the Spanish people. The regency, shut up in Cadiz, without troops or revenue, was but a phantom; and the little power it had was so employed as to raise doubts whether its members were not secretly in league with the enemy. In these circumstances, when the only government to which the colonists owed allegiance had fallen into abeyance, the wisest course they could have pursued was to declare themselves independent. This would at once put a stop to the machinations of France, which they dreaded, and prevent the regency from compromising or sacrificing their interests by its weakness or treachery. The Spaniards, however, who occupied all public situations, were averse to a change which they foresaw must lead to the downfall of their power. This was perfectly understood by the other classes; and in the first movements which took place in the different colonies, nothing was said derogatory to the supremacy of Spain, though independence was clearly aimed at. By spontaneous efforts of the people "juntas of government" were formed, at Caraccas in April 1809, at La Paz in Upper Peru in July, at Quito in August, at Santa Fe and at Buenos Ayres in May 1810, and at Santiago in Chili in September the same year. In 1810, also, the first insurrection broke out in Mexico. The colonists unluckily had been too long the slaves of superstition and tyranny to be fit for conducting so bold an experiment; and after a struggle, which was generally short, but almost everywhere bloody, the juntas were all put down except in Colombia and Buenos Ayres. But in the stir and tumult of the contest, old prejudices had received a shock, and the seeds of political change had struck their roots too deep in the soil to be eradicated. A desultory war was carried on for six years between Buenos Ayres and Upper Peru, with little advantage on either side. At length, in 1817, the former state, which had assumed the style of an independent republic four years before, sent an army across the Andes to Chili, under General San Martin, and

[1] *Mexico*, by H. G. Ward, Esq. vol. i. chap. i. 2d edition. *Memoirs of General Miller*, vol. i. chap. i. 1828.

Revolutions.

defeated the Spaniards at Chacabuco. A second victory, gained at Maipo in April 1818, led to the entire subversion of the Spanish power in this colony. The war was now transferred to Peru, where the Spaniards continued to lose ground, till the decisive battle of Ayacucho put an end to their power in December 1824. Rodil and Olaveta, with the obstinacy of their nation, held out for some months longer, when every chance of success was gone; but after the surrender of Callao in January 1826, the Spanish flag no longer waved on any spot in the land of the Incas.

Colombia.

In New Granada and Venezuela the struggle was more bloody, variable, and protracted than in any other part of South America. As this portion of the dominions of Spain was comparatively easy of access, and from its central position was in some measure the key to the whole, she made immense efforts for its preservation. No less than ten thousand troops were sent out to it within the course of one year. The patriots, on the other hand, possessed advantages here, in the greater intelligence of the population, and the easy intercourse with the West Indies. From 1809, when juntas were established in Caraccas and Quito, to the surrender of Porto Cabello in 1823, the vicissitudes of the war were numerous and extraordinary. The patriots were repeatedly on the eve of a complete triumph, and as often the state of their affairs seemed nearly hopeless. But the spirit of resistance never was entirely subdued. The cause was rooted in the hearts of the people, and was insensibly gaining ground even during its reverses. To attempt the faintest outline of the military operations would lead us beyond our proper limits. It is enough to state, that the decisive victory of Carabobo, gained by the patriots in 1819, gave them an ascendency which they never afterwards lost; but the Spaniards, according to their custom, continued to maintain the contest as long as they had a foot of land in the country, and were only finally expelled in 1823.

Mexico.

In Mexico the revolutionary movement began at Dolores in 1810, and soon wore a very prosperous appearance; but the weakness or false pride of the Creoles, who were cajoled into the ranks of their oppressors the old Spaniards, armed against the patriots those who should have been their firmest supporters; and by one or two mischances, the force of the independent party was ruined in November 1815, when Morelos, their able leader, was taken prisoner and executed. For six years after this period many guerilla bands maintained themselves in the provinces, and greatly annoyed the Spaniards; but they did not act in concert, and no congress or junta professing to represent the Mexican people existed. Even during this interval the desire for independence was making great progress among the population; but the establishment of a constitutional government in Spain in 1820, and its extension to the colonies, gave a new aspect to the affairs of Mexico. The viceroy Apodaca, while outwardly yielding obedience to the new system, was silently taking measures to effect its overthrow; but mistaking the character of the agent he employed, this person, the celebrated Iturbide, turned his own arms against him, proclaimed a constitution, under the name of "the three guarantees," and put an end to the dominion of Spain in 1821, almost without bloodshed. Iturbide, who had nothing in view but his own aggrandizement, called a congress, which he soon dissolved, after getting himself proclaimed emperor. His usurpation kindled a spirit of resistance. He was exiled in 1823, made a new attempt on the liberties of his country in 1824, was taken prisoner, and expiated his crimes by a military death within a few weeks after he landed.[1]

Guatemala.

Guatemala was the last portion of the American continent which threw off the Spanish yoke. In 1821 the persons in office assembled and formed a junta. Divisions arose, which were fomented by the intrusion of a Mexican army sent by Iturbide. This force, however, was beaten, and an elective assembly called, which declared the country independent, and established a constitution in July 1823. Spain now retains none of her possessions in the new world but Cuba and Porto Rico.

Cruelty of the Spaniards.

It is impossible for any one to read the narrative of the wars produced by these revolutions, without having a conviction forced upon him, that the Spaniards rank far below all the Christian nations of Europe, not excepting the Russians, in those moral qualities which are the surest tests of civilisation, a respect for human life, and a strict regard to engagements, whether binding on the honour or the conscience. The executions in cold blood, the countless massacres, the treachery, perfidy, and contempt of the most solemn oaths and engagements, of which they were guilty, in every colony, and almost in every district, are, we believe, without a parallel in the modern civilized world, and strongly remind one of the barbarous and exterminating hostilities of the Jenghis Khans and Tamerlanes of Asia. The Indians were destroyed by thousands on the slightest provocation; and even the officers of European birth who fell into the hands of the Spaniards, were either shot or brutally treated, long after the period when any pretext existed for disregarding the rules of civilized war. More blood, we are satisfied, was shed by Morillo alone in one year, in the single state of Venezuela, than in the thirteen North American states during the seven years of their revolutionary struggle. The patriots, bred in the same school, were too often equally culpable. General Miller estimates the number of human beings destroyed by the sword in Spanish America between 1810 and 1825 at one million! This is probably an exaggeration; but it merits attention, as showing the opinion formed by an observer, who, though a partisan, is both candid and well informed.[2]

Brazil.

The government of Brazil was conducted by the Portuguese on a system extremely similar to that of the Spanish colonies. The monopoly which the mother country retained of the commerce of the colony was equally rigorous; the restrictions on its internal industry as severe; and the same means were employed to keep the people in a state of pupilage and ignorance. Down to 1806 a single printing press had never existed in Brazil. In 1807, when the emperor Napoleon had resolved to possess himself of Portugal, and if possible to get the royal family into his power, the king, seeing no other means of escaping from the clutches of his enemy, embarked with his suite in several ships, and sailed for Brazil, where he arrived in January 1808. He was received with joy by the colonists, who anticipated great benefits from his residence, of which they were not disappointed. One by one the fetters of colonial dependence fell off. Within a few months printing presses and newspapers were established, the ports were open to the trade of all

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[1] Ward's *Mexico*, vol. i. p. 93–210.

[2] *Memoirs of General Miller*, 2 vols. 1828. *Geographical, Statistical, Agricultural, &c. Account of Colombia*, 2 vols. London, 1822. Miers' *Travels in Chili and La Plata*, 2 vols. 1826.

New States.

nations, and the people were invited and encouraged to prosecute all those branches of internal industry from which they had till now been interdicted. To crown and secure these advantages, Brazil was declared an independent kingdom in 1815, subject to the crown of Portugal, but entitled to its separate administration and its own laws. The revolutionary spirit pervading the Spanish colonies now found its way into Brazil, and produced an insurrection at Pernambuco in 1817. It was soon subdued, but received a new impulse from the constitutional systems suddenly introduced into Spain and Portugal in 1820. To quiet the popular feeling, it was announced that the Portuguese constitution would be extended to Brazil. Before this had been done, however, the old king had sailed for Europe, leaving his son Don Pedro to rule in his absence. The people now discovered, or believed, that the object of the king was to degrade Brazil again to the rank of a colony, and to restore the old system in all its rigour. Meetings were held and resolutions adopted, to maintain the independence of the country at all hazards; and the patriots, gaining confidence by degrees, called loudly for the establishment of a legislature, and besought Don Pedro to put himself at the head of the independent government. Ambition or policy induced Pedro to listen to the solicitation: in 1822 he was proclaimed emperor, and had his own title and the independence of Brazil acknowledged by his father three years afterwards. A representative system was at the same time introduced. An unlucky war now arose with Buenos Ayres, which weakened both countries; but it was at length terminated in 1828, by the recognition of the disputed territory as an independent state, under the title of the Banda Oriental.

Having finished this brief notice of the series of revolutions which broke the fetters of America, we shall now give a very short sketch of the new political order of things which has arisen out of these changes, referring for a detailed account of the several states to the articles appropriated to them in the different volumes of the present work.

America, with its isles, embraces at present (1853) twenty-two independent states, and various colonies belonging to seven European powers. The states are, 1. Brazil; 2. Venezuela; 3. New Granada; 4. Ecuador or Quito; 5. Peru; 6. Bolivia or Upper Peru; 7. Chili; 8. La Plata, or the Argentine Republic; 9. Uruguay; 10. Entre Rios; 11. Paraguay; 12. Patagonia; 13. Costa Rica; 14. Mosquitia; 15. Guatemala; 16. Honduras; 17. Nicaragua; 18. San Salvador; 19. Mexico; 20. United States; 21. Hayti; 22. Dominica. The colonies belong to Russia, Britain, Denmark, Sweden, Holland, France, and Spain. Patagonia is merely the geographical name of a district occupied by independent tribes of Indians; Mosquitia, or the Mosquito coast, is a small Indian state ruled by a native king; and Hayti is a Negro state ruled by a black emperor. For detailed accounts of these various states and colonies, we refer to the articles under the proper heads. At present, we must confine ourselves to a brief notice of the more important ones.

Brazil is the largest state in South America, and enjoys the greatest combination of natural advantages. It is bounded on the south, west, and north, by La Plata, Paraguay, Uruguay, Bolivia, Peru, Ecuador, New Granada, Venezuela, and Guiana. Embracing an area of 3,000,000 English miles, it is nearly as large as Europe, and is capable of supporting a much greater population. Its climate is probably cooler and more salubrious than that of any other extensive tropical country; and every part of its soil is rich and fruitful, as its magnificent forests and the exuberance and boundless variety of its vegetable productions attest. Its commercial advantages are admirable. No country in the new world has the same facilities for carrying on intercourse with Europe, and with all its neighbours. The Amazon, with its numerous branches, the Parana, the Tocantin, the St Francisco, and other streams, supply the most remote parts of the interior with easy means of communication with the sea. Brazil possesses iron, copper, and probably all the other metals; but her mines of gold and diamonds are remarkably rich. Her most valuable productions for exportation are, cotton, sugar, coffee, hides, tobacco, vanilla, dyewoods, aromatic plants, timber, &c. Her commerce is much greater than that of all the Spanish colonies put together. The Brazilians are lively, irritable, hospitable, but ignorant, superstitious, and rather inclined to indolence. Their recent acquisition of independence, however, has worked like a charm, and produced an extraordinary change in their industry, opinions, and modes of thinking. Lancasterian and other schools are spreading in all directions; the press brings forth new publications; and 25 journals existed in 1828, in a country where the art of printing was unknown in 1807. According to the constitution introduced by Don Pedro, the legislature consists of a senate of 52 members, who hold their places for life, and a house of representatives of 107, elected by the people for three years; upon the acts of both of which bodies the emperor has a negative. The members of the lower house are chosen by elections of two stages. The householders of a parish meet and appoint one elector for every hundred of their number, and the electors thus chosen meet in districts and choose the deputies. The debates are conducted with open doors, and with much boldness and freedom, according to Mr Walsh.

The population of Brazil amounted to 3,671,558, according to returns published in 1818, and procured probably for the purpose of taxation. This was exclusive of the wandering Indians. In 1823 it was estimated at 4,000,000 by Humboldt. M. Schœffer, a German, carries it to 5,700,000, but a more recent estimate (1848) reduces it to 5,000,000, including 3,500,000 slaves, and 500,000 free persons of colour, but excluding the savage tribes.

Brazil, unlike the Spanish American provinces, has remained subject to its ancient sovereign; and its government, from being colonial, has become imperial and independent, without any violent revolution. The result has been greatly in favour of the peace and prosperity of the country. See BRAZIL.

The portion of South America next to the isthmus includes the states of Venezuela, New Granada, and Ecuador. From 1820 it formed one state under the name of Colombia, till 1831, when a separation took place; but for the sake of brevity, we shall here speak of the three together. The territories of these three states are bounded on the south by Peru, on the south-east and east by Brazil and Guiana, on the other sides by the sea, and embrace an area of 1,020,000 square English miles. The soil is fruitful, and the climate salubrious, except along the coast and in a few other low situations. The eastern part consists chiefly of the llanos or steppes of the Orinoco, which are very hot; the western, of the mountain ridges of the Andes, which support tracts of table-land where the blessings of a temperate climate are enjoyed, and the cerealia of Europe can be successfully cultivated. The tropical vegetation extends to the height of 4000 feet; from 4000 to 9000 is the region where wheat, barley, and leguminous plants thrive. Above the level of 9000 feet the climate becomes severe; and at 15,700 feet vegetation ceases. The situation of New Granada is highly favourable for commerce. It has excellent ports on both seas; and being mistress of the isthmus of Panama, it has superior facilities for establishing a communication from the one to the other. The Orinoco and the Amazon afford the

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inmost districts of Venezuela and Ecuador the advantages of water-carriage to the ocean. The Cassiquiari, an intermediate channel, by which the Orinoco *anastomoses* or connects with the Amazon (a remarkable hydrographical phenomenon), is within the limits of Venezuela. The territory contains much gold and silver; the former in alluvial deposits: it has mines of copper and mercury also, with platinum, iron, and coal. Its tropical productions are similar to those of Brazil; but it has as yet cultivated few articles for foreign markets, and its exports are inconsiderable. The civilised population of this country is chiefly located in the districts near the coast, and in the high valleys or table-land of the Andes. Its amount, according to the Almanac de Gotha, is,

| | |
|---|---|
| Venezuela | 986,000 |
| New Granada | 2,138,000 |
| Ecuador | 665,000 |
| | 3,789,000 |

It is always of importance to know in what proportions the different races are blended; but on this subject we have data only for New Granada, whose inhabitants are thus classified:

| | |
|---|---|
| Whites | 13 per cent. |
| Mestizoes (from whites and Indians) | 23 |
| Indians (civilised) | 26 |
| Mulattoes | 32 |
| Negroes, free or slaves | 5 |

The governments of all the three states are republican. See VENEZUELA, NEW GRANADA, and QUITO (or ECUADOR).

La Plata.

La Plata, or the Argentine Republic, is, in point of natural advantages, the second state of importance in South America. It is bounded on the west by Chili; on the north by Bolivia, Paraguay, Entre Rios, and Uruguay; on the east and south by the sea. It embraces an area of 950,000 square miles, if we include in its territories Tucuman, Salta, Santiago del Estero, and Jujuy, which scarcely acknowledge its authority. Nearly the whole territory of this republic consists of open plains destitute of timber, called *pampas*, extending from the Atlantic and the river Paraguay to the Andes. The eastern part of these plains exhibits a vigorous growth of herbage, intermixed with a forest of gigantic plants 9 or 10 feet high, which have been called thistles, but are now known to be artichokes: in the middle they are covered with grass; and the western division, which extends to the foot of the Andes, consists of barren sandy plains, thinly sprinkled with shrubs and thorny trees. The openness and dryness of the country, however, render it healthy; and by the Parana, the Paraguay, and their branches, it possesses a great extent of natural inland navigation. It has mines of gold, silver, copper, lead, and probably iron; but its mineral riches have been greatly diminished by the separation of Potosi, Cochabamba, La Paz, and other provinces, now forming part of Bolivia. The force of this republic lies almost entirely in the wealth, intelligence, and commercial spirit of its capital, Buenos Ayres, which contains 80,000 souls, including a large proportion of foreigners. A small number of *estancias*, or grazing farms, are sparingly diffused over its boundless plains, the proprietors of which keep multitudes of horses and mules, flocks of sheep, and vast herds of cattle; the latter being chiefly valued for their skins. These people are a bold, frank, hardy, half-civilised race, who live isolated in the wilderness, and scarcely acknowledge any government. Since the separation of Bolivia, the population probably does not exceed 750,000. See PLATA, LA; and for the three small states formed out of the north-eastern portion of its territory, see PARAGUAY, ENTRE RIOS, and URUGUAY.

Chili.

Chili extends along the coast of the Pacific, from 25° to 44° of south latitude: its length is 1300 miles; its breadth varies from 30 to 120; and its surface, exclusive of Araucania and the district beyond the 44th parallel, is 66,960 square miles, according to Mr Miers. The country consists properly of the western slope or declivity of the Andes; for the branches of the mountains, running out in tortuous directions from the main trunk, reach to the sea-shore. It enjoys an excellent and healthful climate; severe cold is unknown in the inhabited parts, and the heat is seldom excessive. The useful soil bears a small proportion to the entire surface of the country, consisting merely of the bottom of the valleys. It has rich mines of gold, silver, and copper in the northern provinces; but very few of them can be worked, in consequence of the absolute sterility of the adjacent country. Its two northern provinces, occupying 450 miles of the coast, are nearly perfect deserts. The soil continues extremely dry, and yields nothing without irrigation, till we reach the latitude of 35°; and it is believed that not one-fiftieth part of the country is fit for cultivation. But south of the river Maule the land is covered with fine timber, and bears crops of wheat and other grain, without the aid of any other moisture than what is supplied by the atmosphere. This is in truth the fine and fruitful part of Chili; and the project was once entertained of selecting its chief town, Conception, for the seat of the government. Chili has no manufactures, and is unfavourably situated for commerce. It has no navigable rivers, while its mountainous surface is an obstacle to the formation of roads; and its communications with all other parts of the world are circuitous and difficult. A representative constitution was established in Chili in 1823. An enumeration dated 1844 makes the population 1,080,000. See CHILI.

Peru.

Peru is a continuation of the country which forms Chili, consisting of the western declivities of the Andes, from the 4th to the 22d degree of south latitude, with the addition of a considerable tract on the east side of the mountains, between the 4th and 15th parallels. There are few countries in the world which have a more singular physical character than the western part of Peru. It is a belt or zone of sands, 1700 miles in length, and from 7 to 50 in breadth, with inequalities of surface which might be called mountains, if they were not seen in connection with the stupendous back ground of the Andes. This long line of desert is intersected by rivers and streams, which are seldom less than 20 or more than 80 miles apart, and on the sides of which narrow strips of productive soil are created by means of irrigation. These isolated valleys form the whole habitable country. Some of the large rivers reach the sea; the smaller are either consumed in irrigating the patches of cultivated land, or absorbed by the encompassing desert, where it never rains, where neither beast nor bird lives, and a blade of vegetation never grew. No stranger can travel from one of these valleys to another without a guide, for the desert is trackless; and the only indications of a route are an occasional cluster of bones, the remains of beasts of burden that have perished. Even experienced guides, who regulate their course by the stars, the sun, or the direction of the wind, sometimes lose their path, and they almost inevitably perish. Of a party of 300 soldiers thrown ashore by a shipwreck in 1823 on one of these desert spaces, nearly a hundred expired before they reached the nearest valley. Ignorance and wonder have been busy with this singular region: legends are current, which tell that descendants of the ancient Peruvians have lived in some of these mysterious valleys, hid from the knowledge of their merciless invaders, since the days of the Incas. We have no reason to believe that more than one acre in a hundred of maritime Peru will ever be available for the sustenance of mankind. The country has two advantages—its mines of the precious metals, and a temperate and delightful climate, in consequence of the absence of rain,

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and the fogs which intercept the solar heat. It can never be rich in the proper sense of the term, or make much progress in the improvements which depend upon a dense population. Like Chili, it has no navigable rivers—and nature has deprived it of the means of forming good roads. There are indeed few countries in the world whose natural advantages have been so much overrated as Peru; and it requires little sagacity to discover that its future career cannot correspond with its past celebrity. The districts east of the Andes, which have a hot climate, accompanied with a rich soil, will ultimately be the most valuable part of the country; but their secluded situation, and want of communication with other countries, must keep them long in a backward state. The government is republican. Peru comprehends a surface of 350,000 square miles; the capital, Lima, contains 70,000 inhabitants; and the entire population of the state is given as under by General Miller:—

| | |
|---|---|
| Whites | 240,819 |
| Indians | 998,846 |
| Mestizoes | 383,782 |
| Free Mulattoes | 69,848 |
| Slaves | 43,628 |
| | 1,736,923 |

A more recent account makes it 1,374,000. See PERU.

Bolivia.

Bolivia, or Upper Peru, lies eastward of Lower Peru, and is bounded on the south by the Argentine Republic, and on north and east by Brazil. It is of an irregular form, and comprehends a space of 480,000 square miles. The climate is pleasant and healthful, the soil is generally dry, and in the eastern parts, as well as the elevated table-land, its aridity produces barrenness. Nature, however, as a compensation for its other disadvantages, has bestowed upon it some of the richest mines in the world. The country was erected into an independent state only in 1825, and named Bolivia in honour of its liberator Bolivar. It has a small strip of barren territory on the shores of the Pacific Ocean, between the 22d and 25th parallel; but it is, properly speaking, entirely an inland country, and more deficient in the means of communicating with foreign nations than any other state in America. See BOLIVIA.

Guatemala.

Guatemala or "Central America" originally occupied all the narrow part of the continent, from the 83d to the 94th degree of west longitude, extending 800 miles in length, and covering a space of 130,000 square miles. The surface of the country is hilly, and in most parts mountainous; the climate warm and very moist. The mineral wealth of the country is not great; but this is compensated by the richness of its soil, and its excellent commercial position. It was a federal republic, but its five provinces have now become independent states. Humboldt estimated the population of the five states at 1,600,000. According to a statement furnished to Mr Thomson, a former British envoy, by the government, it was 2,000,000; while Mr John Baily, whose work on "Central America" was published in 1850, reduces it to 1,437,000, viz.:—

| | |
|---|---|
| Guatemala | 600,000 |
| St Salvador | 280,000 |
| Honduras | 236,000 |
| Nicaragua | 226,000 |
| Costa Rica | 95,000 |
| | 1,437,000 |

The proportions of the different races have been estimated as follows:—

| | Humboldt. | Thomson. |
|---|---|---|
| Whites and Creoles | 20 | 20 |
| Mixed classes | 28 | 40 |
| Indians | 52 | 40 |

Mexico.

Mexico is the most populous and powerful of all the new states erected in America since the commencement of the present century. Previous to the late war with the United States it embraced an area of 1,600,000 square miles, which was reduced to 1,000,000 by the cession of the northern provinces in 1848. About three-fourths of the surface consists either of mountains or table-land, raised from 5000 to 10,000 feet above the sea. Owing to this extraordinary elevation, even those parts of the country which lie within the torrid zone (the low ground on the coast excepted) enjoy a dry, cool, and salubrious atmosphere; but this advantage is counterbalanced by the insufficient supply of moisture, and the rapid evaporation resulting from the same cause, which render the soil generally rather arid, and in many parts absolutely barren; by the smallness of the rivers, and the almost entire absence of inland navigation; and by the obstacles which the steep and rugged ascents from the coast present to land-carriage. The republic is besides almost destitute of ports on the Atlantic side. Mexico is extremely rich in the precious metals; and there are few regions upon which nature has lavished so great a variety of vegetable productions, or where plants fitted to the coldest and the hottest climates may be seen so nearly in juxtaposition. The low ground on the east coast is admirably calculated for raising sugar; and no country is more favourably situated for growing the other great articles of West India produce: coffee, cotton, cocoa, indigo, and tobacco. The raising of *bread-stuffs*, as they are termed by the Anglo-Americans, wheat, maize, and barley, with potatoes, the cassava root, beans, pumpkins, fruit, &c., for domestic consumption, will necessarily be the chief branch of industry on the table-lands. The mines have never employed above 30,000 labourers; and their superior productiveness depends chiefly on two circumstances—the great abundance of the ore, which is only of poor quality, and the comparative facility with which they can be worked, owing to their being generally situated in fertile districts, where, provisions, wood, and all materials can be easily procured.

Mexico has her full share of the ignorance and superstition which belonged to Old Spain; and these evils, with her internal dissensions, and her rapacious, immoral, and intolerant clergy, are great obstacles to her improvement. That excessive inequality of fortune which corrupts both extremes of society was nowhere in the world more prevalent than in Mexico. Individual proprietors possessed immense tracts of land and boundless wealth, while all the great towns swarmed with beggars, and thousands fell a sacrifice to famine from time to time. The Mexican constitution, which is federal, and almost a literal copy of that of the United States, was established in 1824. The distinction of *castes*, which was maintained in the greatest rigour under the colonial system, has now disappeared, and power and office are open, not only legally but practically, to men of all colours. The African blacks formed an extremely small proportion of the Mexican population at all times; and since the revolution slavery has ceased. The number of inhabitants was estimated at 6,800,000 by Humboldt in 1823, and classed as follows:—

| | Numbers. | Proportions. |
|---|---|---|
| Whites | 1,230,000 | 29 per cent. |
| Mixed races | 1,860,000 | 27 |
| Indians | 3,710,000 | 54 |

Mr Ward states that very few of the whites, so called, are free of a mixture of Indian blood; and now when the odious distinctions founded on complexion are abolished, they readily acknowledge it. Mr Ward estimated the population at 8,000,000 in 1827, and, since the loss of the northern provinces, we find it put down at 7,200,000. See MEXICO.

Mines.

We have said nothing respecting the produce of the gold

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and silver mines in the different parts of America, because our object was to bring the information on this subject into one short general statement. The following table, given by Humboldt, exhibits the average produce of all the gold and silver mines in the new world about 1803.

| | Pure gold marks. | Pure silver marks. | Value of both in dollars. |
|---|---|---|---|
| Mexico | 7,000 | 2,338,220 | 23,000,000 |
| Peru | 3,400 | 611,090 | 6,240,000 |
| Chili | 12,212 | 29,700 | 2,060,000 |
| La Plata | 2,200 | 481,830 | 4,850,000 |
| Colombia (New Granada) | 20,505 | | 2,990,000 |
| Brazil | 29,900 | | 4,360,000 |
| | 75,217 | 3,460,840 | 43,500,000 |
| In English money | | | L.8,700,000 |

The Spanish mark, in which the quantity is expressed in the first two columns, is valued at 145·82 dollars in gold, and at 9·4 dollars in silver. This branch of industry has been injured more deeply than any other during the late wars. The great exertions required to maintain the mines free of water, the amount of capital necessary to keep them working, and the facility with which violent hands could be laid upon their produce, all rendered these establishments extremely liable to suffer from domestic convulsions. Mr Ward computes, that in the 15 years between 1810 and 1825, the annual produce of the Mexican mines did not exceed 10,000,000 of dollars, or about *two-fifths* of their average annual produce during the 15 years preceding. In Brazil, the washings have probably experienced no interruption. Humboldt computes the whole produce of the American mines from 1492 to 1803 to be 5,706,000,000 dollars, or L.1,255,000,000, of which only 4½ per cent. was retained in America, and 5,445,000,000 dollars (L.1,197,900,000), or 95½ per cent., was remitted to Europe.

A great auriferous deposit was discovered in Upper California in the end of 1847, just before its formal cession to the United States. It is situated in the valley of the Sacramento River, and its principal branch the Joaquin, and is believed to extend over a range of country 200 miles in length or more. The gold is found in its virgin state in small grains, in three different situations; *firstly*, in sand and gravel beds; *secondly*, among decomposed or disintegrated granite; and *thirdly*, intermixed with a friable talcose slate standing in vertical strata, and containing white quartz, interlaminated or in veins. The largest pieces of gold are found in and near the talcose slate rocks, over which the streams flow; but the finer particles and scales have been carried down by the water to the lowest part of the valleys. It was known before that gold existed in the country; but the wonderful richness of the deposit was only discovered in 1847, in making a mill-race on American Fork, a small branch of the Sacramento. It soon became widely known, and attracted multitudes of persons, first from the neighbouring districts, and by and by from all parts of the world. The population, which was estimated at 15,000 in 1848, had increased to 92,000 in 1850, and in December 1852 was found to be 305,000. As to the produce of the Californian "diggings," we find that an officer of the United States Treasury department estimated the value of the gold obtained down to the commencement of 1852 at 150,000,000 dollars, or L.30,000,000, and the annual produce 64,500,000 dollars, or about L.13,000,000, but for 1852 it was expected to be L.15,000,000. The annual supply of the precious metals from the new world appears therefore to have been nearly doubled by the Californian "diggings."

The estimate just mentioned forms part of a statement prepared by an officer of the Treasury at Washington, in answer to a demi-official inquiry as to the total produce of the gold and silver mines of the world (except Australia) since 1492. It forms a proper supplement to Humboldt's tables.[1]

*Estimate of the precious metals from* 1492 *to* 1852.

| | | |
|---|---|---|
| America, exclusive of the United States | | $6,877,833,800 |
| California, received at Mint | $98,408,000 | |
| California, foreign exports, manufactured, &c. | 51,592,000 | |
| Other United States gold at Mint | 15,855,000 | |
| Ditto not brought to Mint | 1,145,000 | |
| Total United States | | 167,000,000 |
| Total America | | $7,044,833,800 |
| Europe and Asia, exclusive of Russia | | 1,755,000,000 |
| Russia | | 213,581,000 |
| Total production, 1492 to 1852 | | $9,013,414,800 |
| In English money | | L.1,800,000,000 |

The present annual product of the precious metals, the writer estimates as follows:—

| | |
|---|---|
| All South America | $30,710,000 |
| Add for any probable increase, according to the best authorities | 3,290,000 |
| Hungary, Saxony, and Northern Asia | 4,000,000 |
| Russia, at the highest estimate of late years | 20,000,000 |
| Africa and South Asia (a rough estimate) | 1,000,000 |
| Carolina, Georgia, &c. | 500,000 |
| California | 64,500,000 |
| Total | $124,000,000 |
| In English money | L.24,800,000 |

United States.

The United States were colonised a century later than Spanish America; but their brilliant and rapid progress shows in a striking light how much more the prosperity of nations depends on *moral* than on *physical* advantages. The North Americans had no gold mines, and a territory of only indifferent fertility, covered with impenetrable woods; but they brought with them intelligence, industry, a love of freedom, habits of order, and a pure and severe morality. Armed with these gifts of the soul, they have converted the wilderness into a land teeming with life, and smiling with plenty; and they have built up a social system so pre-eminently calculated to promote the happiness and moral improvement of mankind, that it has truly become the "envy of nations." The republic is bounded on the north by Canada, on the south-west by Mexico, and on the other sides by the sea or the Indian lands. It now consists of thirty-two sovereign states, and of three *territories*, which will be converted into *states* as soon as each acquires a population of 60,000 souls. The extent of the country, if we include the Indian lands stretching west to the Pacific Ocean, over which it claims a right of pre-emption, embraces an area of 3,260,000 square miles. The agriculture of the United States partakes to some extent of a tropical character. The sugar-cane is cultivated in Louisiana, Florida, and other states, as high as the latitude of 31½°. Cotton is raised in all the southern states within the 37th parallel, and tobacco

[2] Hunt's *Commercial Magazine* (New York) for 1852, p. 91.

New States. in those within the 41st. Wheat succeeds in the middle and northern states, and maize thrives in every part of the union. Agriculture is conducted with considerable skill; but the "high farming" practised in England would not pay in America, where money is of much value, and land of little. Scarcely any portion of the soil is rented in the United States: the farmers are almost universally proprietors; and when their property is extensive, which rarely happens, it is soon broken into small occupancies, under the law of equal division. The Americans are making considerable progress in manufactures, particularly in those of cotton. The mechanical skill which has been developed in England, by centuries of progressive industry, is rapidly transplanted to the United States by crowds of emigrants; while the increasing use of machinery is depriving England of the superiority derived from her cheap labour. In the useful arts generally America is on a level with France and England; in the fine arts and the sciences she is much behind. The internal commerce of the United States is conducted with extraordinary spirit. The capital expended on roads, canals, harbours, bridges, and other public works, appears scarcely credible to those who reflect on the short term of the republic's existence. The extent of her foreign trade and the amount of her shipping, place her next to Great Britain on the list of commercial nations.

| | |
|---|---|
| The population of the United States in 1850 was by census | 23,191,000 |
| In 1800 it was | 5,306,000 |
| Increase in 50 years | 17,885,000 |

If the rate had been uniform for the half century, the annual increase must have been 2·996 per cent.; but at present (1852) the immigrants from foreign countries amount to fully 300,000, or three-sevenths of the annual increase, only the other four-sevenths being due to the natural growth of the population. The whites numbered 19,557,271 in the census; the free coloured population 429,710; and the slaves 3,204,093.

In Florida and South Carolina the slaves are rather more numerous than the whites, but they are less numerous in the other states. Slavery does not exist in the states of Maine, Massachusetts, New Hampshire, Vermont, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Indiana, Illinois, Ohio, Wisconsin, Iowa, and California; and it is verging towards extinction in Delaware and Maryland. The slaves multiply as fast as the whites, a proof that their treatment is incomparably more mild than in the West Indies, where their numbers constantly diminish.

The American government is a pure representative democracy, in which the people are recognised as the fountain of all power; and the sole object of all its mechanism is to give effect to their deliberate opinions. The federal and state governments are constituted on the same plan. The legislature consists in every case of two bodies, a house of representatives chosen for one or two years, and a senate for a period varying from two years to six; but both always by popular election, except in the case of the federal senate, which is chosen by the legislatures of the twenty-four states. The president holds his office for four years, but is occasionally re-elected for four years more. While the politicians of Europe, bred in the schools of monarchy and aristocracy, have been predicting anarchy and confusion as the result of these republican institutions, their solid excellence has been quietly developing itself, in the cheering spectacle which the United States present of perfect order, security, and contentment, combined with growing intelligence, prosperity, and unrivalled liberty.

There is no national church in America, and yet religion is in a flourishing condition in all the populous parts of the country. The most numerous denominations are, the Presbyterians, Independents, Baptists, and Methodists.

The characteristic facts in the condition of America are, the non-existence of titles, of privileged classes, of corporations in our sense of the term, of a landed aristocracy, of mendicity except to a very limited extent, and of an endowed church; the cheapness and efficiency of its government, the universality of education, the omnipresence of its periodical press, the high feeling of self-respect which exists in the very humblest classes, and the boundless spirit of enterprise which pervades society from top to bottom. The higher classes are less polished than in England, the middle are perhaps less carefully instructed; but the American people, taken collectively, are better educated, and have more intelligence and manliness of character, than any other nation in the world. The master evils of the republic are its insecure and ever fluctuating paper currency, and the negro slavery, which blackens and benumbs all the southern states.

British America. The portion of the American continent claimed by the British is bounded on the south by the territories of the United States, on the north by the Polar Sea, on the west by the Russian territories, from which it is divided by the meridian of 141° west. It contains an area of 2,600,000 square miles, of which about one-half may be habitable, and one-seventh part tolerably fertile; but the districts which have been marked out into counties or townships, and in which settlements are begun, form a very small portion of this immense region. Of these the latest return (1851) is as follows:—

| | Area, square miles. | Population. |
|---|---|---|
| Lower Canada | 250,000 | 904,000 |
| Upper Canada | 105,000 | 952,000 |
| New Brunswick | 27,700 | 211,473 |
| Nova Scotia / Cape Britain | 18,742 | 276,117 |
| Prince Edward's Island | 2,134 | 62,348 |
| Newfoundland | 35,913 | 100,000 |
| Vancouver | 16,000 | 11,463 |
| | 455,493 | 2,517,401 |

See Canada, &c.

Russian America. Russian America comprises the north-west angle of the continent, as far as the 141st meridian west from London, with a narrow strip of coast reaching as far south as $55\frac{1}{2}$° of north latitude. It occupies a surface of about 500,000 square miles, of which the useful soil probably does not constitute a tenth part. The Russians have merely a number of posts or factories stationed along the coast for conducting the trade in furs, which gives these possessions their only value. New Archangel, in latitude 57·3° and longitude 135·20° west, is the head establishment. It is a fortress, with a small garrison and 40 pieces of cannon. Owing to the rigour of the climate, this portion of America can never support more than a very limited population.

Hayti. Hayti, called formerly Hispaniola and St Domingo, was a colony belonging partly to France and partly to Spain, till 1791, when the blacks rose in arms, killed a number of whites and expelled the rest. The attempt of England in 1793, and of France in 1801, to conquer the island, both failed, and Hayti has at length been acknowledged as an independent state by all the great powers, including France. The island, which contains about 26,000 square miles, is remarkably fertile; but its climate, like that of the West Indies generally, is rather unhealthful. The population, Colonies.

which before the revolution was estimated at 600,000, is now said to amount to 900,000 or 1,000,000, and it is almost entirely composed of blacks and mulattoes. The island formed one state till 1843, when the eastern or Spanish portion revolted, and established its independence. It is now (1852) the republic of "Dominica," ruled by a president, while the western portion, retaining the name of Hayti, constitutes an empire under Faustin I. After long negotiations, the French government agreed in 1838 to acknowledge the independence of Hayti, on condition of the latter paying 60,000,000 of francs, by small annual instalments continued for 30 years. The money was destined chiefly to indemnify the French proprietors who were chased from the island in 1791.

West Indies.

The multifarious nature of the subject prevents us from attempting any description of the West India colonies, insular and continental. The islands have been variously denominated, but the most convenient division seems to us the following:—1. The Great Antilles, comprehending Cuba, Hayti, Jamaica, and Porto Rico; 2. The Small Antilles, extending in a semicircle from Porto Rico to the coast of Guiana; 3. The Bahama Isles, about 500 in number, but only a small number of which are inhabited.

The British colonies are 18 in number, viz., 15 *insular*, Jamaica, Antigua, Barbadoes, Dominica, Grenada, Montserrat, Nevis, St Kitts, St Lucia, St Vincents, Tobago, Tortola, Trinidad, Bahamas, Bermuda; and 3 *continental*, Demerara, Berbice, Honduras. The colonies contained a population of 972,000 in 1851, of whom probably four-fifths were persons of colour.

The Almanac de Gotha assigns to Cuba a population of 898,752 in 1851 and to Porto Rico 288,000. Other authorities make it considerably greater. According to a recent Spanish writer, the different classes stand thus in Cuba:—Whites and Creols 42 per cent., slaves 43, free persons of colour 15 per cent.

The French colonies in the West Indies include Martinique, Guadaloupe, and some smaller isles, and on the continent Guiana. According to a recent authority, the population of these colonies in 1841 was 277,000, of whom 183,780 were slaves.

The Dutch have Surinam on the continent, with the islands of Curaçoa, St Eustatius, and St Martin. The collective population of these possessions, according to the Almanac de Gotha for 1853, was 90,581, of whom probably three-fourths are slaves.

The Danes have the small islands of Santa Cruz, St Thomas, and St Martin, containing a population of 39,614 in 1850, of whom five-sixths are slaves. St Bartholomew, another of the lesser Antilles, belongs to Sweden.

Humboldt gave the following estimate of the entire population of America in 1823:—

| | Number. | Proportion. |
|---|---|---|
| Whites | 13,471,000 | 38 per cent. |
| Indians | 8,610,000 | 25 |
| Negroes {Slaves 5,000,000 / Free 1,433,000} | 6,433,000 | 19 |
| Mixed races | 6,428,000 | 18 |
| | 34,942,000 | |

Putting together the populations assigned to the several states in the preceding pages, the total amount for 1850 is 52,800,000, and the increase since 1823 is almost entirely confined to the United States.

The black population of America, including negroes and mulattoes, forms three groups, the centres of which are in the southern parts of the United States in the West India islands, and in the eastern parts of Brazil:—

Population.

| | |
|---|---|
| In the United States (slaves and free) | 3,624,000 |
| In West Indies | 2,400,000 |
| In Brazil | 2,800,000 |
| | 8,824,000 |

The number of blacks in all the other parts of America probably does not amount to 100,000. Slavery brings two evils with it, which strike at the roots of national prosperity; it produces an aversion to labour in the free population, and it renders person and property insecure. We may therefore safely predict, that the countries where the African race most abound will be the most unimproved and backward part of the American continent a century hence.

Increase of population.

One of the most interesting questions connected with America relates to the increase and probable amount, at a future period, of its inhabitants. It was the astonishing progress of the United States that first clearly unfolded the principles on which the multiplication of human beings depends. We now know with certainty that a prosperous community, possessing abundance of unoccupied land, will double its numbers in 25 years, without any aid from emigration; and as the scale ascends in a geometrical ratio, a short time necessarily produces a wonderful change. It is to be observed, however, that the civilised white population of the United States, possessing the advantages of superior industry, order, and forethought, naturally increases faster than the other classes. It increases at the rate of 3 per cent. per annum. The inhabitants of Spanish and Portuguese America, composed of men in whom Indian and European blood are mingled, possess a far lower degree of civilisation, and the principle of growth operates among them much more feebly. In the thirty years which have elapsed since they achieved independence, the addition to their numbers has been extremely small, probably not exceeding one-fifth. Even if their governments were becoming less anarchical, their low intellectual and moral character is a formidable obstacle to their progress, and we doubt whether under the most favourable circumstances they will double their numbers in less than a century. Let us assume, however, that they multiply at the rate of one per cent. per annum, and in this case they will double their numbers in 75 years. Experience shows that the independent indigenous tribes moulder away whereever they come into juxtaposition with the civilised races. As for the black population, it does not maintain its numbers in the West Indies, nor probably in Brazil, while in the United States it grows rapidly. At present we shall throw it out of our estimate, as it forms only one-sixth of the whole; and taking the other portions of the civilised or settled population as given above, let us count forward, and take a conjectural peep into the future of the New World.

The problem is, what will be the number of the inhabitants of the new continent two or three centuries hence, and of what races will it consist? Setting aside the negroes to simplify the question, and the savages, who will gradually disappear, it is evident that the soil of America is destined to be occupied by two races, who may be designated as the Anglo-Saxon and the Spanish-Indian. In the latter the Indian blood greatly predominates, for the Creoles or pure progeny of the Spaniards probably do not constitute more than 20 per cent. of the population, while the civilised Indians may amount to 50, and the Mestizoes to 30.

| | |
|---|---|
| The whites in the United States were in 1850 | 19,500,000 |
| The population of British America, | 2,500,000 |
| | 22,000,000 |
| The population of Spanish and Portuguese America, exclusive of slaves, was in round numbers, | 20,000,000 |

Population.

The Anglo-Saxon population in America increases at 3 per cent. annually, and doubles its numbers in 25 years.

| | |
|---|---|
| Its amount in 1850 was | 22,000,000 |
| In 1875 it will be | 44,000,000 |
| In 1900, | 88,000,000 |
| In 1925, | 176,000,000 |

A population of 176,000,000 spread over the territories of the United States and Canada, would only afford an average of 40 persons to each square mile, about 1-7th part of the density which England now exhibits, and could occasion no pressure. But let us suppose the rate of increase after 1925 to fall to 2 per cent., the period of doubling will then be 35 years.

| | |
|---|---|
| In 1960 the number will be | 352,000,000 |
| In 1995 do. do. | 704,000,000 |

Suppose the rate again to decline to $1\frac{1}{2}$ per cent., which scarcely exceeds that of England and Prussia, the period of doubling will then be 50 years.

| | |
|---|---|
| In 2045 the number will be | 1,408,000,000 |
| In 2095 do. do. | 2,816,000,000 |

Let us now compare with this the growth of the Spanish-Indian population, doubling its numbers in 75 years.

| | |
|---|---|
| Its present amount is | 20,000,000 |
| In 1925 it will be | 40,000,000 |
| In 2000 do. | 80,000,000 |
| In 2075 do. | 160,000,000 |
| In 2095 (interval of 20 years) | 200,000,000 |

It hence appears that, supposing both races to have free space for expansion, the Anglo-Saxon population in 240 years from the present time will amout to 2816 millions, while the Spanish-Indian population will only have multiplied to 200 millions, or *one-fourteenth part* of the other. It will be shewn by and by on probable grounds, that the new continent if fully peopled could support 3600 millions, and there would consequently be room enough for both; but long before this density is attained, the two races will inevitably come into collision. In new settlements, where the best lands are invariably first occupied, and the inferior neglected, the population is always thinly diffused. The Anglo-Saxons will therefore crowd to the richer fields of the south, while millions of acres of their own poorer lands are still untenanted. For we may rest assured that before cultivation is extended to the third-rate soils on the north side of the boundary, means will be found to appropriate the first-rate soils on the south side. These may be acquired by purchase like the lands of Louisiana, or by conquest like those of New Mexico and California, but in one way or another they will be acquired. Nearly twenty years ago M. de Tocqueville calculated that along the great space from the Gulf of Mexico to the Canadian Lakes the whites were advancing over the wilderness at an average rate of 17 miles per annum, and that enlightened observer was powerfully impressed by the grandeur and solemnity of this deluge of men, for ever swelling and flowing onward, to the west, the south, and the north, as "driven by the hand of God." Since he wrote the rate of progress has perhaps doubled, and every year will quicken its pace. If, then, we take a glance at the state of America at any future period, say 240 years hence (A.D. 2095), we must take the ratio of increase of the two civilised races as the prime element of our calculation. We may assume that the whole continent from Behring's Straits and Hudson's Bay, to Cape Horn, will be divided between the two races in some such proportion as their rate of growth indicates,—it may be 10, 15, or 20 to 1. Supposing them to maintain a separate existence, the weaker race will probably be driven, like the Welsh before the English, into the mountainous and inhospitable regions. On the other hand, it is possible, and not improbable, that the smaller population may be absorbed into the mass of the greater, be incorporated with it, and adopt its language. The result, like other things in the womb of time, may be modified by causes yet unseen; but in whatever shape it may present itself, there is little risk in predicting that the Anglo-Saxon race is destined by its superior intelligence and energy, to rule the new world from end to end. American statesmen now speak of the whole continent as the heritage of their people. Even thirty years ago the government of the United States formally announced that it would resist by force any attempt of a European power to plant a *new* colony on the Western continent.

America.

The problem as to the future fate of the negroes in the United States is one of difficult solution, and the difficulty arises mainly from the fact that they multiply as fast as the whites. If, like the blacks of Brazil or Cuba, their numbers constantly fell off, or even continued stationary, while the whites increase as they now do, the result would be, that in a century the negroes would form only a 50th or a 100th part of the population, a proportion quite insignificant. That they do increase at three per cent. per annum, in spite of hard labour, poor fare, and exposure to the elements in a subtropical climate, while among the working-classes of Britain the rate is little more than one per cent., and among those of France only the half of one per cent., is a result which could not have been anticipated. An explanation of the anomaly is not easily found; but there are two circumstances to which a certain influence may be attributed: *1st*, The disgraceful practice of breeding slaves for sale (as horses are raised for the market) is now established in the Southern States, and prevails extensively; *2dly*, The strict discipline maintained on slave-estates, with its attendant regular habits and enforced sobriety, will prevent, or greatly lessen, the mortality arising from intemperance, which operates so fatally on the Indian tribes, and to a great extent also on the free negroes. De Tocqueville informs us that the mortality is greater among the free negroes than among the slaves, and that, in the ten years ending 1831, the proportion of deaths in Philadelphia, was twice as great among the blacks as among the whites.

It thus appears that a part of the increase among the negroes is not natural but factitious, and that slavery as it exists in the United States, both multiplies the number, and lengthens (comparatively) the lives of those who are subject to it. It follows that the emancipation of the blacks, which Jefferson declared to be "as certain as any thing in the book of fate," will, when it takes place, check their increase, and may even positively reduce their number, as freedom in juxtaposition with the Europeans is daily thinning the number of the Indians. The proprietors of the Southern States are as sensible of the evils of slavery as those of the northern; and emancipation would come much sooner if a dread were not felt of filling the country with a demoralised population, such as the liberated negroes are found to be. To meet the difficulty the colony of Liberia was established on the west coast of Africa in 1820, and two or three thousands of the free blacks have since then been sent thither. Its affairs have been conducted with good order, and it has even been found instrumental in checking the slave trade on the shores of Africa. But the free negroes have shewn little desire to return to the land of their ancestors, and the expense of conveying them across 5000 miles of ocean is a serious objection. Cuba seems destined to fall into the hands of the Americans at no distant day, and from its great extent could afford room for all the blacks, bond and free, in the United States. Perhaps a new Liberia might be planted there with better hopes of success. As for the amalgamation of the two races, to which some look forward, the most enlightened observers deem it all but impossible.

Useful soil in New and Old Continents.

Paradoxical as the fact may appear, we are satisfied that

America.

the new continent, though less than half the size of the old, contains at least an equal quantity of useful soil, and much more than an equal amount of productive power. America is indebted for this advantage to its comparatively small breadth, which brings nearly all its interior within reach of the fertilizing exhalations of the occan. In the old continent, owing to its great extent from east to west, the central parts, deprived of moisture, are almost everywhere deserts; and a belt round the western, southern, and eastern shores, comprises nearly all that contributes to the support of man. How much fruitful land, for instance, is there in Continental Asia? If we draw a line from the Gulf of Cutch (near the Indus) to the head of the Yellow Sea, we cut off India and China, with the intervening Birman empire, and the southern valleys of Thibet; and this space, which comprises only about one-fifth of the surface of Asia, embraces five-sixths of its productive power. Arabia, Persia, Central Thibet, Western India, Chinese and Independent Tartary, are deserts, with scattered patches of useful soil not amounting to the twentieth part of their extent. Siberia, or northern Asia, is little better, owing to aridity and cold together. Anatolia, Armenia, the Punjab, and a narrow strip along the western shores of the Pacific Ocean, north as far as the 60th parallel, compose the only valuable agricultural territory beyond India and China. Europe, which is merely the western margin of Asia, is all fruitful in the south; but on the north its fruitfulness terminates at the 60th or 62d parallel. Africa has simply a border of useful soil round three-fourths of its sea-coast, with some detached portions of tolerably good land in its interior. Of the 31,000,000 of square miles which these three continents occupy, we cannot find, after some calculation, that the productive soil constitutes so much as one-third, and of that third a part is but poor.

Now, in estimating the useful soil in America, we reject, 1. all the region northward of the latitude of 53°, amounting to 2,600,000 square miles; 2. a belt of barren land about 300 miles broad by 1000 in length, or 300,000 square miles, lying on the east side of the Rocky Mountains; 3. a belt of arid land of similar extent situated on the east side of the Andes, between 24° and 40° of south latitude; 4. the desert shore of Peru, equal to 100,000 square miles; 5. an extent of 100,000 square miles for the arid country of Lower California and Sonora; and, 6. an extent of 500,000 square miles for the summits of the Andes and the south extremity of Patagonia. These make an aggregate of 3,900,000, square miles; and this, deducted from 13,900,000, leaves 10,000,000 square miles as the quantity of useful soil in the new world.

Ratio of fertility to latitude.

Now, what relation does the fruitfulness of the ground bear to the latitude of the place? The productive powers of the soil depend on two circumstances, heat and moisture; and these increase as we approach the equator. First, the warm regions of the globe yield larger returns of those plants which they have in common with the temperate zones; and, next, they have peculiar plants which afford a much greater portion of nourishment from the same extent of surface. Thus, maize, which produces 40 or 50 for one in France, produces 150 for one on an average in Mexico; and Humboldt computes that an arpent (five-sixths of an acre), which will scarcely support two men when sown in wheat, will support fifty when planted with bananas. From a consideration of these and other facts, we infer that the productive or rather nutritive powers of the soil, will be pretty correctly indicated by combining the ratios of the heat and the moisture, expressing the former of these in degrees of the centigrade scale. Something, we know, depends on the distribution of the heat through the different seasons; but as we do not aim at minute accuracy, this may be overlooked.

| Latitude. | Annual rain, inches. | Mean annual heat. | Product. | Ratio. |
|---|---|---|---|---|
| 60 | 16 | 7 | 112 | 4 |
| 45 | 29 | 14 | 406 | 15 |
| 0 | 96 | 28 | 2688 | 100 |

Thus, if the description of food were a matter of indifference, the same extent of ground which supports four persons at the latitude of 60°, would support 15 at the latitude of 45°, and 100 at the equator. But the food preferred will not always be that which the land yields in greatest abundance: and another most important qualifying circumstance must be considered,—it is labour which renders the ground fruitful; and the power of the human frame to sustain labour is greatly diminished in hot climates. In the torrid zone, in low situations, we doubt if it is possible for men to work regularly in the fields for more than five hours a day, or half the daily period of labour in England. On these grounds, and to avoid all exaggeration, we shall consider the capacity of the land to support population as proportional to the third power of the cosine (or radius of gyration) for the latitude. It will therefore stand thus in round numbers:—

| | | | | | |
|---|---|---|---|---|---|
| Latitude, | 0° | 15° | 30° | 45° | 60° |
| Productiveness, | 100 | 90 | 65 | 35 | $12\frac{1}{2}$ |

In England the density of population is above 300 persons per square mile; but England is in some measure the workshop of the world, and supports, by her foreign trade, a greater population than her soil can nourish. In France the density of population is about 160; in Germany it varies from 100 to 200. Assuming, on these grounds, that the number of persons whom a square mile can properly sustain, without generating the pressure of a redundant population, is 150 at the latitude of 50°, we have 26 as the sum which expresses the productiveness of this parallel. Then taking, for the sake of simplicity, 35 as the index of the productiveness of the useful soil beyond 30° in America, and 85 as that of the country within the parallel of 30° on each side of the equator, we have about 4,000,000 square miles, each capable of supporting 200 persons, and 5,700,000 square miles, each capable of supporting 490 persons. It follows, that if the natural resources of America were fully developed, it would afford sustenance to 3,600,000,000 of inhabitants, a number nearly five times as great as the entire mass of human beings now existing upon the globe! The novelty of this result may create perplexity and doubt on a first view; but we are satisfied that those who investigate the subject for themselves will be satisfied that our estimate is moderate. But, what is even more surprising,—there is every probability that this prodigious population will be in existence within three or at most four centuries. We are quite aware of the objections which may be raised to this conclusion, but they all seem to us to admit of an answer. In particular, we would observe, that the expense and difficulty of transporting men from situations where they are redundant, to others where vacant space exists, which is so much felt in the Old World, will be incredibly facilitated by the employment of steam-navigation upon the innumerable rivers which are ramified over four-fifths of the New Continent.

The imagination is lost in contemplating a state of things which will make so great and rapid a change in the condition of the world. We almost fancy that it is a dream; and yet the result is based on principles quite as certain as those which govern the conduct of men in their ordinary pursuits. Nearly all social improvements spring from the reciprocal influence of condensed numbers and diffused intelligence. What, then, will be the state of society in America two centuries hence, when two thousand millions of civilised men are crowded into a space *comparatively* so narrow, and when this immense mass of human beings speak only two languages, perhaps only one! Such a state of things may be said to undo the curse of Babel, and restore the great mass of mankind to their pristine facility of intercourse; for the languages spoken by the communities of Europe and Asia will be as unimportant then, in the general scale of the globe, as the dialects of Hungary, Finland, and Bohemia, are in Europe at this day. History shows that wealth, power, science, literature, all follow in the train of numbers, general intelligence, and freedom. The same causes which transferred the sceptre of civilisation from the banks of the Euphrates and the Nile to Western Europe, must, in the course of no long period, carry it from the latter to the plains of the Mississippi and the Amazon. When we reflect on these changes, which are not more extraordinary than they are near and certain, the conviction is forced upon us, that society, after all its advances, is yet but in its infancy; that the habitable world, when its productive powers are regarded, may be said hitherto to have been an untenanted waste; and that we have at present only an imperfect glimpse of the state of things under which the true destiny of man, and the grand scheme of providence in this lower world, is to receive its full development. We are quite aware that some will smile at these speculations; but if any one suspects us of drawing on our fancy, we would just request him to examine thoroughly the condition and past progress of the North American republic. Let him look at its amazing strides in wealth, intelligence, and social improvement; at its habits of order, combined with an indomitable love of liberty; at its marvellous instinct of self-government, which has made the founding of a new state in the wilderness as easy and peaceful an undertaking as the building of a house or the planting of a vineyard; let him look at the prodigious growth of its population; and let him answer the question, "what power can stop the tide of civilisation which is pouring from this single source over an unoccupied world?" Let him trace the laws on which this progress depends, and let him then apply them to unfold the future history of society in the new continent.

Proposed canal at Isthmus.

The project of joining the Atlantic and Pacific Oceans by a canal carried across the narrow part of the American continent, has often excited the attention of statesmen and commercial men. This canal, if executed upon a scale sufficient to admit vessels of 300 or 400 tons, would have a powerful influence upon the fate of America. For all the purposes of commercial intercourse it would bring the east and west sides of the continent within one-third part of their present distance from one another; and would be of even more advantage to the New World than the discovery of the passage to India by the Cape has been to the Old. It has also been proposed to accomplish the same object by a boat canal, or by a railroad, and four different routes have been recommended. A digest of the surveys and explorations connected with these, and an estimate of their comparative merits, has been published in the *Journal of the Geographical Society* (vol. xx. 1851), by Captain Fitzroy, R.N. From this our materials are derived.

1. The Isthmus of Tehuantepec, at $94\frac{1}{2}°$ west longitude. The distance from sea to sea in a straight line is 140 English miles, the surface has few great inequalities, and the lowest summit level is about 700 feet above the sea. The climate is said to be rather better than at the parts of the isthmus farther eastward, and there is a settled population, though not very numerous, from whom labour might be obtained. On the other hand, there is no port at either end of the line, the rivers are small, and barred at their mouths by sand-banks, and the length of the route, as well as the elevation of its summit level would render the execution of a railroad or a canal too expensive to permit the hope of even a moderate remuneration for the outlay. The project however, has found warm support in the United States, as it would render available by far the shortest maritime route to California. A survey has been made, and a cession of the necessary quantity of land has, we believe, been obtained.



2. The Nicaragua route, at 11° of north latitude. The first portion of this is the river San Juan, which flows from the Lake of Nicaragua, and after a course of 80 miles falls into the Caribbean Sea. It is of considerable depth, but is obstructed by rapids, and the port at its mouth, now called Greytown, is only capable of receiving small vessels. The lake is 90 or 100 miles long, 30 or 40 broad, and 125 feet above mean tide level at Greytown. Its depth varies from 2 fathoms to 40, but much of it has never been sounded, and recent surveys show shallows at both ends. From this lake to the Pacific six different routes have been traced, and some of them surveyed. One through the Lake Managua (which is 28 feet higher than Nicaragua Lake), westward to the Bay of Fonseca, would require 90 or 100 miles of canal, and the whole length of inland navigation from Greytown would exceed 300 miles; another route from the same lake to Realejo is 40 miles shorter; and a third to Tamarinda a good deal shorter still, but both the latter want good ports at their termini on the Pacific. A fourth route goes direct from the south-west side of Nicaragua Lake to San Juan del Sur; it is only 10 to 12 miles in length, but requires a tunnel (for ships) 1 or 2 miles long, and the port at its mouth is very small. A fifth runs from the same lake a little farther east to the Bay of Salinas, a distance of 15 miles, half of which is by the River Sapoa, and now navigable for boats; and the summit level is only 130 feet above the lake, and twice as much above the Pacific. It is believed there would be a sufficient supply of water from the stream, and the canal would further have the advantage of a good port. Captain Fitzroy seems to think this one of the most promising lines, but it has not yet been carefully surveyed. Of the sixth proposed route, running from the east end of the lake to the Gulf of Nicoya, neither the precise length nor the nature of the intervening country is known. Of the whole district Captain Fitzroy says, that though insufficiently explored, "enough is known to discourage any attempt to construct either canal or railway, unless the Sapoa track (the fifth) should prove to be as eligible as Dr Oersted believes. Even then there will be the disadvantages of so inferior a harbour as that of Greytown, and the difficulties of the river, which must be cleansed from its numerous obstructions, though renewed annually by floods." He considers the climate pestilential, particularly in the low grounds on both sides of the river, which holds its course amidst forests, swamps, and mud banks. Mr Squier, however, an intelligent American, in his work on Nicaragua (New York 1852) thinks the climate comparatively good. In reference to a canal there is a physical evil not to be overlooked, namely, the volcanic eruptions which shake the soil, and might desturb the levels; and there is a moral one still more serious, arising from the frequent insurrections and political revolutions, which makes property insecure, and may render engagements with the government mere waste paper. The latter evil applies to the whole isthmus, but more especially to this district, touching as it does the territories of three states (Nicaragua, Costa Rica, and Mosquito) which are often at war with one another.

3. The Panama line, at 79° and 80° of west longitude. The extreme narrowness of the isthmus here, called attention to it as an eligible point for establishing a communication between the two seas, before any other locality was thought of. Numerous explorations have been made; four routes have been pretty carefully surveyed, those of Loyd, Morel, Garella, and Hughes; and along the last of these a railway is now in course of construction. It commences on the Atlantic at Limon or Navy Bay, from which the direct

America. distance to Panama, according to Captain Fitzroy, is (33 geographical) 38½ English miles. It passes by Gorgona, and is to be carried 42 miles over elevations of nearly 300 feet, through a tunnel, and over large viaducts and bridges, terminating a little westward of Panama. The port of Chagres is unfit for large ships. Limon Bay, which is large, and has a good depth of water, is exposed to strong north winds. A breakwater, to protect it from these, has been proposed, but is impracticable on account of the vast sum it would cost. But Captain Fitzroy thinks that a large wet dock or basin might be excavated between Manzanilla Island and the mainland, at the terminus of the railroad, and might serve as the first step towards an artificial harbour, to which Limon Bay would be accessory as a useful roadstead. "On the opposite coast, near Panama, a spacious and tolerably sheltered anchorage, with access to works carried out into the sea, may be found in the bay, but not very near the city." A ship canal here, whether at the elevation of the railroad (300 feet), or at the lower level proposed by Garella, of 150 feet, would require works on a gigantic scale; for his plan includes a tunnel *for ships*, 125 feet in interior height, 97 feet wide, and nearly three miles long, with about 33 locks. Without some better security than can now be obtained, it is not probable that any private company will risk the capital necessary for the execution of such works. Morel, in his survey, professes to have found a valley or tract of low ground between the Trinidad, a branch of the Chagres, and the Caymito, which falls into the Pacific 10 miles west of Panama, of which low ground the summit level is only 40 feet above the sea. This, unluckily, is contradicted by other authorities; but if such a low summit level exist, a channel navigable by the largest ships might possibly be made from sea to sea without a lock. The portion of the railroad now in progress is the southern half, extending from Panama to Gorgona, and was expected to be finished in 1853. On the north side, the river Chagres is made use of as far as navigable.

4. The Atrato and Cupica line commences on the Atlantic side in the Gulf of Darien, at 77° of west longitude. It has not been surveyed, but the nature and form of the ground are well known, and its suitableness for a canal was pointed out by Humboldt 40 years ago. The route extends from the inner part of the Gulf of Darien up the river Atrato, thence westward along its branch, the Naipi, and through a low tract of ground to the river Cupica, which falls into the Pacific. The whole length of the proposed line is estimated at 114 miles. For two-thirds of this distance, or 76 miles, the rivers are said to be navigable by ships, for 19 miles more by loaded boats, and it is supposed that a canal might be cut through the remaining 19 miles without any extraordinary difficulty. The proprietor of an estate on the Naipi told Mr Watts, the British vice-consul at Carthagena, that he was in the habit of crossing to the Bay of Cupica, and the rise between the bay and the river was gradual, and only about 150 feet in the whole. That the ground is really low, is proved by the fact that the launch of a Chilian frigate, carrying 15 men, was drawn over it in 10 hours, the men having to cut the bush as they advanced. The canal and river communication along this line would have the benefit of a good port at each extremity. Dr Cullen, an intelligent Scotsman who has travelled over it, recommends it strongly; and Captain Fitzroy is inclined to think that it will be found preferable to every other for a great ship canal.

Animals. The opinion entertained in the infancy of natural history, that all the larger animals had spread from one common centre to the different countries where we find them, is, we believe, now abandoned by all scientific writers. It is found that every region of the globe, separated from others by well-marked boundaries, or by contrasted climates, has plants and animals peculiar to itself. The vast multitude of facts now ascertained respecting the distribution of animals can be explained on no hypothesis but one. We are forced to infer, that after the last catastrophe which destroyed the living beings inhabiting the earth, a great variety of new animal tribes were created; that each was placed on the spot to which its powers and functions were best adapted; and that from this as a centre it was left to spread by such means of locomotion as nature had provided it with. Some birds, for instance, strong of wing, and some few quadrupeds of migratory habits, are diffused from the west coast of Europe to the east coast of Asia; while many others, which, from their mode of life or their small size, were ill fitted for travelling, are confined within a very narrow space. Where wild animals resembling each other, exist in regions distinct and entirely separated, it is found that they are not of the same species, but are corresponding species belonging to the same genus. The horse, the ox, the antelope, the elephant, and the rhinoceros of Asia, are distinct species from those of Southern Africa, where the same genera exist. This hypothesis, as Dr Prichard remarks, does not contradict the testimony of the Scriptures; it merely assumes that there were animals created subsequent to the deluge in various parts of the earth, of which it was not necessary for the sacred historian to speak.

The American animals belonging to the Cuvierian Division of *Vertebrata* are very numerous. It is true that some of the larger quadrupeds have no living types in the New World. There are none to compare in size with the elephant, the rhinoceros, the hippopotamus, the giraffe, or the camel; but fossil remains of the mastodon, megatherium, and megalonyx will vie in size with the largest quadrupeds of the Old World.

In the class of Mammifera, America is very rich, as the following synopsis of the species in each order will show:—

| | |
|---|---|
| Quadrumana, | 59 |
| Carnivora, | 89 |
| Marsupialia, | 21 |
| Rodentia, | 71 |
| Edentata, | 16 |
| Pachydermata, | 6 |
| Ruminantia, | 22 |
| Cetacea, | 18 |
| | 302 |

Some of these are common to the Old and the New Worlds, and a few have been introduced by Europeans; but several, which were at one period considered as identically the same in both continents, have by more recent investigations been found to be only allied species. Some of the larger animals of Eastern Asia and North-Western America, as the reindeer, make annual migrations over the Arctic Seas from one continent to the other; and many of the mammals inhabiting the sea no doubt may be considered as identical. We shall here note the more important American vertebrate animals under the *orders* to which they belong, attaching to each *genus* the number of American *species*, and of the more important mention the specific names.

| Quadrumana.—*Apes.* | Species. |
|---|---|
| *Mysetes*, Howler, | 7 |
| *Pithecia*, Saki, | 10 |
| *Ateles*, Sapajou, | 10 |
| *Cebus*, Capuchin, | 12 |
| *Nocthorus*, | 3 |
| *Callithrix*, | 17 |
| | 59 |

America.

CARNIVORA.

| | |
|---|---|
| *Cheiroptera*, Bat, | 12 |
| *Erinaceus*, American hedgehog, | 1 |
| *Sorex*, Shrew, | 3 |
| *Scalops*, Shrew-mole, | 5 |
| *Talpa*, Mole, | 1 |
| *Ursus*, Bear, | 5 |
| Grizzly bear. Black bear. White bear. Cordillera bear. Barren ground bear. | |
| *Procyon*, Racoon, | 2 |
| *Nasua*, Coati, | 3 |
| *Meles*, Badger, | 2 |
| *Gulo*, Wolverine, | 1 |
| *Viverra*, *Putorius*, } Weasel, | 13 |
| *Mephites*, Skunk, | 5 |
| *Lutra*, Otter, | 5 |
| *Canis*, Dog, | 4 |
| Common dog. Maned wolf. Gray wolf. Mexican wolf. | |
| *Vulpes*, Fox, | 7 |
| Arctic fox. Gray fox. Black fox. Bald fox. Virginian fox. Chilé fox. Silvery fox. | |
| *Felis*, Cat, | 11 |
| Puma. Guigna. Jaguar. Colorolo. Ocelot. Bay lynx. Black jaguar. Canadian lynx. Jaguarondi. American serval. Margay. | |
| *Phoca*, Seal, | 8 |
| *Trichecus*, Walrus, | 1 |
| | 89 |

MARSUPIALIA.

| | |
|---|---|
| *Didelphis*, Opossum, | 21 |

Of which the chief are Virginian, Palmated, Crab-eating, Mexican, Short-tailed, Merian, and Murine.

RODENTIA.

| | | |
|---|---|---|
| *Sciurus*, Squirrel, | | 10 |
| *Arctomys*, Marmot, | | 4 |
| *Mus*, Mouse, | | 20 |
| Viz.:—Echymys, | 5 | |
| Mouse, | 8 | |
| Merion, | 3 | |
| Lemming, | 1 | |
| Economic rat, | 2 | |
| Musk rat, | 1 | |
| *Castor*, Beaver, | | 2 |
| *Hystrix*, Porcupine, | | 3 |
| *Lepus*, Hare, | | 17 |
| *Hydrochœrus*, Water hog, | | 1 |
| *Cavia*, Cavy, | | 6 |
| *Cœlogenus*, Paca, | | 1 |
| *Lagostomus*, Viscacha, | | 1 |
| *Lagotis*, Chincha, | | 2 |
| *Callomys*, Chinchilla, | | 1 |
| *Atrocoma*, | | 2 |
| *Auromys*, | | 1 |
| *Pœphagomys*, | | 1 |
| *Octodon*, | | 1 |
| | | 73 |

EDENTATA.

| | |
|---|---|
| *Bradypus*, Sloth, | 3 |
| *Dasypus*, Armadillo, | 10 |
| *Myrmecophaga*, Ant-eater, | 3 |
| | 16 |

Besides the living Edentata, America affords the vast fossil skeletons of the Megatherium and Megalonyx.

PACHYDERMATA.

| | |
|---|---|
| *Sus*, Boar (imported), | 1 |
| *Dicoteles*, Peccari, | 2 |
| *Tapirus*, Tapir, | 1 |
| *Equus*, Horse (imported), | 2 |
| | 6 |

Besides these living Pachydermata, America abounds with the fossil bones of animals rivalling the elephant of the Old World in size, viz., the Mastodon giganteum, and Mastodon Andium. The skeletons of the former occur in vast quantity in the frozen mud of the islands of Escholtz Bay, within Behring's Straits.

RUMINANTIA.

| | |
|---|---|
| *Auchenia*, Llama, | 3 |
| Guanaco. Vicuña. Alpaca. | |
| *Cervus*, Deer, | 10 |
| Wapiti deer. Rufous deer. Virginian deer. Guiana deer. Marsh deer. Wandering deer. Prairie deer. Simple-horned deer. Forest deer. Rein deer. | |
| *Alces*, Elk, | 1 |
| Moose deer or Carabou. | |
| *Antilope*, Antelope, | 2 |
| Prong-horned antelope. Palmated antelope. | |
| *Ovis*, Sheep, | 2 |
| Mountain sheep. Common sheep (imported). | |
| *Capra*, Goat, | 1 |
| *Bos*, Ox, | 3 |
| Bison. Common ox (imported). Musk ox. | |
| | 22 |

CETACEA.

| | |
|---|---|
| *Manatus*, Manati, | 3 |
| Northern manati. Broad-nosed manati. Southern manati. | |
| *Delphinus*, Dolphin, | 7 |
| Common dolphin. Beaked dolphin. Porpesse. Deductor. Grampus. Fitzroy's dolphin. Beluga. | |
| *Monodon*, Narwal, | 1 |
| *Physeter*, Cachalot, | 2 |
| Sperm cachalot. Blunt-headed cachalot. | |
| *Balæna*, Whale, | 5 |
| Greenland whale. Broad-nosed whale. Razor-back or physalis. Beaked whale. Finner or boops. | |
| | 18 |

Birds.

The birds of America are very numerous in almost every great family. The researches of Wilson, Charles Buonaparte, Audubon, Richardson, and Dekay, have beautifully illustrated the ornithology of North America; while those of Azara, Humboldt, Swainson, Waterton, Edmondstone, and Darwin, have thrown great light on that of South America. The North American species of birds already described amount to between 560 and 600; the species of South America are at least as numerous; so that we may fairly estimate the ornithology of America to include 1100, or perhaps 1300 species; and some genera are wholly peculiar to the New World,—as the genera of humming birds, toucans, aracaris, pauxis, crax, penelope, tinamous, and the wild turkey.

Reptiles.

The serpents of America are very numerous, amounting to 80 innocuous A, and to 12 or 13 venomous snakes B. In the work of Schlegel we find the following genera of both kinds.

A. Tortrix 1; calamaria 7; coronella 6; xenodon 5; heterodon 3; lycodon 4; coluber 8; herpetodryas 12; psammophis 2; dendrophis 3; dryiophis 3; dipsas 11; tropidonotus 3; homalopsis 6; boa 5.

B. Elaps 3; trigonocephalus 5; crotalus 4.

Of these the genera heterodon, and crotalus or rattlesnake are entirely peculiar to America, and the latter are by far the most deadly of serpents. The reptilia of North America have been well described by Dekay and Holbrooke. These authors mention the following, *Testudinata*, or tortoises; chelonia, or turtle, 3; sphargis, or leatherback turtle, 1; trionyx, or soft tortoise, 4; chelydra, or half-defended tortoise, 3; emys, or fresh water tortoise, 19; chelys 2; terrapin 3,—in all 35.

They give the North American saurians as, crocodile 2; alligator 1; anolis 1; scinks 4; agama 4; tropidolepis 2; ophisaurus 1; leptophis 1,—in all 16. Of the *Ranidæ* there are of rana, frog, 13; bufo, toad, 5; hyla, tree frog, 8,—in all 26.

The fishes of America are most numerous. The fresh waters abound with *Siluridæ;* the seas with chætodons, diodons, all of the strangest forms. We shall only mention one other American fish, the *amblyopsis spelæus* of Dekay, a small fish absolutely destitute of eyes. It is found in the vast mammoth cave of Kentucky. It belongs to Agassiz's family of *cyprinodotes*, but was at first considered as allied to the *Siluridæ*. It is worthy of remark, that the same cavern is inhabited by several minute animals also without eyes; as if nature had in an especial manner adapted them for a subterranean life, in which eyes would have been useless.

It is remarked by Azara, that single species of wild animals are diffused over a much wider surface in the New World than in the Old. The jaguar and tapir, for instance, are found from the banks of the Plata to those of the Rio del Norte in Mexico. This circumstance strengthens the conclusion, that America derived its human inhabitants from the old continent, and remained, of course for a much longer period, entirely in possession of the animal tribes; and further, that the former civilisation (such as it was) arose only at a late period.[1]



Changes in European animals.

The European animals which have been naturalised in America are the cow, horse, ass, hog, sheep, goat, dog; and these have multiplied to such a degree as to exceed the native quadrupeds greatly in numbers. The warm climate of the tropical parts of America has produced considerable changes in the habits and physical qualities of most of these species. The hog, which generally wanders in the woods, and lives on the wild fruits and roots found there, has lost in a great measure its domestic habits, and assumed the character of the wild boar. The black cattle also, roaming at large in a country entirely uninclosed, are found to fall off unless they receive a certain quantity of salt in their food, which in some cases they procure from plants, in others from brackish water. By distributing salt to them at a certain regular hour, they are taught to assemble at the owner's residence, and are thus kept from becoming wild. In Europe the constant practice of milking cows has enlarged the udder greatly beyond its natural size, and so changed the secretions, that the supply does not cease when the calf is removed. In Colombia, where circumstances are entirely different, nature shows a strong tendency to resume its original type. A cow gives milk there only while the calf is with her. It must be allowed to suck during the day, and the fluid is procured only by separating them during the night, and milking the cow in the morning before the calf visits her. The ass has undergone little alteration in America, and it has nowhere become wild. It is otherwise with the horse. Numbers of these animals in a wild state exist in Colombia, and many other parts of America, both South and North, where they wander over the plains and savannahs in troops. It is observed that the colour of the animals living in this state returns to that bay chesnut which is considered as characteristic of the natural wild horse. It is worthy of notice, that the amble, the pace to which the domestic horse in Spanish America is exclusively trained, becomes in the course of some generations hereditary, and is assumed by the young ones without teaching. The sheep thrives and multiplies in the temperate parts of the New World, and shows no tendency to withdraw from the protection of man; but in the warm regions it undergoes a remarkable change. If the lamb be shorn at the usual time, its wool is of the same description as in Europe, and it will grow again in the same way; but if it be suffered to remain on the animal's body after the proper season for cutting, it thickens, felts together, and detaches itself, and then is succeeded by a short close shining hair, very like that of the goat in the same climate. The goat in Colombia has the size of its udder contracted, and undergoes a change similar to that which is experienced by the cow.[2] (C. M.)

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AMERICA, United States of. See United States.

AMERIGO VESPUCCI. See Vespucci.

AMERSFOORT, a town of Holland, in the province of Utrecht, 12 miles E.N.E. of the city of that name, and situated on the river Eem, which here is navigable. In 1850 it contained 12,360 inhabitants. The chief buildings are the town-house, and the great church dedicated to St George. It has a court of primary jurisdiction, a college, and an industrial school. Woollen, cotton, silk, glass, and tobacco, are manufactured here; and the transit trade is very considerable.

AMERSHAM, or Agmondesham, an ancient market and borough town of Buckinghamshire, in the hundred of Burnham, pleasantly situated in a valley between richly-wooded hills, through which the river Colnes flows. It consists chiefly of two streets, crossing each other; and at the point of intersection stands the church, a very handsome building, containing several beautiful monuments. The town has

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[1] *Azara*, French translation. Preface, p. 50.

[2] *Sur les Changemens survenus*, &c., par M. Roulin, en *Bulletin des Sciences Naturelles*, Avril 1829.

some manufactories of cotton goods and black lace. It formerly returned two members to parliament. The population in 1851 amounted to 2093. It has a free grammar school, with three exhibitions at Oxford.

AMES, Fisher, an eminent American statesman and writer, son of Nathaniel Ames, a physician, was born at Dedham, in Massachusetts, on 9th April 1785. After practising the law for some little time, he abandoned that profession for the more congenial pursuit of politics, and in 1788 became a member of the Massachusetts convention for ratifying the constitution. In this assembly he bore a conspicuous part, and in the next year, having passed to the house of representatives in the state legislature, he distinguished himself greatly by his eloquence and forensic talents. During the eight years of Washington's administration he took a prominent part in the national councils; and on the retirement of that eminent man from office, he returned to his residence at Dedham to resume the practice of the law, which the state of his health, after a few years, obliged him to relinquish. But Ames was not idle: he continued his literary labours, and published numerous essays, chiefly in relation to the contest between Great Britain and revolutionary France, as it might affect the liberty and prosperity of America. Four years before his death, he was chosen president of Harvard College, an honour which his broken state of health obliged him to decline. After suffering for two years from extreme debility, he expired on the 4th July 1808, having acquired the admiration and respect of his countrymen by the brilliancy of his talents and his private virtues. His writings were collected and published, with a memoir of the author, in 1809, by the Rev. Dr Kirkland, in one large octavo volume.

Ames, *Joseph*, author of a valuable work on the progress of printing in England, called *Typographical Antiquities*, which is often quoted by bibliographers. He was born in 1689, and died in 1759. The best editions of his work are those published with the additions of Herbert and of Dibdin.

Ames, *William*, D.D., a learned Independent divine, was born in 1576, and educated at Christ's College, Cambridge. In the reign of King James I., he left the university, in order to avoid expulsion for nonconformity, and retired to the Hague, where he had not been long before he was invited to accept of the divinity chair in the university of Franeker, in Friesland, which he filled with great ability for above twelve years. He removed from thence to Rotterdam on account of his health; and there he continued during the remainder of his life. His controversial writings, which compose the greater part of his works, are chiefly against Bellarmine and the Arminians. He also wrote, 1. *A fresh Suit against Human Ceremonies in God's Worship*; 2. *Lectiones in Psalmos Davidis*; 3. *Medulla Theologiæ*; and several pieces relative to the sciences. He died of an asthma, at Rotterdam, in November 1633.

AMESBURY, a market-town in the hundred of the same name, in the county of Wilts, 77 miles from London, and 7 from Salisbury. It is situated in a narrow valley on the river Avon, on Salisbury plain. It is an ill-built town, but contains the beautiful house built by Inigo Jones for the Duke of Queensberry. At Milston, in this neighbourhood, Addison was born. Near the town stands the druidical monument of Stonehenge. Population in 1851, 1172.

AMETHYST, a transparent gem of a purple colour, which seems composed of a strong blue and a deep red; and, according as either of these prevails, affording different tinges of purple, sometimes approaching to violet, and sometimes even fading to a pale rose colour. Though the amethyst is generally of a purple colour, it is nevertheless sometimes found naturally colourless, and may at any time be easily made so by putting it into the fire; in which pellucid or colourless state it so resembles the diamond, that its want of hardness seems the best way of distinguishing it. Some derive the name *amethyst* from its colour, which resembles wine mixed with water; while others, with more probability, think it got its name from its supposed virtue of preventing drunkenness,—an opinion which, however imaginary, prevailed to that degree among the ancients, that it was usual for great drinkers to wear it about their necks. Be this as it may, the amethyst is scarcely inferior to any of the gems in the beauty of its colour. The *common amethyst* is a variety of quartz; the *oriental amethyst* is a variety of spinelle. Its most common form is a six-sided prism, terminated by a flat and short pyramid of the same number of sides. The amethyst is found in the East and West Indies, Siberia, and in every part of Europe; the oriental being so hard and bright as to equal any of the coloured gems in value. The common amethysts, however, fall infinitely short of these; all the European ones, and not a few of those brought from the East and West Indies, are a mere variety of rock crystal.



*Counterfeit or Factitious Amethyst.* Spars and crystals tinged red and yellow, &c., are sold for amethysts. The false ones come from Germany, are tinged by vapours in the mines, and contain lead and manganese.

Amethysts may be counterfeited by glass, to which the proper colour or stain is given. There were fine ones made in France about the year 1690, which may even impose on connoisseurs, unless the stone be taken out of the collet.

Amethyst, in *Heraldry*, a term for the purple colour in the coat of a nobleman, in use with those who blazon with precious stones instead of metals and colours. This, in a gentleman's escutcheon, is called *Purpure*; and in those of sovereign princes, *Mercury*.

AMETHYSTINE is applied, in *Antiquity*, to a kind of purple garment dyed of the hue of amethyst. In this sense amethystine differed from *Tyrian* as well as from *hyacinthine* purple, being a kind of medium between them.

AMHARA, one of the great divisions of Abyssinia, including the whole country north of the upper basin of the Blue River, and separated on the north-east from Tigré by the Tacazze. The province of Amhara Proper is in the south-east of this territory, and constitutes a state or kingdom still nominally subject to the head of the royal family, who is however a mere puppet in the hands of his temporary minister, with a paltry pension. The great lake of Dembea lies in the centre, surrounded by the plain of Dembea, which has been called the granary of the country, on account of its fertility and the blandness of its climate. The language is the Amharic, a branch of the Semitic stock.

AMHERST, Jeffrey, *Lord*, was born in 1717 in Kent. He served in the Duke of Cumberland's campaigns in Germany, and afterwards with distinction in the military operations that wrested Canada from the French. He was governor of Virginia in 1763, and of Guernsey in 1770. He was created a baron in 1776, while he was commander-in-chief in England, which office he retained till the dissolution of Lord North's administration in 1782. He was again appointed commander-in-chief in 1793, an office which he resigned on account of his age in 1795. He died in 1797. Amherstburgh in Upper Canada was named after this able officer.

Amherst, a seaport-town of Eastern India, situate in a district of the same name, in the province of Tenasserim, at the mouth of the Saluen or Martaban River. It was founded by the English in 1826, on the restoration of the town of Martaban to the Burmese, and named in compliment to the governor-general of India, who projected its erection. The proclamation inviting the natives to people the town was well adapted to the character and capacities of those whom it addressed. "The inhabitants of the towns and villages who wish to come shall be free from molestation, extortion, and oppression. They shall be free to worship as usual, temples, monasteries, priests, and holy men. The people shall go and come, buy and sell, do and live as they please, conforming to the laws. In regard to slavery, since all men, common people or chiefs, are by nature equal, there shall be under the English government no slaves. Whoever desires to come to the new town, may come from all parts and live happy; and those who do not wish to remain may go where they please without hinderance." Batteries erected on the heights protect both town and harbour. The latter is spacious and secure, with a depth of three fathoms at low tides; but it is difficult of access, especially during the south-west monsoon. Teak forests abound in the neighbourhood, and the timber they furnish forms a principal article of export. Distance east from Rangoon 100 miles; from Moulmein south 30 miles. Lat. 16. 4. N. Long. 97. 40. E. (E. T.)

AMHERST, a small town in the county of Hampshire, Massachusetts, U. S., North America, 90 miles west of Boston. It is chiefly noted for its literary institutions, which consist of a college, an academy, and a classical institution. Its college was opened in 1821, and in 1850 had 166 students. Population about 2500. This is the name of several other places in the United States.

AMHERSTBURG, in Essex county, Upper Canada, is in Lat. 42. 5. N. Long. 83. 10. W. It is on the north shore of Lake Erie, near the River Detroit. It has a garrison and some redoubts.

AMHURST, NICHOLAS, an English poet and political writer of the eighteenth century, was born at Marden in Kent, and entered of St John's College, Oxford; from which he was expelled for irregularity of conduct and libertine principles. Retaining great resentment against the university on this account, he abused its learning and discipline, and some of the most respectable characters in it, in a poem published in 1724, called *Oculus Britanniæ*, and in a book entitled *Terræ Filius*. He published a Miscellany of Poems, sacred and profane; and *The Convocation*, a poem in five cantos, which was a satire on the Bishop of Bangor's antagonists. But he is best known for the share he had in the political paper called *The Craftsman;* though, after being the drudge of his party for nearly 20 years, he was utterly forgotten in the famous compromise of 1742. He died in that year of a broken heart, and was indebted to the charity of his booksellers for a grave.

AMIANTHUS, or ASBESTUS; *Asbeste*, Haüy. The general composition of this substance may be stated as a silicate of magnesia, lime, and protoxide of iron. It occurs in highly delicate fibres, often thinner than a hair, longitudinally cohering, and easily separated. The finest varieties are of a brilliant silky white, and flexible. The Tarentaise in Savoy, and the island of Corsica, are cited as the localities affording the most perfectly fibrous white and silky varieties; and it occurs so abundantly in the last, that Dolomieu was enabled to use it in place of hay for packing his specimens. Anciently it was woven into napery and towels, which, when foul, were thrown into the fire, from whence they came out perfectly clean. Amianthus cloth was sometimes employed by the ancients to preserve the bones of the dead in the funeral pile.

AMICABLE BENCHES, in *Roman Antiquity*, were, according to Pitiscus, lower and less honourable seats allotted for the *judices pedanei*, or inferior judges, who, upon being admitted to the emperor's council, were dignified by him with the title *amici*.

*AMICABLE Numbers* denote pairs of numbers, of which each is mutually equal to the sum of all the aliquot parts of the other. So the first or least pair of amicable numbers are 220 and 284; all the aliquot parts of which with their sums, are as follows, viz.:



Of 220, they are 1, 2, 4, 5, 10, 11, 20, 22, 44, 55, 110, their sum being - - - - - - - 284
Of 284, they are 1, 2, 4, 71, 142, and their sum is 220

The second pair of amicable numbers are 17,296 and 18,416, which have also the same property as above.

And the third pair of amicable numbers are 9,363,584 and 9,437,056.

These three pairs of amicable numbers were found out by F. Schooten (sect. 9 of his *Exercitationes Mathematicæ*), who, it is said, first gave the name of *amicable* to such numbers, though such properties of numbers, it seems, had before been treated of by Rudolphus, Descartes, and others.

To find the first pair, Schooten puts $4x$ and $4yz$, or $a^2x$ and $a^2yz$ for the two numbers, where $a=2$; then making each of these equal to the sum of the aliquot parts of the other, gives two equations, from which are found the values of $x$ and $z$, and consequently assuming a proper value for $y$, the two amicable numbers themselves $4x$ and $4yz$.

In like manner for the other pairs of such numbers; in which he finds it necessary to assume $16x$ and $16\,yz$ or $a^4x$ and $a^4yz$ for the second pair, and $128x$ and $128yz$, or $a^7x$ and $a^7yz$ for the third pair.

Schooten then gives this practical rule, from Descartes, for finding amicable numbers, viz., assume the number 2, or some power of the number 2, such that if unity or 1 be subtracted from each of these three following quantities, viz.—

From 3 times the assumed number,

Also from 6 times the assumed number,

And from 18 times the square of the assumed number, the three remainders may be all prime numbers; then the last prime number being multiplied by double the assumed number, the product will be one of the amicable numbers sought, and the sum of its aliquot parts will be the other. That is, if $a$ be put = the number 2, and $n$ some integer number, such that $3a^n-1$, and $6a^n-1$, and $18a^{2n}-1$, be all three prime numbers; then is $\overline{18a^{2n}-1}\times 2a^n$ one of the amicable numbers, and the sum of its aliquot parts is the other. On this subject see Euleri *Opuscula varii Argumenti*, tom. ii. p. 23–107.

AMICTUS, among *Ecclesiastical Writers*, the uppermost garment anciently worn by the clergy; the other five being the alba, cingulum, stola, manipulus, and planeta. The amictus was a linen garment, of a square figure, covering the head, neck, and shoulders, and buckled or clasped before the breast. It is still worn by the religious abroad. Its English name is *Amice*.

AMICUS CURIÆ, a law term, to denote a bystander who informs the court of a matter in law that is doubtful or mistaken.

AMIDA, a god worshipped by the Japanese, who has many temples erected to him in the Island of Japan, of which the principal is at Jeddo. The Japanese have such a confidence in their idol Amida, that they hope to attain eternal felicity by the frequent invocation of his name. One of the figures of this idol is preserved at Rome.—See *Kampfer*, 243.

AMIENS, an arrondissement in the department of the Somme, in the north of France. Its extent is 719 square miles, or about 460,035 English acres. It comprehends thirteen cantons, viz., Amiens, Conti, Corbi, Hornoy, Moliens-Bibame, Oisemont, Piquigny, Poix, Soins, and Villers-Bocage, with 249 communes or parishes. In 1851 it contained 189,968 inhabitants.

AMIENS, a city, the capital as well of the department of the Somme as of the circle of its own name. It is a fortified place with a strong citadel, on the Somme, which receives here the waters of the Seille, and passes through the town in three branches. It has access to the sea, but only for small craft. It is a well-built ancient town, containing a cathedral, fourteen churches, and two hospitals. The population in 1851 amounted to 49,139. The cathedral is a venerable object, both for its beauty and extent. The town-house is a large, handsome stone building, and contains a fine collection of pictures of the French school. Amiens is the seat of the prefect, of a bishop, and of the departmental courts of justice. There is a commercial board, a society of agriculture, a botanic garden, a lyceum, a theatre, and a library. Amiens was always a manufacturing city. Though it suffered much during the revolution of 1789, it has since revived; and at present produces considerable quantities of woollen cloths, cassimeres, and worsted stuffs. There are also some moderate establishments for making cotton goods, the yarn of which, for all but the finer kinds, is spun in the city. It has also trade in tanning and in soap making. This city is distinguished as the birthplace of Peter the Hermit, the preacher of the first crusade, and of Voiture the poet, as well as for the treaty of peace of 1802. Long. 2. 23. E. Lat. 49. 53. N.

AMILCAR, the name of several Carthaginian captains. The most celebrated of them is Amilcar Barcas, the father of Hannibal. See HAMILCAR.

AMILICTI, in the *Chaldaic Theology*, denote a kind of intellectual powers, or persons in the divine hierarchy. The amilicti are represented as three in number, and constitute one of the triads in the third order of the hierarchy.

AMINTA, in *Literary History*, a beautiful pastoral comedy composed by Tasso, the model of all dramatic pieces wherein shepherds are actors. Guarini's *Pastor Fido* and the *Fili de Sciro* of Bonarelli are only copies of this excellent piece.

AMIOT, PERE, a learned Jesuit, born in 1718 at Toulon. He was sent to Pekin in 1751, and continued to reside there until his death in 1794. He obtained the favourable notice of the emperor Kien Lung; which, with his profound knowledge of the Chinese and Mantcheou languages, enabled him to collect and transmit to Europe more information on China than all his predecessors. His researches have enriched all the memoirs on that singular people during the last century.

AMISUS, in *Ancient Geography*, the chief city of the ancient kingdom of Pontus. It was built by the Milesians, and peopled partly by them and partly by a colony from Athens. Under the kings of Pontus it became a very flourishing city. Mithridates Eupator made a large addition to the town, which he called Eupatoria, and made it his residence alternately with Sinope. It was taken by the Roman general Lucullus in the Mithridatic war, and afterwards by Pharnaces son of Mithridates. Julius Cæsar, after defeating Pharnaces, restored it to its ancient liberty. Amisus is now called Samsoon.

AMITERNUM, an ancient city of the Sabines, situated near the sources of the Aternus. Its site is now occupied by the modern village of Vittorino, where numerous remains are still to be seen. This was the birthplace of the historian Sallust.

AMITTERE LEGEM TERRÆ, among *Lawyers*, a phrase importing the loss of liberty of swearing in any court; the punishment of a champion overcome or yielding in battle, —of jurors found guilty in a writ of attaint,—and of a person outlawed.

AMLWCH, a seaport borough in the hundred of Twrcelyn, in the island of Anglesey, North Wales. It has a harbour cut out of the rock with great labour and cost, capable of containing 30 vessels of about 200 tons burden. It rose rapidly after the discovery of the copper mines of Pary's Mountain, but since the ore there has been exhausted it has declined. It is 261 miles from London, and 15 from Beaumaris. Population in 1851, 3169.



AMMA, among *Ecclesiastical Writers*, a term used to denote an abbess or spiritual mother.

AMMA, an ancient Greek land measure, equal to 60 feet.

AMMAN, JOHANN CONRAD, a physician, and one of the earliest writers on the instruction of the *deaf and dumb*, was born at Schaffhausen, in Switzerland, in 1669. In 1687 he graduated at Basle; and as his religious principles did not permit him to settle in his native country, he retired to Holland, where he appears to have devoted his time and attention chiefly to the cure of the defects and imperfections of speech. He first called the attention of the public to his method, in a paper which was inserted in the *Philosophical Transactions;* and which appeared in a separate form in the year 1692, under the title, *Surdus Loquens, sive Methodus quâ qui surdus natus est loqui possit;* and afterwards, with much additional matter, in 1702 and 1728, under the title, *Dissertatio de Loquela, quâ non solum vox humana et loquendi artificium ex originibus suis eruuntur, sed et traduntur media, quibus ii qui ab incunabulis* SURDI ET MUTI *fuerunt, loquelam adipisci, quique difficulter loquuntur, vitia sua emendare possint.* In this work, which Haller terms "*vere aureum*," he develops, with great ability, the mechanism of vocal utterance, and describes the process which he employed in teaching its use to the unfortunate class of persons committed to his care. This consisted principally in exciting the attention of his pupils to the motions of his lips and larynx while he spoke, and then inducing them by gentle means to imitate these movements, till he brought them to repeat distinctly letters, syllables, and words. As his method was excellent, we may readily give him credit for the success to which he lays claim. In a long course of practice, he says that he never failed in his endeavours but in two instances; one of which was that of a girl who was an idiot, and the other that of a Jew, from whose father he foresaw that he would not get any thanks for his trouble. The edition of *Cælius Aurelianus*, which was undertaken by the Wetsteins in 1709, and still ranks as one of the best editions of that author, was superintended by Amman. (T. M.)

AMMAN, *Paul*, a physician and botanist, was born at Breslau in 1634. In 1662 he received the degree of doctor of physic from the university of Leipsic, and in 1664 was admitted a member of the society *Naturæ Curiosorum*, under the name of *Dryander*. Shortly afterwards he was chosen extraordinary professor of medicine in the above-mentioned university; and in 1674 he was promoted to the botanical chair, which he again, in 1682, exchanged for the physiological. He died in 1691. Paul Amman seems to have been a man of an acute mind and extensive learning; but a restless and irritable disposition led him to engage too much in controversy, and to indulge in a degree of raillery in his writings, which the nature of the subjects hardly warranted. By his first work, which was published in 1670, under the title *Medicina Critica, seu Centuria Casuum in Facultate Lipsiensi resolutorum variis discursibus aucta*, he drew down upon himself the displeasure of the faculty, who had certainly no cause to rejoice at this exposure of their decisions. In the *Parænesis ad docentes occupata circa Institutionum medicarum Emendationem*, which appeared three years afterwards, and in the *Irenicum Numæ Pompilii cum Hippocrate*, which he published in 1689, he showed his independent turn of thinking, by boldly attacking the systems of Galen and Hippocrates, and the abuses to which the implicit adoption of them had given rise. But it is chiefly on his botanical writings that his fame ought to rest. The *Supellex Botanica, et Manuductio ad Materiam Medicam*, which he committed to the press in 1675, contains a full but somewhat prolix catalogue of the plants of the botanic garden of Leipsic and its environs, with their synonyms; followed by a brief introduction to the study of the *Materia Medica*, which exhibits an accurate knowledge of the science he was then employed in teaching. His next publication was entitled, *Character Naturalis Plantarum;* to the second edition of which, in 1685, he prefixed a dissertation on the true classification of plants. In this work he adopted the arrangement of Morison, endeavouring to show, as the title imports, that the genera of plants were only to be distinguished by their parts of fructification, and illustrating his method by the description of 1476 different genera and species, in alphabetical order. An enlarged edition of this book was published by Daniel Nebel in 1700, with the addition of the characters of Tournefort and Hermann. For a complete list of Paul Amman's writings, see Haller, *Bibl. Med.*, and Eloy, *Dict. Hist.* (T. M.)

Amman, or *Ammant*, in the *German* and *Belgic Polity*, a judge who has the cognizance of civil causes. It is also used among the French for a public notary, or officer, who draws up instruments and deeds.

AMMANATI, Bartolomeo, a celebrated Florentine architect and sculptor, of the time of Michael Angelo, who was much employed both at home and in Rome. The beautiful and stable bridge over the Arno, *Ponte della Trinita*, is one of his celebrated works. The three arches are elliptic, very light, and elegant, yet have resisted the utmost fury of the river which has swept away several other bridges at different times. He was born in 1511, and died in 1592, at the age of 81. His wife, daughter of Giov. Antonio Baltiferi, an elegant and accomplished woman, published a volume of poems that are highly esteemed in Italy.

AMMIANUS Marcellinus, a Roman historian of the fourth century, was born in the city of Antioch, in Syria. Having served several years in the early part of his life in the army, he was afterwards promoted to the honourable station of *protector domesticus*. In the year 350 he entered the service of Constantius, the emperor of the East, and under the command of Ursicinus, a general of the horse, he served during several expeditions. According to his own modest relation, it appears that he acquired considerable military fame, and that he deserved well of his sovereign. He attended the emperor Julian in his expedition into Persia, but history is silent respecting his having obtained any higher military promotion than that which has already been mentioned. He was either in the city or the vicinity of Antioch when the conspiracy of Theodorus was discovered, in the reign of Valens, and was an eye-witness of the severe torments to which many persons were exposed by the emperor on that account.

But his lasting reputation was not to be acquired from military exertions. He left the army and retired to Rome, where he employed his time and talents in writing a history of that empire, comprising a period of 282 years. Though a Greek by birth, he wrote in the Latin language; but, according to the remark of Vossius, his Latin shows that he was a Greek, and also a soldier. His history extended from the accession of Nerva to the death of Valens; and the work was originally divided into thirty-one books. Of these the first thirteen have perished, and the eighteen which remain commence with the seventeenth year of the reign of Constantius, and terminate at the year 378. But there are several facts mentioned in the history which prove that the author was alive in the year 380. Of this number are the accession of Theodosius to the eastern empire, the character of Gratian, and the consulate of Neothorius. Some have reckoned the style harsh and redundant, but this may easily be excused, from his education and military life; and the valuable information communicated abundantly compensates for that defect. Candour and impartiality are leading features in his history. Gibbon appears to have fairly estimated his character, when he says that he is "an accurate and faithful guide, who composed the history of his own times without indulging the prejudices and passions which usually affect the mind of a contemporary."



There is a difference of opinion as to whether he was a Christian or a pagan. But the respectful manner in which he speaks of pagan deities, and of the advantage of heathen auguries to foretell future events, renders it abundantly evident that he was a heathen. The favourable account which he gives of the religion, manners, and fortitude of Christians, is the result of his candour and impartiality as an historian. The work of Ammianus has passed through several editions, of which the best are the Leyden edition of 1693, and those of Leipsic, published in 1773 and 1808.

AMMIRATO, Scipio, an eminent Italian historian, born at Lecce in Naples in 1531. After travelling over great part of Italy without settling to his satisfaction, he was engaged by the great duke of Tuscany to write the *History of Florence*, for which he was presented to a canonry in the cathedral there. He wrote other works while in this station, and died in 1600.

AMMODYTES, a genus of Mamacopterygious fishes; of which our sand eel, *A. Tobianus*, is one.

AMMON, or Ammonium, the ancient name of the celebrated oasis (Siwah) on the west of Egypt, containing the oracle of the god Ammon. Arrian calls it a *place*, in which stood the temple of Jupiter Ammon, entirely surrounded by sandy wastes. Pliny states, that the oracle of Ammon was 12 days' journey from Memphis, and among the *Nomi* of Egypt he reckons the *Nomos Ammoniacus;* Diodorus Siculus says that the district where the temple stood, though surrounded with deserts, was watered by dews which fell nowhere else in all that country. It was agreeably adorned with fruitful trees and springs, and full of villages. In the middle stood the Acropolis or citadel, encompassed with a triple wall; the first and inmost of which contained the palace; the others the apartments of the women, the household, and children, as also the temple of the god, and the sacred fountains for lustrations. Without the Acropolis stood, at no great distance, another temple of Ammon, shaded by a number of tall trees; near which there was a fountain, called that of the sun, or *Solis Fons*, because subject to extraordinary changes according to the time of the day; morning and evening warm, at noon cold, at midnight extremely hot. A kind of fossil salt was said to be naturally produced here. It was dug out of the earth in large oblong pieces, transparent as crystal. It was thought to be a present worthy of kings, and was used by the Egyptians in their sacrifices. From this our sal-ammoniac has taken its name. The observations of Brown and Hornemann prove that the oasis of Siwah is the district in which this celebrated oracle was situated. Pliny places it at 12 days' journey from Memphis, and Hornemann reached Siwah in 12 days from Cairo. These travellers found an old building 32 feet long, 15 broad, and 18 high, formed of large stones, and with some hieroglyphics upon it. This is most probably the ancient sanctuary of Ammon, which was placed in an inclosure, and surrounded by an outer wall. Near this old building is a spring, which still preserves, in popular opinion, the qualities attributed by the ancients to the Fountain of the Sun, and which, in fact, belong to all deep-seated cold springs. Our modern travellers found also the salt incrustations, the numerous date-trees, and the sea-shells and fossil wood in the neighbouring desert, which Strabo and other ancient writers notice. Arrian and Diodorus describe the district as having a breadth of 40 or 50 stadia, with which Brown's estimate of 4 to 6 English miles nearly agrees. Hornemann makes the circumference 50 miles, but he includes some patches of habitable land near it, but not contiguous to it.

Ammon, or Hammon, in *Heathen Mythology*, the name of the Egyptian Jupiter, worshipped under the figure of a ram. See Amon.

Ammon, or Ammonius, *Andreas*, an excellent Latin poet, born at Lucca in 1477, was sent by Pope Leo X. to England, in the characters of prothonotary of the apostolic see, and collector-general of that kingdom. He was a man of singular genius and learning, and soon became acquainted with the principal literati of those times; particularly with Erasmus, Colet, and others, for the sake of whose company he resided some time at Oxford. The advice which Erasmus gives him, in regard to pushing his fortune, has a good deal of humour in it, and was certainly intended as a satire on the artful methods generally practised by the selfish and ambitious part of mankind. "In the first place," says he, "throw off all sense of shame; thrust yourself into every one's business, and elbow out whomsoever you can; neither love nor hate any one; measure everything by your own advantage; let this be the scope and drift of all your actions. Give nothing but what is to be returned with usury, and be complaisant to every body. Have always two strings to your bow. Feign that you are solicited by many from abroad, and get everything ready for your departure. Show letters inviting you elsewhere, with great promises." Ammon was Latin secretary to Henry VIII., but at what time he was appointed does not appear. In 1512 he was made canon and prebendary of the collegiate chapel of St Stephen, in the palace of Westminster. He was likewise prebendary of Wells; and in 1514 was presented to the rectory of Dychial in that diocese. About the same time, by the king's special recommendation, he was also made prebendary of Salisbury. He died in the year 1517, and was buried in St Stephen's chapel in the palace of Westminster. He was esteemed an elegant Latin writer, and an admirable poet. The epistles of Erasmus to Ammon, abounds with encomiums on his genius and learning. His works are, 1. Epistolæ ad Erasmum, lib. i.; 2. Scotici Conflictus Historia, lib. i.; 3. Bucolicæ vel Eclogæ, lib. i. Basil, 1546, 8vo; 4. De Rebus Nihil, lib. i.; 5. Panegyricus quidam, lib. i.; 6. Varii Generis Epigrammata, lib. i.; 7. Poemata Diversa, lib. i.

AMMONIA, or Volatile Alkali. See Chemistry.

Ammonia, a name of Juno in Greece. It is also used in ancient authors for the country of Lybia.

AMMONIAC, a concrete, gummy, resinous juice brought from the East Indies, usually in large masses, composed of little lumps or tears, of a milky colour, but soon changing, upon being exposed to the air, to a yellowish hue. We now know that the plant which affords this juice is *Dorema ammoniacum*. It is one of the Umbelliferæ (*Pent. digyn.*), and grows on an arid soil in the province of Irak in Persia, 42 miles from Ispahan. It grows also near Herat in Khorassan, and on the north-western slopes of the Himalayas. The plant is said also to grow in Nubia, Abyssinia, and the interior parts of Egypt. It is brought to the western parts of Europe from Egypt, and to England from the Red Sea, by ships trading to the east. Such tears as are large, dry, free from little stones, seeds, or other impurities, should be picked out, and preferred for internal use: the coarser kind is purified by softening it in hot water and colature, and then carefully inspissating it; unless this be skilfully done, the gum will lose a considerable portion of its more volatile parts. There is often vended in the shops, under the name of strained gum-ammoniacum, a composition of ingredients much inferior in virtue. Ammoniac has a nauseous, sweet taste, followed by a bitter one; and a peculiar smell, somewhat like that of galbanum, but more grateful; it softens in the mouth, and grows of a whiter colour when chewed. Thrown upon live coals, it burns away in flame. It is partially soluble in water and in vinegar, with which it assumes the appearance of milk; but the resinous part, amounting to about one-half, subsides on standing. It is of considerable use in the *Materia Medica* as an antispasmodic.

Ammoniac, *Sal*, a saline substance, formerly much used in dyeing and some other arts. At present not much of it is employed in this country, most of the sal-ammoniac manufactured in Great Britain being sent to Russia.

Sal-ammoniac is usually in the form of a hard, white cake, opaque, or only slightly translucent. Its taste is cooling, saline, and rather disagreeable; though it has been occasionally employed as a seasoner of food. Its specific gravity is 1·441, according to the mean of the experiments of Wallerius, Watson, and Kirwan. It requires rather more than three times its weight of cold water to dissolve it. The primary form is considered to be the cube; but it crystallises also in octahedrons, and in a figure bounded by 24 trapeziums, formed by replacing the angles of the cube by three triangular faces. These, when they increase very much, cause the faces of the cube to disappear, and thus form a 24-sided figure, known in mineralogy by the name of *leucite* crystal. A hundred parts of alcohol, of the specific gravity 0·834, dissolve $1\frac{1}{2}$ part of this salt. When exposed to a moist atmosphere, it gradually absorbs water, and deliquesces, though very slowly. When heated, it sublimes unaltered in a white smoke, having a peculiar smell, very characteristic of sal-ammoniac. If a cold body be presented to this smoke, the sal-ammoniac condenses on it, and forms a white crust. When thus sublimed, it has the property of carrying along with it various bodies, which, when heated by themselves, are perfectly fixed.

If quicklime or potash be triturated with sal-ammoniac, a strong smell of ammonia exhales. If sulphuric acid be poured upon it, vapours of muriatic acid are separated in abundance. If equal bulks of muriatic acid gas and ammoniacal gas be brought into contact, they immediately combine and condense into sal-ammoniac. These facts, which are well known, show us that sal-ammoniac is a salt composed of muriatic acid and ammonia. The composition of this salt seems to have been first discovered by Tournefort in 1700. The experiments of Geoffroy junior in 1716 and 1723 were still more decisive, and those of Duhamel, in 1735, left no doubt upon the subject. Various experiments have been made by modern chemists to determine the proportions of the constituents of this salt. Dr Thomson first pointed out a process by synthesis, which has the advantage of being very simple, and at the same time rigidly accurate. He observed, that when muriatic gas and ammoniacal gas, both as dry as possible, are brought in contact with each other, they always combine in equal volumes; therefore sal-ammoniac is composed of 100 measures of muriatic acid gas, united with 100 measures of ammoniacal gas. Now, 100 inches of muriatic acid gas weigh 40·011 grains, and 100 cubic inches of ammoniacal gas weigh 18·3837 grains. Hence sal-ammoniac is composed of

| | | |
|---|---|---|
| Muriatic acid ............... | 40·011 | or 4·625 |
| Ammonia ................... | 18·3837 | or 2·125 |

But 4·625 is the weight of an atom of muriatic acid, while 2·125 is the weight of an atom of ammonia. Hence, it is evident that sal-ammoniac is a compound of

| | |
|---|---|
| 1 atom muriatic acid ..................... | 4·625 |
| 1 atom ammonia ......................... | 2·125 |
| | 6·750 |

and that an integrant particle of it weighs 6·750.

Ammoniac. But there is another way in which the composition of this salt may be viewed. Muriatic acid is a compound of chlorine and hydrogen. It has been shown, that most of the substances hitherto called *muriates* are in fact *chlorides*, or combinations of chlorine with the metallic bases of the alkalies, earths, or metallic oxides respectively. Thus, *common salt* is a *chloride of sodium*, or a compound of chlorine and sodium; *horn silver* is a *chloride of silver*, or a compound of chlorine and silver. If a hole be dug in a piece of sal-ammoniac; if this hole be slightly moistened by breathing on it; if a globule of mercury be put into it, and this globule be subjected to the action of a tolerably powerful galvanic battery, the mercury speedily acquires the consistence of butter, and swells up so as to amount to nearly four times its original bulk. In short, it is converted into an amalgam. Ammonia itself may be substituted for sal-ammoniac; but the experiment, in that case, is attended with greater difficulty. In this case the ammonia is evidently altered by the galvanic energy, and one of its constituents has combined with the mercury, and converted it into an amalgam. If the amalgam be put under water, it is speedily reduced to the state of pure mercury, while in the mean time ammonia and hydrogen gas are evolved. The same thing happens if the amalgam be put into a glass tube without any water. It would appear from this, that, by the galvanic energy, ammonia has been united to hydrogen, and converted into a substance which is capable of amalgamating with mercury.

Now, no instance can be produced of any substance uniting with mercury, and forming an amalgam which retains the metallic lustre, except a metal. Hence we are entitled to infer, that the mercury in the preceding experiment has united with a metal, and that the compound of ammonia and hydrogen is a metal. This supposed compound of ammonia and hydrogen has received the name of *ammonium*.

Ammonia itself has been shown to be a compound of

| | |
|---|---|
| 1 atom azote | 1·75 |
| 3 atoms hydrogen | 0·375 |
| | 2·125 |

while muriatic acid is a compound of

| | |
|---|---|
| 1 atom chlorine | 4·5 |
| 1 atom hydrogen | 0·125 |
| | 4·625 |

Were the atom of hydrogen in the muriatic acid to combine with the ammonia and convert it into *ammonium*, then ammonium would be a compound of

| | |
|---|---|
| 1 atom azote | 1·75 |
| 4 atoms hydrogen | 0·50 |
| | 2·25 |

The integrant particle of it would weigh 2·25. We might conceive sal-ammoniac to be a compound of

| | |
|---|---|
| 1 atom chlorine | 4·5 |
| 1 atom ammonium | 2·25 |
| | 6·75 |

According to this view, it would be a *chloride of ammonium*. The atomic constituents are the same according to both views; the only difference lies in the way in which these atoms are united. If sal-ammoniac be a muriate of ammonia, then one atom of hydrogen is united with one atom of chlorine, constituting muriatic acid, while three atoms of hydrogen are united with one atom of azote, constituting ammonia. If it be a chloride of ammonium, then four atoms of hydrogen are united to one atom of azote, constituting ammonium, an integrant particle of which is united to an atom of chlorine. It is impossible to determine, in the present state of chemical knowledge, which of these views is the true one. We have no other evidence of the existence of ammonium than the amalgam formed with mercury by means of sal-ammoniac and the galvanic battery, and the resolution of this amalgam into mercury, ammonia, and hydrogen. But this curious experiment is not easily explained upon any other supposition.

Ammoniac.

The name *ammoniacus sal* occurs in Pliny, lib. xxxi. cap. vii. He tells us that it was applied to a kind of fossil salt found below the sand, in a district of Cyrenaica, from which circumstance its name was derived. It was similar in appearance to the *alumen scissile*, had a disagreeable taste, but was useful in medicine. The general opinion is, that the sal-ammoniac of the ancients was the same as that of the moderns; but the imperfect description of Pliny is far from being sufficient to decide the point. The native sal-ammoniac of Bucharia, as described by Model and Karsten, and which was analyzed by Klaproth, has no resemblance to the salt described by Pliny. The same remark applies to the sal-ammoniac of volcanoes. Dioscorides, in mentioning sal-ammoniac (book v. chap. cxxvi.), makes use of a phrase quite irreconcilable with the description of Pliny, and rather applicable to rock-salt than to our sal-ammoniac. Sal-ammoniac, he says, is peculiarly prized if it can be easily split into rectangular fragments. Finally, we have no proof whatever that sal-ammoniac occurs at present, either near the temple of Jupiter Ammon, or in any part of Cyrenaica. These circumstances induce us to conclude that the term *sal-ammoniac* was applied as indefinitely by the ancients as most of their other chemical words. It may have been given to the same salt which is known to the moderns by that appellation, but was not confined to it.

The name *sal-ammoniac* is derived, according to some, from the temple of Jupiter Ammon, in the neighbourhood of which it was found; according to others, from a district of Cyrenaica called Ammonia; but according to Pliny, from the sand in which it occurred,—the Greek name for sand being *αμμος*.

But whether our sal-ammoniac was known to the ancients or not, there can be no doubt that it was well known to the alchemists. Albertus Magnus, in his treatise *De Alchymia*, informs us, that there were two kinds of sal-ammoniac, a natural and an artificial. The natural was sometimes white, and sometimes red; the artificial was more useful to the chemist. He does not tell us how it was prepared, but he describes the method of subliming it, which can leave no doubt that it was real sal-ammoniac. In the *Opera Mineralia* of Isaac Hollandus the father, addressed to his son, there is likewise a description of the mode of subliming sal-ammoniac. There can be no doubt, then, that true sal-ammoniac was known in the thirteenth century. Basil Valentine, in his *Currus Triumphalis Antimonii*, describes some of the peculiar properties of sal-ammoniac in a still less equivocal manner, if possible; but, after the two older writers already quoted, his evidence is unnecessary.

Sal-ammoniac occurs native in Bucharia, and probably in other parts of the world. It is found also in small quantities near volcanoes, being formed during the extraordinary convulsions of these mountains. This fact seems in corroboration of an opinion advanced by some mineralogists, that the principal fuel of volcanoes is pit-coal, and that they are always moistened with sea-water; for sal-ammoniac is sublimed in small quantities during the burning of London bricks, the sand of which is brought from the sea-shore, while the fuel is pit-coal.

Ammoniac. In the Latin, English, and French chemical books published in the seventeenth and the beginning of the eighteenth century, the name of this salt is usually written *sal-armoniac.* This we conceive to be an old German word; for Agricola has given us an alphabetical catalogue of all the Latin technical terms which he uses in his works, with a German translation of each. Now, the German translation which he gives of *sal-ammoniacus* is *sal-armoniac.* The present German name for this salt is *salmiak.*

Egypt is the country where sal-ammoniac was first manufactured, and from which Europe for many years was supplied with it. This commerce was first carried on by the Venetians, and afterwards by the Dutch. Nothing was known about the method employed by the Egyptians till the year 1719. In 1716 Geoffroy junior read a paper to the French academy, showing that sal-ammoniac must be formed by sublimation; but his opinion was opposed so violently by Homberg and Lemery, that the paper was not printed. In 1719 M. Lemaire, the French consul at Cairo, sent the academy an account of the mode of manufacturing sal-ammoniac in Egypt. The salt, it appeared, was obtained by simple sublimation from soot. In the year 1760 Linnæus communicated to the Royal Society a correct detail of the whole process, which he had received from Dr Hasselquist, who had travelled in that country as a naturalist. This account is published in the 51st volume of the *Philosophical Transactions*, 1760, p. 504. Almost the only fuel used in Egypt is the dung of cattle. This is collected during the first four months of the year, when the cattle feed on spring grass, which in Egypt is a kind of clover. It is dried, and sold to the common people as fuel. The soot from this fuel is carefully collected and sold to the sal-ammoniac makers, who only work during the months of March and April; for at other periods of the year the dung of their cattle is not fit for their purpose. An oblong oven is built of bricks and moist dung, as long again as broad, and of such a size that the outside or flat part of the top of the arch may hold fifty glass vessels, ten in length, and five in breadth, each vessel having a cavity left for it in the brick work of the arch. These glass vessels are globular, with a neck an inch long and two inches wide. In general they are about eighteen inches in diameter. Each vessel is coated over with a fine clay found in the Nile, and afterwards with straw. They are filled two thirds with soot, and put into their holes at the top of the oven. At first a gentle fire is raised, and the temperature is gradually increased to the highest degree, at which it is kept for three days. A smoke with a sourish smell, not unpleasant, issues first from the glasses, then the salt sublimes, and coats the upper part of the vessel.

It was long supposed that camels' urine and camels' dung were essential for the success of the above process; but this is a mistake. The dung of black-cattle, horses, sheep, goats, &c. are all used promiscuously. The dung of these animals contains the sal-ammoniac ready formed. This depends upon the food which the animals live on, and accordingly it is only fit for the purpose at one season of the year. The soot contains the sal-ammoniac likewise ready formed, and merely mixed with a quantity of charcoal, oil, &c. from which it is freed by sublimation. Chaptal informs us that he found sal-ammoniac in the soot obtained by burning the dung of cattle that had fed on the saline plants in the marshes near the Mediterranean. Thus the Egyptian method of obtaining sal-ammoniac is the simplest possible.

The first attempt to manufacture sal-ammoniac in Europe was made by a Mr Goodwin, a chemist of London, about the beginning of the eighteenth century. We do not know his process accurately; but he appears to have used the mother ley of common salt and putrid urine as ingredients. Dossie, in his *Institutes of Experimental Chemistry*, gives it as his opinion, that the salt obtained by this process was not sal-ammoniac, but sulphate of ammonia, and even describes a process for subliming that salt. But he must have been mistaken; for sulphate of ammonia, as appears from the experiments of Hatchett, is entirely decomposed when we attempt to sublime it. Goodwin's process, however, whatever it was, did not succeed, and was speedily abandoned. In the year 1740 a patent was taken out for making sal-ammoniac by a London manufacturer. The process was nearly the same as Goodwin's, and was equally unsuccessful. The first successful manufacture of sal-ammoniac in this country was established in Edinburgh by Dr Hutton and Mr Davy. We do not know in what year the manufactory was begun; but as the plan was concerted while these gentlemen were students at the university of Edinburgh, the establishment of the work cannot have been far from the year 1760. From the university of Edinburgh, Dr Hutton went to Paris. During his absence Mr Davy began the manufactory, and on his return admitted him as a partner. This original manufactory existed in Edinburgh till within these few years. The low price of sal-ammoniac during the war with Russia induced the proprietors to abandon it, as was the case with almost all the sal-ammoniac works in Britain.

Sal-ammoniac was first manufactured in France by Baumé, who established a work about the year 1760; but whether it was posterior or anterior to the work of Hutton and Davy, we do not know. Manufactories of it were afterwards established in Germany, Holland, and Flanders.

Various modes were followed in Europe to procure this salt. But the theory (if we can apply the term here) of most of the manufacturers was the same. They formed a sulphate of ammonia, which they mixed with common salt. A double decomposition took place. The sulphuric acid of the sulphate united with the soda of the common salt, and formed Glauber's salt, which was obtained in great abundance by crystallization, and sold as a medicine. The muriatic acid and ammonia, uniting together, formed sal-ammoniac, which was sublimed. When the British government imposed a heavy duty on Glauber salts, the manufacture of sal-ammoniac in this country received so severe a blow, that it is not likely ever to recover it. We shall give a short sketch of the processes followed in different manufactories, in order to afford a more distinct idea of the method of procuring this salt.

Before the French revolution, several manufactures of sal-ammoniac existed in Flanders, which deserve to be described; first, because they were in some measure an imitation of the original Egyptian method. Bricks, or rather balls, were formed of the following materials: twenty-five parts of pounded pit-coal, five parts of soot, two parts of clay, and as much of a saturated aqueous solution of common salt as was sufficient to convert the whole into a paste; this paste was moulded in an iron mould, and the balls suffered to dry. These were burnt in a brick furnace, along with a quantity of dry bones, the proportion of which does not appear to have been accurately determined. The furnace communicated by an aperture, two inches wide, into a vaulted brick chamber above. From the top of this chamber there was a communication, likewise two inches wide, with a horizontal gallery, which terminated in a perpendicular chimney. The fire was kept up with these materials for five or six months, and then allowed to go out. By the combustion of the pit-coals, soot, and bones, a quantity of carbonate of ammonia is formed. The common salt is decomposed by the clay, and muriatic acid disengaged. This acid coming in contact with the carbonate of ammonia, decomposes it, and sal-ammoniac is formed. The sides and roof of the vaulted chamber are found coated with this impure sal-ammoniac, which is carefully removed. The bottom of the chamber, and the horizontal gallery above, contain likewise sal-ammoniac, but so much loaded with bitumen, that it requires to be burnt a second time before the sal-ammoniac can be extracted. The impure sal-ammoniac is put into egg-shaped clay vessels, twenty inches long and sixteen in diameter. Each is filled to within three inches of the top. The lower part of these vessels is exposed to a graduated heat for forty-eight hours, while the upper part, being left in the air, is comparatively cool. The oily matter is first driven off, and then the sal-ammoniac is sublimed in a cake in the upper part of the vessel. The charcoal, and any other fixed matter present, remains at the bottom. Finally, the clay vessels are broken, and the cakes of sal-ammoniac taken out. There is a small hole in the upper part of the clay vessels, and care is taken to keep this hole open during the whole process, to prevent the vessels from bursting. Fifteen parts of the sooty matter taken from the vaulted chambers yield about five parts of sal-ammoniac. (*Journal des Mines*, No. X. p. 3.)

The original process of Baumé was to distil animal substances, in order to procure from them carbonate of ammonia. With this salt he decomposed the muriate of magnesia, which exists in considerable quantity in the mother ley of common salt, when that substance is procured from sea-water; the liquid containing the sal-ammoniac was evaporated, and the sal-ammoniac sublimed. This process was speedily abandoned, and another substituted in its place by MM. Leblanc and Dizé. They brought into contact, in a leaden chamber, vapours of ammonia and of muriatic acid. The ammonia was procured by distilling animal substances, and the muriatic acid by decomposing common salt by means of sulphuric acid. But this method, though it yielded a very pure sal-ammoniac, was speedily abandoned on account of its expense.

The process of Hutton and Davy was to procure ammonia, which they did chiefly from soot. This they converted into sulphate of ammonia. The sulphate was mixed with common salt, and thus two salts were procured; Glauber's salt, which they obtained by crystallization, and sal-ammoniac, which was sublimed.

Almost all the manufactures of sal-ammoniac, whether in Britain, France, or Germany, were similar in principle to that of Hutton and Davy. The only difference consisted in the means employed to procure the sulphate of ammonia. We shall describe a manufacture, formerly existing in London, in which the methods employed were both scientific and economical.

The material from which the ammonia was extracted was bones. These were collected in the streets and from dunghills, chiefly by old women. The bones were bruised and boiled, in order to extract the fat which they contained, which was sold to the soap-makers. They were then put into iron cylinders eight feet long and three feet in diameter, placed horizontally over a fire-place, so that they could be made red-hot. At one end of the cylinder was a mouth, about fourteen inches in diameter, by which the bones were introduced. This mouth was accurately shut by a cover, and made air-tight by means of lute. From the other end of the cylinder proceeded a cast-iron pipe, from six to eight inches in diameter, and twenty feet long, terminating in one or more oblong leaden receivers, which were kept cool by water placed in a leaden vessel, the bottom of which formed their cover, the juncture being secured by lute. Of these receivers there were commonly two to each still, or three to two stills. Every receiver was about twelve feet long, one foot deep, and fourteen inches wide; and the refrigeratory that covered it held about four inches in depth of water. At the end most remote from the still was a pipe, fitted with a wooden plug, for the purpose of drawing off the condensed liquor; and above this was a hole through which the gas and uncondensible vapour passed off into the open air.

A single charge of each still yielded about 36 pounds of impure alkaline liquor, and about 30 pounds of black fetid oil floating on its surface. This latter being skimmed off, the ammonia was saturated with sulphuric acid, either by means of the mother liquor from the green vitriol makers, or still more economically by means of calcined and pulverized gypsum. In this last case the materials were mixed, and left in contact for some hours. A double decomposition took place; the sulphuric acid of the gypsum uniting with the ammonia, while the carbonic acid of the carbonate combined with the lime of the gypsum. The solution of sulphate of ammonia thus produced was mixed with common salt, by which Glauber's salt and sal-ammoniac were formed, and separated from each other.

For this purpose the liquid, clarified by subsidence and decantation, was transferred into oblong leaden boilers, about nine feet long, three wide, and nine inches deep. Two thirds of the length of these boilers were set upon iron plates heated by a fire beneath; the remaining part was supported by flat tiles, and defended from the heat by a solid brick work. As the water evaporates, the Glauber's salt begins to crystallize. It is swept from time to time to the cool extremity of the boiler, whence it is shovelled into baskets placed over the end of the boiler, that the liquid which drains off may not be lost. The evaporation is continued till feathered crystals of sal-ammoniac begin to appear on the surface. The liquid is then run into coolers, and deposits little else than sal-ammoniac till the temperature sinks to 70°. The crystals must now be removed, that they may not be mixed with the Glauber's salt, which begins at that temperature to be deposited. The sal-ammoniac thus obtained is first drained in baskets, and then exposed to heat in a kind of oven, till the water of crystallization is driven off. It becomes spongy, friable, of an ash-colour, mixed with small white filaments.

This salt is introduced, while still hot, into globular grey earthen jars, fitted with a cover (with a hole of about half an inch diameter in its centre), luted on with a mixture of clay and horse-dung. These are set in earthen pots over a strong fire, in a furnace of either a circular or oval form, and capable of containing from six to eighteen, surrounded with sand up to the edge of the pot, and also having about $2\frac{1}{2}$ inches of sand on the cover, confined by an iron ring about three inches deep, and two inches less in diameter than the cover, in order that the luting, should it give way, may be repaired without suffering the covers to be cooled by the removal of the sand; for, during the sublimation, their temperature should be about 320°. These earthen vessels may be filled with the dried salt to within two inches of the top. It may be gently pressed in, but not rammed close. The fire, which has been lighted some time before, is now to be raised gradually till the iron pots are of a pretty strong red heat all

Ammonites. round. They are so placed in the furnace that the upper part is first heated, the bottoms resting on solid brick work. At first a quantity of aqueous vapour, carrying with it a portion of the salt, escapes through the hole in the cover. The hole must be left open as long as any moisture exhales. This is known by bringing a cold smooth iron plate near the hole, in order to condense the sublimate. When the water is gone, the salt attaches itself to this plate in the form of a dry semi-transparent crust. The hole is now to be stopped up with lute, and more sand put upon the cover. The heat is to be kept up till it is judged that most of the sal-ammoniac, but not the whole, has sublimed. The time requisite for this, depending on the furnace, can only be learned by experience. If the heat be continued too long, the cake of sal-ammoniac acquires a yellow colour, and a scorched, opaque, crackled appearance, which, injuring its saleability, ought to be avoided. When the lute gives way, and requires repairing during the process, the appearance of the cake of sal-ammoniac is injured. On this account glass vessels would be preferable to those of clay. But in this country the expense of glass is so great, on account of the high duty laid upon it, that manufacturers are scarcely able to use it in those cases where the vessels must be broken at the end of every process, as is the case in the sublimation of sal-ammoniac. (Aikin's *Dictionary of Chemistry*, article Sal-Ammoniac.)

One process more deserves to be mentioned, on account of its ingenuity and simplicity. It was the invention of Mr Astley, who secured the exclusive privilege by a patent, and had a manufactory at Borrowstowness on the Frith of Forth, and another at Portobello, near Edinburgh. He mixed together animal matters (chiefly woollen rags) with what in Scotland is called *spirit of salt.* It is the mother ley that remains after all the crystals of common salt that can be got have been separated from seawater. It consists chiefly of muriate of magnesia. This mixture was burnt in furnaces, and the produce received in small chambers placed over the furnaces. This produce contained abundance of sal-ammoniac, which was obtained pure by sublimation. We conceive the theory of this process to be, that carbonate of ammonia is formed by the combustion of the animal matter. This carbonate immediately decomposes the muriate of magnesia, and sal-ammoniac sublimes. In principle, therefore, it does not differ from Baumé's original process, though in point of economy it is probably greatly superior to it. We have little doubt that Baumé's method yields a greater return from the same quantity of materials; but this is probably much more than counterbalanced by the much greater expense attending his process. Nothing can demonstrate this more clearly than the circumstance that his method was abandoned in France as too expensive, though labour be much cheaper in that country than in this, while Mr Astley manufactured his sal-ammoniac with profit in the neighbourhood of Edinburgh. (T. T.)

AMMONITES, a fossil genus of spiral chambered shell, containing numerous species approaching nearest to the living nautilus.—See Von Buch, *Ann. de Sciences Nat.;* Sowerby's *Conchology;* D'Orbigny, *Palæont. Franc.*

AMMONITES, the descendants of the younger son of Lot (Gen. xix. 38). They originally occupied a tract of country east of the Amorites, and separated from the Moabites by the river Arnon. It was previously in the possession of a gigantic race called Zamzummins (Deut. ii. 20). The Israelites, on reaching the borders of the Promised Land, were commanded not to molest the children of Ammon, for the sake of their progenitor Lot. Nevertheless, frequent wars were carried on between Israel and the Ammonites up to the time of Judas Maccabæus (B.C. 164), who fought many battles with the Ammonites, and took Jazer, with the towns belonging to it. Justin Martyr affirms that in his time the Ammonites were numerous (*Dial. cum Tryph.* § 119). Origen speaks of their country under the general denomination of Arabia. Josephus says that the Moabites and Ammonites were inhabitants of Cœle-Syria (*Antiq.* i. 11, § 5).

Ammonitis — Ammonius.

Their national idol was Molech or Milcom, whose worship was introduced among the Israelites by the Ammonitish wives of Solomon (1 Kings xi. 5. 7).

AMMONITIS, in *Ancient Geography*, a country of Arabia Petræa, occupied by the children of Ammon, whence the appellation. It was a small district, situated among the upper branches of the river Jabbok, eastward of the Dead Sea.

AMMONIUS, surnamed SACCAS, from his having been in his youth a porter, was born in Alexandria about the end of the second century. He was one of the most celebrated philosophers of his age; and, adopting with alterations the Eclectic philosophy, laid the foundation of that sect which was distinguished by the name of the *New Platonists.*

This learned man was born of Christian parents, and educated in their religion, the outward profession of which, it is said, he never entirely deserted. As his genius was vast and comprehensive, so were his projects bold and singular: he attempted a general coalition of all sects, whether philosophical or religious, by framing a system of doctrines which he imagined calculated to unite them all, the Christians not excepted, in the most perfect harmony. In pursuance of this design, he maintained that the great principles of all philosophical and religious truth were to be found equally in all sects; that they differed from each other only in their method of expressing them, and in some opinions of little or no importance; and that, by a proper interpretation of their respective sentiments, they might easily be united into one body. Accordingly all the Gentile religions, and even the Christian, were to be illustrated and explained by the principles of this universal philosophy; and the fables of the poets and priests were to be removed from Paganism, and the comments and interpretations of the disciples of Jesus from Christianity. In conformity to this plan, he insisted that all the religious systems of all nations should be restored to their original purity, and reduced to their primitive standard, viz., the ancient philosophy of the east, preserved uncorrupted by Plato: and he affirmed that this project was agreeable to the intentions of Jesus Christ, whose sole view in descending upon earth was to set bounds to the reigning superstition, to remove the errors that had blended themselves with the religions of all nations, but not to abolish the ancient theology from which they were derived. He therefore adopted the doctrines which were received in Egypt concerning the universe and the Deity, considered as constituting one great whole; concerning the eternity of the world, the nature of souls, the empire of Providence, and the government of the world by dæmons. He also established a system of moral discipline, which allowed the people in general to live according to the laws of their country and the dictates of nature, but required the wise to exalt their minds by contemplation, and to mortify the body, so that they might be capable of enjoying the presence and assistance of the dæmons, and of ascending after death to the presence of the Supreme Parent. In order to reconcile the popular religion, and particularly the Christian, with this new system, he made the whole history of the heathen gods an allegory; maintaining that they were only celestial ministers, entitled to an inferior kind of worship. He acknowledged also that Jesus Christ was an excellent man, and the friend of God; but alleged that it was not his design entirely to abolish the worship of dæmons, and that his only intention was to purify the ancient religion. This system, so plausible in its first rise, but so comprehensive and complying in its progress, has been the source of innumerable errors and corruptions in the Christian church. At its first establishment it received some countenance from Athenagoras, Pantænus, and Clemens the Alexandrian, and all who had the care of the public school belonging to the Christians at Alexandria. It was afterwards adopted with various degrees of assent by Longinus, the celebrated author of the treatise on the Sublime, Plotinus, Herennius, Origen, Porphyry, Iamblichus the disciple of Porphyry, Sopater, Edisius, Eustathius, Maximus of Ephesus, Priscus, Chrysanthius the master of Julian, Julian the Apostate, Hierocles, Proclus, and many others, both Pagans and Christians. Ammonius opened his school A.D. 193, and died A.D. 243.

His opinions may be gathered from the writings and disputations of his disciples. The only work of his now extant is a *Diatessaron*, or Harmony of the Gospels, which is preserved in the Latin version of Victor, bishop of Capua (who wrongly ascribed it to Tatian), and of Luscinius.

AMMUNITION, a general name for all warlike provisions, but more particularly powder, ball, &c.

AMNESTY, in matters of policy, denotes a pardon granted by a prince to his rebellious subjects, usually with some exceptions: such was that granted by Charles II. at his restoration. The word is formed from the Greek ἀμνηστία, the name of an edict of this kind published by Thrasybulus, on his expulsion of the tyrants out of Athens. An amnesty marks the pre-existence of revolution or rebellion, and those countries are happiest where it is least known. Many amnesties have been granted in France and other parts of Europe during the past half century, but since the Jacobite insurrections none has been deemed necessary in Britain. The latest act of amnesty is the 20th Geo. II. c. 52, "An Act for the King's most gracious general and free pardon." A similar act was passed after the rebellion of 1715. In both instances, however, punishments had been extensively inflicted before the passing of the amnesty, and acts of forfeiture were passed against those persons conspicuous in the insurrections who could not be apprehended and brought to trial. The old treason law of England contained a general principle of amnesty honourable to the humanity of its authors, exempting from punishment those charged with treason against a king *de jure*, unless he were king *de facto*. This was pleaded by Sir Harry Vane when he was brought to trial at the Restoration; but the plea was met by the discreditable quibble that Charles II. was king not only *de jure* but *de facto* from the time of his father's death, though he was "kept out of the exercise of his royal authority by traitors and rebels."

AMNIOS, or AMNION, a thin pellucid membrane, which surrounds the fœtus in the womb. See ANATOMY.

AMOEBÆUM, in *Ancient Poetry*, a kind of poem representing a dispute between two persons, who are made to answer each other alternately: such are the third and seventh of Virgil's Eclogues.

AMOL, or AMUL, a city of Persia, in the province of Masenderan, on the Heras, about 12 miles above its entrance into the Caspian, and over which there is a bridge of 12 arches. The population in winter is about 40,000, but a great number of these are shepherds, who leave the city in summer to tend their flocks. Here is a magnificent mausoleum erected by Shah Abbas to a former sovereign; and in its vicinity are many mounds and Persian remains.

AMOMUM, an aromatic genus of plants, natives of hot climates, especially the East Indies. See BOTANY.

AMON, or AMUN, or AMMON, the name of an Egyptian god, in whom the classical writers unanimously recognise their own Zeus and Jupiter. The primitive seat of his worship appears to have been at Meroë, from which it descended to Thebes, and thence, according to Herodotus (ii. 54), was transmitted to the oasis of Siwah and to Dodona; in all which places there were celebrated oracles of this god. His chief temple and oracle in Egypt, however, were at Thebes, a city peculiarly consecrated to him, and which is probably meant by the No and No Amon of the prophets. He is generally represented on Egyptian monuments by the seated figure of a man with a ram's head, or by that of an entire ram, and of a blue colour. In honour of him, the inhabitants of the Thebaid abstained from the flesh of sheep, but they annually sacrificed a ram to him and dressed his image in the hide. A religious reason for that ceremony is assigned by Herodotus (ii. 42); but Diodorus (iii. 72) ascribes his wearing horns to a more trivial cause.

As for the power which was worshipped under the form of Amon, Macrobius asserts (*Saturnal.* i. 21) that the Libyans adored the setting sun under that of their Ammon; but he points to the connection between the ram's horns of the god and Aries in the zodiac.

The etymology of the name is obscure. Eustathius says that, according to some, the word means *shepherd*. Jablonski proposed an etymology by which it would signify *producing light;* and Champollion, in his latest interpretation, assigned it the sense of *hidden*. There is little doubt that the pointed Hebrew text correctly represents the Egyptian name of the god, and, besides what may be gathered from the forms of the name in the classical writers, Kosegarten argues that the enchorial Amn was pronounced Amon, because names in which it forms a part are so written in Greek, as Ἀμονρασόνθηρ. Moreover, Ἀμῶν and Ἀμοῦν are found in Iamblichus and Plutarch; and the latter expressly says that the Greeks changed the native name into Ἄμμων.

AMON, fourteenth king of Judah, reigned two years, and was assassinated B.C. 642.

AMONEBURG, a small town of Hesse-Cassel, on the river Ohm, 8 miles east of Marburg. Pop. 1200.

AMONTONS, GUILLAUME, a celebrated French experimental philosopher, was the son of an advocate who had left his native province of Normandy, and established himself at Paris, where the subject of this memoir was born in 1663. The exertions of genius frequently take a particular direction from accidental circumstances. A severe illness with which Amontons was afflicted in his early youth, had the effect of rendering him almost entirely deaf, and consequently of secluding him in a great measure from the ordinary commerce and amusements of society. Being compelled by this accident to depend for his enjoyments on the resources of his own mind, he began to take great pleasure in the construction of machines of various kinds, and in the study of the laws of mechanics; a path of inquiry which he pursued through life with unremitting ardour and distinguished success. One of the first objects which engaged his attention was the discovery of the perpetual motion; an attempt which, though necessarily unsuccessful, was productive of greater advantage to him than it has usually been to those who have pursued that vain chimera.

Amontons directed his views in a particular manner to the improvement of instruments employed in physical experiments; a subject which requires the finest applications of mechanical principles, and which till that time had not met with a due share of attention. In 1687, before he had attained his 24th year, he presented to the Academy of Sciences an hygrometer of his own invention, which was received with approbation by that learned body. In 1695 he published the only work which he has given to the world. It was dedicated to the academy, and entitled *Remarques et*

*Expériences Physiques sur la Construction d'un Nouvel Clepsydre sur les Baromètres, les Thermomètres, et les Hygromètres.* After Huygens' beautiful application of the pendulum to the regulation of the motion of clocks, any attempt to revive the clepsydra, an incommodious instrument, and not susceptible of much accuracy, might seem to subject its author to the imputation of not sufficiently appreciating the great importance of a discovery which has so completely changed the face of astronomical science; but the object of Amontons was to produce an instrument capable of measuring time on board ship, in circumstances where the motion of the vessel rendered such timekeepers as were then known useless. The machine which he constructed is said to have been extremely ingenious, and probably differed entirely from those of the ancients, among whom the clepsydra was in common use.

In 1689 Amontons was admitted into the Academy of Sciences, the memoirs of which he enriched with many important contributions. The first paper which he presented after his admission was one on the theory of *Friction*, a subject then involved in great obscurity, and on which his inquiries tended to throw considerable light. After that appeared, in succession, an account of a New Thermometer, and of numerous Experiments made with the Barometer, relative to the nature and properties of Air,—a detailed account of all which is given in the history of the academy. By his countrymen he is generally regarded as the inventor of the telegraph; and he had the honour of exhibiting the methods by which he proposed to accomplish the object in view, before some members of the royal family. It appears, however, from a paper read by Dr Hooke to the Royal Society in 1684, that that ingenious philosopher had brought the telegraph, in theory at least, to a state of far greater maturity than Amontons, and nearly 20 years earlier. The experiments of the latter were made about the year 1702. It may be regarded as a curious fact in the history of inventions, that although the great importance of telegraphic communication is obvious, and the method of accomplishing it was clearly explained by Hooke, and its practicability demonstrated by Amontons, it continued to be regarded as a mere *jeu d'esprit*, and was not regularly applied to useful purposes till nearly a century afterwards, at the time of the French Revolution. Amontons died in 1705, aged 42.

AMORBACH, a city of the kingdom of Bavaria, in the circle of Lower Franconia, 24 miles south of Aschaffenburg. It is situated at the junction of the rivers Mudau and Bill, and has a castle, the residence of the princes of Leiningen, and once a very rich Benedictine abbey, two churches, a chapel, an almshouse, and manufactures of cloth, paper, &c. Pop. 2900.

AMORGO, an island in the Archipelago, south-east of Naxos, in Lat. 36. 48. N. Long. 26. 0. E. It is about 36 miles in circumference, and has a small town of the same name, with an excellent harbour, Port Anna, on its north-east coast. It is mountainous, and produces wine, oil, wheat, barley, &c. Pop. 3000. The poet Simonides was born here.

AMORITES, the descendants of one of the sons of Canaan, the most powerful and distinguished of the Canaanitish nations. We find them first noticed in Gen. xiv. 7, "the Amorites that dwelt in Hazezon-tamar," afterwards called Engedi, a city in the wilderness of Judea not far from the Dead Sea. In the promise to Abraham (Gen. xv. 21), the Amorites are specified as one of the nations whose country would be given to his posterity. When the Israelites were about to enter the Promised Land, the Amorites occupied a tract on both sides of the Jordan. They were under two kings—Sihon king of Heshbon, and Og king of Bashan, who "dwelt at Ashtaroth" (Deut. i. 4). Before hostilities commenced messengers were sent to Sihon, requesting permission to pass through his land; but Sihon refused, and came to Jahaz and fought with Israel; and Israel smote him with the edge of the sword, &c. (Num. xxi. 24). Og also gave battle to the Israelites at Edrei, and was totally defeated. Still, after repeated severe defeats, the Amorites, by means of their war-chariots and cavalry, confined the Danites to the hills, and would not suffer them to settle in the plains: they even succeeded in retaining possession of some of the mountainous parts. "The Amorites *would* dwell in Mount Heres in Aijalon, and in Shaalbim, yet the hand of the house of Joseph prevailed, so that they became tributaries. And the coast of the Amorites was from *the going up to Akrabbim* (*the steep of Scorpions*), from the rock and upwards" (Judges i. 34–36).



AMORPHOUS (α, priv., and μόρφη, form), a term of frequent use in physical science, to denote the absence of determinate form.

AMORTIZATION, in *Law*, the alienation of lands or tenements to a corporation or fraternity and their successors. See MORTMAIN.

AMOS, one of the twelve minor prophets, and a contemporary of Isaiah and Hosea. He was a native of Tekoah, about six miles south of Bethlehem, inhabited chiefly by shepherds, to which class he belonged, being also a dresser of sycamore-trees. The period during which he filled the prophetic office was of short duration, unless we suppose that he uttered other predictions which are not recorded. It is stated expressly that he prophesied in the days of Uzziah, king of Judah, and in the days of Jeroboam, the son of Joash, king of Israel, two years before the earthquake (Amos i. 1). As Jeroboam died in the fifteenth year of Uzziah's reign, this earthquake, to which there is an allusion in Zechariah (xiv. 5), could not have happened later than the seventeenth year of Uzziah: and as Uzziah and Jeroboam were contemporaries for about fourteen years, from B.C. 798 to 784, the latter of these dates will mark the period when Amos prophesied.

The allusions in the writings of this prophet are numerous and varied; they refer to natural objects, to historical events, to agricultural or pastoral employments and occurrences, and to national institutions and customs.

Some peculiar expressions occur; such as "cleanness of teeth," a parallelism to "want of bread," iv. 6.; and in the orthography there are a few peculiarities.

The canonicity of the Book of Amos is amply supported both by Jewish and Christian authorities. Philo, Josephus, and the Talmud include it among the minor prophets. It is also in the catalogues of Melito, Jerome, and the sixtieth canon of the Council of Laodicea. Justin Martyr, in his *Dialogue with Trypho* (§ 22), quotes a considerable part of the fifth and sixth chapters. There are two quotations from it in the New Testament: the first (v. 25, 26) by the proto-martyr Stephen, Acts vii. 42; the second (ix. 11) by the apostle James, Acts xv. 16.

AMOUR, GUILLAUME DE ST, a canon of Beauvais in the thirteenth century, who distinguished himself greatly by his defence of the privileges of the university of Paris against ecclesiastical encroachments.

AMOUR, or AMUR, a great river of Chinese Tartary, which has its rise in the central deserts of northern Asia, among the mountains of Daouria, in about Long. 109. E. and Lat. 49. N. It has a winding course; flowing first in a northerly direction; and afterwards making a long detour towards the east; then turning to the north, it falls into the sea of Okhotsk, in about Lat. 53. N., opposite to the middle of the island or peninsula of Saghalien. This river is called Amur by the Russians, after the confluence of the Argun and the Schilka; and still higher up the Schilka is formed by the union of the Onon and Ingoda. It is called Schilka by the Tungoose; Saghalien Oula, or Black Mountain River, by the Tartars; and Ghelon Kiangh, or the Dragon River, by the Chinese. It was first known to the Russians in 1639; and they resolved to annex to their empire the territory through which it flows, on account of the valuable furs with which it was known to abound. Many sanguinary conflicts accordingly took place between them and the Chinese, which ended in a treaty in 1689, by which the Russians abandoned their settlement on its banks, from which they were wholly excluded until the year 1847, when the navigation of this river was by treaty again opened to them. The river, which pours out an immense body of water, is navigable for large vessels as far as the Russian town of Nertschink, 1500 miles from the sea, though its stream is rapid, and it is annually frozen for some time. The length of its course is upwards of 2200 miles.

AMOY, a commercial city and seaport of China, in the province of Fokien, on a small island of the same name, in Lat. 24. 10. N. and Long. 118. 13. E. The city is neither clean nor well built, but it has many public buildings and shops. It is commanded by a citadel on a height, with fortifications. Amoy was captured by the British in 1841; and is one of the five Chinese ports opened up to British commerce by the treaty of 1842. Its harbour is deep, commodious, and safe, so that vessels on entering do not require the assistance of pilots. The traffic of Amoy is very considerable: in 1847, 117 vessels entered its harbour, with an aggregate burden of 16,494 tons; and the value of its imports, by British ships, during the same year was L.179,758, by foreign vessels L.75,976; of its exports in British vessels L.7139, in foreign vessels L.8568. Its principal exports are crockery-ware, umbrellas, tea, sugar, sugar-candy, paper, tobacco, camphor, and grass-cloth. Population in 1847, 250,000.

AMPERE, Andre Marie, professor of mathematical analysis in the Polytechnic School of Paris, and one of the most distinguished philosophers of this century, was born at Lyons in 1775. Among his numerous publications, on various branches of knowledge, he is best known by his Electro-Magnetico-Dynamic papers, which were afterwards embodied in two volumes entitled *Recueil des Observations Electro-Dynamiques*, Paris, 1824–26. His mechanical invention is there exhibited in the various beautiful contrivances by which he demonstrated the force and direction of electro-magnetic currents, and his sagacity by the philosophical spirit with which he explained the phenomena. His speculations *On the Application of the Calculus of Variations to Mechanical Problems*, as well as his first publication in 1820, *Considerations on the Mathematical Theory of Games of Chance*, are specimens of refined and profound speculation. He also showed an early interest in the Chemical Theory of Definite Proportions. In 1824 he published a remarkable paper *On the Surface-curve of Luminous Waves;* and about 1830, a good *Essay on the Philosophy of the Sciences.* Besides these larger works, he was the author of several papers in *Le Journal de l'Ecole Polytechnique*, and in *Memoires de l'Institut.*, on mechanical philosophy and natural history. Ampere died at Paris in 1836, at the age of 61. (T. S. T.)

AMPHIARAUS, in *Pagan Mythology*, a celebrated prophet, who possessed part of the kingdom of Argos. He was believed to excel in divining by dreams, and is said to have been the first who divined by fire. Amphiaraus, knowing by the spirit of prophecy that he should lose his life in the war against Thebes, hid himself in order to avoid engaging in that expedition; but his wife Eriphyle, being prevailed upon by a present, discovered the place in which he had concealed himself, so that he was obliged to accompany the other princes who marched against Thebes. This proved fatal to him; for the earth being split asunder by a thunderbolt, both he and his chariot were swallowed up in the opening. Amphiaraus, after his death, was ranked among the gods; temples were dedicated to him; and his oracle became very famous, as well as the sports instituted in his honour.



AMPHIBIA, a term in *Zoology* bestowed on different groups of animals, and with a considerable variety of signification. When rigorously interpreted, it applies to very few animals, as, with rare exceptions, naturalists know of no species which are strictly amphibious; that is to say, possessed of the power of performing the vital act of respiration either in air or water. When intended, however, merely to express the habit of existing alternately for a time in either of these elements, the term *amphibious* applies to various groups, which have little in common with each other. Hence the artificial mode of arrangement adopted by Gesner and the older naturalists, who, taking into consideration chiefly the habitations of animals, bestowed the name of amphibia on beavers, otters, frogs, and other incongruous genera. Linnæus applied the name, in his earlier works, to a class composed of reptiles and chondropterygious fishes; but he afterwards restricted it to reptiles alone possessed of cold red blood and a simple circulation. The amphibia of Baron Cuvier, again, are such of the mammalia or mammiferous quadrupeds as are enabled by their motive organs to dwell in water as well as on the land; for example, seals, sea lions, the walrus, &c. In his system they occupy an intermediate station between the feline and marsupial or pouched animals. They pass the greater portion of their time at sea, and seldom come ashore except to suckle their young, or dry their moistened furs by exposure to sun and air. Their power of sustaining without injury a long-continued submersion does not, however, result from a continuance of the *foramen ovale*, by which it was supposed that the blood of these creatures passed from one chamber of the heart to another, without the necessity of being propelled through the lungs. Seals do not differ in that respect from other animals.

Buffon was of opinion that the newly born young of all mammiferous quadrupeds might be submerged in a nourishing fluid without depriving them of life, because their circulation at that early period was supposed to resemble that of amphibious reptiles. Experiments, however, on this subject would no doubt have accorded perfectly with those of Le Gallois, instituted with a view to ascertain the possibility of dividing the spinal marrow without the production of death. It is singular that Daubenton, his skilful and laborious coadjutor, did not remind Buffon that the fœtus, while suspended in the liquid of the amnios, receives oxygenated blood from the mother, whilst after birth a necessity ensues for the vital act of respiration being performed by the individual itself. It is also known that the *foramen ovale* does not exist at the period of birth, except in such species as are destined to enjoy a continuance of that peculiarity of structure; from which we may infer that a primordial disposition of organs is of greater importance, and less easily alterable, than many modern physiologists are accustomed to suppose.

The principal characteristic of reptiles in general consists in this, that only a portion of the blood is transmitted through the lungs, the remainder being projected by the heart directly to the other parts of the body, without being specially subjected to the influence of the respiratory organs; whereas in the higher classes, such as man, the rest of the mammalia, and birds, the whole of the blood must pass by the lungs before it is retransmitted to the more distant parts of the circulating system. The respiration of animals, or the process by which the blood is oxygenated, becomes weaker and less frequent in proportion to the diminution which takes place in the quantity of blood transmitted to the lungs, compared with that which passes directly from the heart; and as it is respiration which warms the blood, and produces in the fibres their susceptibility of nervous irritation, it follows, as observed by Cuvier, that the blood of reptiles is cold, and their muscular strength much less than that of birds or quadrupeds. The seat of their sensations is also much less centralised than in the last-named classes; and hence many of them exhibit life and motion long after their heads have been severed from their bodies.

A truly amphibious animal, according to the proper meaning of the term, ought to possess the power of breathing under water like a fish, and of respiring the atmospheric air like a land animal. According to this interpretation, neither seals nor beavers, nor even whales, are truly amphibious; for they cannot sustain their existence under water except by aid of a certain portion of air which they have inspired at the surface. In like manner, neither the frog nor the tadpole is amphibious (unless it may be for a short time at a certain intermediate period of life); for the former only seeks the water as a place of temporary resort, in which, however, it cannot breathe; and the latter is entirely aquatic, being unprovided with lungs, and consequently unable to respire, except through the medium of water. A frog can therefore only be said to be amphibious in as far as it possesses, at two distinct periods of its life, the faculty of living first in the water and then on the land; but its habit of life is by no means optional, and the change of structure, both in the respiratory and digestive system, as it passes from the immature to the adult state, is among the most extraordinary in the whole range of the animal economy. Born with gills, and destitute of external members, its form and functions are rather those of a fish than of a reptile; but as it advances in growth, the four limbs become developed, the tail decreases and finally disappears, the jaws are formed, the gills are absorbed, and their uses are supplied by lungs. It can no longer breathe under water.

Among the many wonderful anomalies with which the kingdom of nature presents us, there exist, however, certain truly amphibious animals, classed under the genera of *Proteus* and *Siren*, both of which are provided at one and the same time with the gills of a fish and the lungs of a terrestrial creature; but their habits and propensities are decidedly aquatic. The former inhabit the subterranean waters of Carniola; the latter (of which there are several species) occur among the marshes and rice-fields of South Carolina. For an account of these singular animals see the article REPTILIA. (J. W.)

AMPHIBOLE and AMPHIBOLITE, augite and hornblende. See MINERALOGY.

AMPHIBOLOGY, in *Grammar* and *Rhetoric*, a term used to denote a phrase susceptible of two different interpretations. Amphibology arises from the order of the phrase, rather than from the ambiguous meaning of a word. Of this kind was that answer which Pyrrhus received from the oracle: *Aio te, Æacida, Romanos vincere posse;* where the amphibology consists in this, that the words *te* and *Romanos* may either of them precede, or either of them follow the words *posse vincere*, indifferently.

AMPHIBRACHYS, in *Greek* and *Latin Poetry*, the name of a foot consisting of three syllables, whereof that in the middle is long and the other two short; such are the words ăbīrĕ, ămārĕ.

AMPHICOME, in *Natural History*, a kind of figured stone, of a round shape, but rugged, and beset with eminences, celebrated on account of its use in divination. The word is originally Greek, αμφικομη, *q. d. utrinque comata*, or hairy on all sides. This stone is also called *Erotylus*, Ερωτυλος, *Amatoria*, probably on account of its supposed power of creating love. The amphicome is mentioned by Democritus and Pliny.



AMPHICTYONY, in *Greek Antiquity*, was an association of several tribes for the purpose of insuring the observation of the law of nations towards one another, and of protecting the temple of the deity whose worship formed the outward bond of union among the several tribes. It is acknowledged on all hands, and admitted by the ancients themselves, that the name is formed from ἀμφί and κτίζω, or rather κτίω, whence its meaning is "the dwellers around" (a common centre). According to this etymology, the name ought to be spelt *Amphictiony;* but in deference to the ancient legend, which connects the institution with the mythical hero Amphictyon, the spelling *Amphictyony* still prevails; although there were Greek amphictyonies with which that hero neither had, nor could have had, any connection whatever. There is positive evidence that several associations of this kind existed in Greece at a very early period; and they are of special interest to the philosophic historian, because they are the first symptoms of civilisation and humanity, and do great honour to the age in which they originated; but what that age was, and what the circumstances were which occasioned the formation of such confederacies, are questions concerning which we have no historical information. Tradition, indeed, connects the institution with the Attic king Amphictyon; but it was in all probability not formed till after the period of the Doric migration, when the affairs of Greece became gradually settled.

The most important of these confederations was the *Amphictyony of Delphi, or Thermopylæ.* It has been supposed that this was a confederation of the Hellenes against the Pelasgians; but this opinion is sufficiently refuted by the fact, that among its members we find both Hellenes and Pelasgians. The names of the twelve tribes forming this Amphictyonic league are not the same in all authorities. Harpocration, with whom Libanius and Suidas on the whole agree, mentions the Ionians, Dorians, Perrhæbians, Bœotians, Magnetes, Achæans, Phthians, Malians, Dolopians, Ænianians, Delphians, and Phocians. Æschines has no more than eleven, and instead of the Achæans, Ænianians, Delphians, and Dolopians, he only gives the Thessalians, Œteans, and Locrians; while lastly, Pausanias's list contains only ten names, viz., the Ionians, Dolopians, Thessalians, Ænianians, Magnetes, Malians, Phthians, Dorians, Phocians, and Locrians. The differences in these lists have been accounted for by the assumption that they refer to different times, but we have no evidence of any members of the confederacy having ever dropped off before the sacred war, after which the Phocians were excluded for a short time. Hence we have to supply two tribes for the list of Pausanias, and one for that of Æschines; for it must be observed that the number twelve was unalterably fixed. The tribe wanting in Æschines are the Dolopians, and those which must be added to the list of Pausanias are the Perrhæbians and Bœotians. The Œteans, mentioned by Æschines alone, are the same as the Ænianians whom he omits, and who dwelt around Mount Œta. The Achæans and Phthians, moreover, are the same, and should have been recorded as the Phthian Achæans. The Delphians also did not at first form members of the league, but rose to that rank only in later times, and instead of these two names the Thessalians and Locrians have to be entered in the list of Harpocration. Hence the Delphic Amphictyony consisted of the Ionians, Dolopians, Thessalians, Ænianians (Œteans), Magnetes, Malians, Phthian Achæans, Dorians, Phocians (including the Delphians), Locrians, Bœotians, and Perrhæbians, who were Pelasgians. All these nations dwelt, in the earliest times, in and about Thessaly, while afterwards we find them more scattered over different parts of Greece; and this circumstance alone shows, that the formation of the league must belong to a very early period.

All the twelve members of this confederacy, though some were very insignificant, and were even treated by others as subjects, had equal rights at the meetings, and the vote of the smallest tribe was as weighty as that of the most powerful. The objects of the league are distinctly expressed in the oath which the Amphictyons had to take, and which is preserved in Æschines' oration 'De Falsa Legatione.' This oath bound the Amphictyons not to destroy any of the Amphictyonic towns, not to turn away its running waters either in time of war or in time of peace; and if any one should attempt to rob the temple of Delphi (the common centre of the confederacy), to employ their hands, feet, tongue, and their whole power, to bring him to punishment. The humanising influence which this and other enactments of the confederacy were intended to exercise, is perceptible in the part relating to war. The framer of the law evidently regarded war only as an unavoidable means of settling disputes between two states; but it was to be carried on only for the purpose of bringing the dispute to a decision, and not for destruction and devastation. Another enactment probably was that the inhabitants of a conquered city should not be sold as slaves. But the chief care of the Amphictyons appears to have been to watch over the temple, to punish those who were guilty of a crime against it, and to reward those who did anything to increase its splendour and glory. In later times the political influence of the league generally lay dormant, until it was exercised by some powerful state or individual for selfish purposes.

The Amphictyons had regularly two meetings every year in the spring at Delphi, and in the autumn at Anthela, near the pass of Thermopylæ. At Delphi the deputies met in the temple of Apollo, and at Anthela in that of Demeter. This circumstance of the two places of meeting, and of the two divinities with which the Amphictyony was connected, renders it highly probable that, in the form in which we know it, it was a union of originally two distinct Amphictyonies, each of which had its own religious centre. The deputies of the several states who met at these places are called *Pylagoræ* (Πυλαγόροι, or αι), and *Hieromnemones* (Ἱερομνήμονες). The difference between these two classes of deputies has been the subject of much discussion among the learned; but if we admit that our Amphictyony was a union of two, the Pylagoræ were probably the deputies sent to Thermopylæ, and the Hieromnemones those sent to Delphi, the former, after the union, taking precedence at the meetings at Thermopylæ, and the latter at those of Delphi. The deputies sent to these annual meetings were appointed by lot in their respective states; and each state had two votes. The meetings, however, were attended not only by the deputies but by thousands of others who flocked to Delphi or Thermopylæ for religious and mercantile purposes, or only for the sake of amusement. This occasioned popular meetings (ἐκκλησίαι) distinct from those of the regular deputies. But we cannot suppose that all the Greeks indiscriminately were allowed to take part in those popular assemblies, which must have consisted of visitors from the states which were members of the Amphictyony.

The constitution of the confederacy and the number of its members remained, as far as we know, unaltered until the time of the sacred war; after the termination of which, in B.C. 346, the Phocians were excluded from the league. The same was the fate of the Lacedæmonians, who had supported the Phocians. The vacancy was filled up by the admission of the Macedonians to the league. The Phocians, however, were afterwards restored to their position, because they had distinguished themselves by their valour during the invasion of the Gauls under Brennus. At the time of the Ætolian ascendency in Greece, the Ætolians appear to have usurped the power of the Amphictyons. Strabo speaks of the Amphictyons as broken up in his own time; and although their name occurs even at a much later time, yet they cannot have exercised any influence on the affairs of Greece. The whole institution died away into the same obscurity in which its origin is buried.

Amphictyony.

Wise and humane as were the objects of the Amphictyons, yet, wherever they actively interfered in the affairs of Greece during the historical period, we find that they were more powerful for evil than for good; and the holy wars which were carried on by them in the defence of the Delphic temple, and the honour of its god, contributed not a little to the demoralisation of the Greeks.

The very first time that the Amphictyons interfered in the affairs of Greece, we find them acting in direct opposition to the spirit of their institution. We allude to the Crissæan or first sacred war, which broke out in B.C. 594 and lasted till B.C. 585. The inhabitants of Crissa (or Cirrha) on the Corinthian Gulf, were charged with extortion and violence towards the strangers who landed at their port, or passed through their territory on their way to Delphi. For this the Amphictyons declared war against Crissa, and it was vigorously carried on, in the name of the league, by the Thessalians and Cleisthenes, the tyrant of Sicyon. They even pretended to have the sanction of Apollo to dedicate the Crissæans and their territory to the god, to enslave them, and make their land a waste for ever. The war is said to have been terminated by a stratagem of Solon, who poisoned the waters of the river Pleistos, from which the town was supplied. When the town was taken, the vow of the Amphictyons was literally carried into effect: Crissa was razed to the ground, its harbour choked up, and its fertile plain changed into a wilderness. Such was the terrible vengeance taken by a body of confederates, whose original object was to prevent those very things which they now perpetrated to uphold the honour of the deity presiding over them. The second sacred war, which likewise lasted for ten years, from B.C. 355 to 346, was carried on with unparalleled exasperation for a period of ten years, and nearly all the Greeks took part in it. The Thebans had set their hearts upon conquering Phocis, but screened their designs behind a charge preferred against the Locrians, alleging that they had robbed the temple of Delphi, because they had taken into cultivation a tract of land belonging to the Delphic temple. The Amphictyonic council, before which the charge was brought, condemned the Phocians to pay a heavy fine, and to destroy the crops of the sacred fields. No sooner was this verdict pronounced than the Thebans, Thessalians, Locrians, and Œteans took up arms to execute it. The Phocians were joined by Athens and Sparta, and took possession of the temple of Delphi and its treasures, which they were obliged to employ in defraying the expenses of the war. The war was carried on with unexampled cruelty; for even the surrender of the dead for burial was refused, and all Phocian captives were put to death. This war also afforded Philip of Macedonia an opportunity to interfere in the affairs of Greece, being invited by the Thessalians to co-operate with them against the Phocians. Philip and his Macedonians acted as the champions of the god, and defeated the Phocians in a bloody battle near Magnesia. Three thousand captive Phocians were put to death. The latter, however, remained undaunted until at length they were compelled by treachery to surrender. The Amphictyons now excluded them for ever from the league, their arms and horses were to be delivered up, their towns to be destroyed, and the people were henceforth to live in small villages, and to pay annually to the god sixty talents (about L.15,000) until the temple should be completely indemnified. Macedonian and Theban troops carried the judgment into execution: twenty-two towns disappeared from the face of the earth, and the otherwise fertile country remained for many years a wilderness. A third sacred war was decreed against the town of Amphissa, because its inhabitants had taken into cultivation the plain of Crissa; but in reality the war was brought about by the venal creatures who endeavoured to promote the ambitious schemes of Philip of Macedonia, who was bent upon making himself master of Greece. This war broke out in B.C. 338, and its unfortunate consequences led to the catastrophe which deprived Greece of her independence in the battle of Chæronea. Such is a brief outline of the history of the Delphic Amphictyony, which not only itself violated its first principles, but is not known to have ever raised its voice to condemn the wanton destruction of other Amphictyonic towns, such as Platææ and Thebes.

Other confederations of a similar kind were,—

1. The *Amphictyony of Calaurea*, connected with the temple of Poseidon, in the island of Calaurea. This Amphictyony consisted of the towns of Hermione, Epidaurus, Ægina, Athens, Prasiæ, Nauplia, and the Minyan Orchomenos. Sparta and Argos became members of it at a late period, after having contrived to get Nauplia and Prasiæ excluded. This circumstance shows that this confederation was in all probability formed before the Doric migration.

2. *Amphictyony of Onchestos*, in the territory of Haliartus in Bœotia, was likewise connected with the temple of Poseidon. As at all other Amphictyonies, the meetings of the members were celebrated with various religious rites, solemnities, and public games. We do not know the nations that constituted this league.

3. *Amphictyony of Amarynthos*, in Eubœa, connected with the temple of Artemis. We know that the two towns of Eretria and Chalcis were members of it, and that there existed an ancient treaty, by which these two cities pledged themselves not to use against each other any missiles thrown from afar. The meetings were celebrated with splendid festivals.

4. *Amphictyony of Delos*, connected with the temple of Apollo, was a league formed among the inhabitants of the Cyclades and the Ionians in the neighbourhood. Its institution was ascribed to Theseus. The solemnities connected with its meetings gradually fell into disuse, until they were revived and increased in B.C. 426, when the island of Delos was purified by the Athenians. The Athenians, after this time, regularly sent an annual embassy to Delos, and they also retained for themselves the superintendence of the temple and the administration of its treasures. (L.S.)

AMPHIDRYON, in *Ecclesiastical Writers*, denotes the veil or curtain which was drawn before the door of the *bema* in ancient churches.

AMPHILA, a wide bay in the Red Sea, encumbered with thirteen small uninhabited islets. Lat. 14. 30. N. Long. 41. E.

AMPHILOCHIA, in *Ancient Geography*, was a small district at the eastern end of the Ambracian Gulf. Its chief town was Argos, surnamed *Amphilochicum*, to distinguish it from the greater Argos.

AMPHILOCHIUS, bishop of Iconium in the fourth century, was the friend of St Gregory Nazianzen and St Basil. He assisted at the first general council of Constantinople in 381, presided at the council of Sidæ, and was a strenuous opposer of the Arians. He died in 394. His works were published in Greek and Latin at Paris, in 1644, by Francis Combefis.

AMPHILOCHUS, son of Amphiaraus and Eriphyle, was believed to have been a celebrated diviner. He had an altar erected to him at Athens, and an oracle at Mallos in Cilicia, which city was said to have been founded by him and Mopsus. The answers of this oracle were given by dreams; and the party inquiring used to pass a night in the temple, that night's dream being the answer.



AMPHIMACER, in *Ancient Poetry*, a foot consisting of three syllables, whereof the first and the last are long, and that in the middle short: such is the word cāstĭtās.

AMPHION, in *Greek Mythology*, the son of Zeus by Antiope, and the husband of Niobe, was a famous musician of antiquity, at the magical sounds of whose lyre the stones began to move, and formed themselves into walls around Thebes, after his conquest of that city. He was killed by Apollo for assaulting his temple; or, as some report, he destroyed himself in despair at the slaughter of his children by that god. See NIOBE.

AMPHIORCIA, or AMPHOMOSIA, in *Grecian Antiquity*, the oath taken in court by the plaintiff and the defendant, that they would speak the truth. The judges also took this oath, that they would administer the laws with impartiality.

AMPHIPOLIS, an Athenian colony, built on the site of the Thracian city Ἐννέα Ὁδοί, *the nine ways*, 497 years B.C. It was on the east bank of the river Strymon, near its origin from the lake Cercinitis. Its importance arose from its site on a navigable river, and its vicinity to the gold mines of *Mons Pangæus*. It is now Jeni Keni.

AMPHIPROSTYLES, in the architecture of the ancients, a temple which had columns in the front, and as many in the aspect behind, but none on the sides. See ARCHITECTURE.

AMPHISCII, among *Geographers*, a name applied to the people who inhabit the torrid zone. The Amphiscii, as the word imports, have their shadows one part of the year towards the north, and the other towards the south, according to the sun's place in the ecliptic. They are also called *Ascii*.

AMPHISSA, in *Ancient Geography*, the chief town of the Locri Ozolæ, about seven miles west of Delphi. The modern town of Salona occupies its site.

AMPHITHEATRE, in *Ancient Architecture*, a building of an elliptic form, of two or more stories of open arcades, with a number of interior galleries and arched passages, which served both as a communication and support to several rows of seats which rose above each other, and were arranged round a large space called the *arena*. The derivation of the word *ampitheatre* indicates that it is a place where the spectators, circuitously arranged, saw the performance equally well on all sides.

The history of amphitheatres is of considerable importance, in consequence of its connection with ancient manners. These structures owed their origin to the barbarity of the ancients, and their ruin to the humanity of the moderns. They are the production of Roman invention in the last ages of the republic. The Romans were immoderately fond of every amusement of a bloody and horrible nature. Their rulers encouraged this general feature in the Roman character, to rouse and foster that martial spirit which rendered them masters of the world. After the Samnite wars had extended the Roman sceptre over the whole peninsula of Italy, the first gladiatorial conflicts were exhibited in Rome in the year B.C. 260. Lucius Metellus brought into the circus the elephants which were part of the spoil of the Carthaginians, in the year 252, and this proved the introduction of wild beasts into the spectacles of Rome. This addition was equally agreeable to the Roman taste; and those who courted the popular favour vied with each other in entertaining the people in this barbarous manner. This soon gave birth to a profession of men denominated *gladiators*, who were trained to the combat, and for reward slaughtered one another in the arena, whilst every savage animal which the wilds of Asia or Africa produced added to the horrors of the scene.

In the days of Pompey and Cæsar these barbarous amusements were given with an astonishing profusion. In the games given by Pompey, the elephants attempted to break down the barrier between them and the people: this circumstance, and the form of the circus not enabling all the spectators to have a full view, induced Cæsar to alter the original form, and construct edifices where the people might be entertained without danger or interruption. Amphitheatres were suited to this purpose; they were therefore adopted, and became the common place for the exhibitions both of gladiators and wild beasts.

It is supposed that the first amphitheatre was composed of those singular machines, formed by Caius Curio, for the games which he presented among the funeral honours of his father. Caius constructed, in a semicircular form, two contiguous wooden theatres, moveable on wheels, first placed back to back; and the people having been amused in these the one-half of the day, they were then wheeled round, forming one spacious theatre, where the gladiators contended during the remainder of the day. Pliny is the only writer who makes mention of this amphitheatre; and from his account it is difficult to ascertain whether this was the first idea of an amphitheatre, or whether the previous sight of one had suggested this huge and wonderful structure. It is said that Julius Cæsar, a few years after, formed a hunting theatre of wood; and, in consequence of the circular position of the seats, it obtained the name of an *amphitheatre*. This appears to have been of a very superior kind, and in great estimation.

In the reign of Augustus, Statilius Taurus erected one of stone, but it seems to have been seldom used; and, from its being consumed by fire in the time of Nero, it is evident that it was not wholly of stone. These wooden buildings appear to have been generally temporary, but a few of them permanent, from the endowment bestowed upon them. The politic spirit of Augustus induced him to erect several of these; and Caligula began one, which he left unfinished. Nero formed a large and spacious one, the building of which is said to have occupied a year. Herod of Judæa erected amphitheatres both in Jerusalem and in Cæsarea. During the reign of Tiberius, one was built at Fidenæ, which Tacitus informs us fell while the games were performing, killing or injuring about 50,000 persons. There was another at Placentia, reported to have been the most spacious in Italy; but it was destroyed by fire in the contest between Vitellius and Otho.

The unfortunate accidents which happened to these wooden buildings led to the construction of others of a more strong and durable nature, where the crowd might be entertained without danger. This honour was reserved to Vespasian and Titus. In his eighth consulate the former began the amphitheatre, which the latter finished during his reign. It is said that the expense of this building would have erected a metropolis, and it is deservedly esteemed one of the most celebrated edifices of ancient times. Dio says that 9000 wild beasts were destroyed at the dedication of this huge building, but Eutropius restricts their number to 5000. After the hunting of these ferocious animals was ended, the arena was instantly filled with water, and sea animals were made to contend, and a sea-fight exhibited. This immense building obtained the appellation of the *Coliseum* or *Colosseum*.

This amphitheatre became the model of other amphitheatres throughout the empire. Compared with the original model, these were natural valleys, with seats formed in the surrounding heights similar to the amphitheatre at Corinth. On the declivity of two hills seats of stones were sometimes placed, and the extremes formed by regular works of stone. Of this kind was that of Gortyna in Candia. One in the vicinity of Sandwich in Kent had its benches formed of turf; and similar must have been those amphitheatres which were formed along with the camps and military stations of the Roman soldiers.

Amphitheatre.

When Christianity became the religion of the empire, it ameliorated the dispositions of the Romans, and induced them to lay aside this barbarous custom. Constantine the Great terminated the gladiatorial combats in the East during his reign; but they were not finally abolished at Rome until the beginning of the fifth century, in the reign of Honorius. The combats of wild beasts continued, however, some time longer; but during the progress of the fifth century these gradually declined, until they were finally abolished, and the amphitheatres were abandoned to the ravages of time and accident. During the middle ages they were sometimes employed for judicial conflicts, tilts, and tournaments; but these practices having been discontinued, the amphitheatres experienced universal neglect and ruin.

It is scarcely possible to give a clear idea of the manner in which such immense crowds of people were seated and arranged, and how they had a convenient entrance and exit. It has already been mentioned, that these buildings were circuitous, and that the exterior circuit was composed of two or more stories of arcades; and it may now be added, that the number of these stories varied according to the nature of the building. A corresponding number of arched passages and staircases opened upon the ground floor towards these stories, in the direction of radii towards the arena. These communications were again intersected by arched passages, which encircled the whole structure, and afforded an uninterrupted entrance to every part of the amphitheatre. Sometimes an intermediate gallery surrounded the whole in the centre of the fabric, and served as a common place of resort to all the stairs which led to the higher galleries. This was the form of one at Nismes. Sometimes each staircase had its distinct communication by itself. Such was the case with one at Verona.

The four radiating entries on the diameter were usually more capacious; and by the two principal of these the emperor, the senate, and other persons of distinction, were conducted to their seats on a place which was called the *podium*. The other two led to the arena, and by these the gladiators and beasts made their entrance. The various ranks of the people passed by the staircases, which led to their respective seats. The doors which opened from the staircases were called *vomitories*, and varied in magnitude, according to the extent of the amphitheatre and the number of exterior arches. The number of seats between the several vomitories was unequal, and seems to have been subject to no positive regulation. These benches were about one foot and eight inches in height, and about two feet four inches in breadth. A platform four feet eight inches broad was formed of one of these benches, which served as a circular communication to the whole building. These obtained the name of *precinctions*, and the boundaries on the side were called *belts*. The latter were surrounded by balustrades, to protect the persons from falling who occupied the benches in the vicinity. The podium was more spacious than the precinctions, and was a platform encircling the arena. From one precinction to the belt of another, a flight of stairs two feet six inches in breadth descended opposite to every vomitory. Small canals were cut in the tops of the benches, by which the rain and urine were conducted from bench to bench, until they reached the instruments prepared to convey them to the drains below. These stairs radiated from the highest

Amphitheatre.

bench to the podium; so that, with the precinctions, they separated the whole cavity into wedge-like divisions (*cunei*), which the people occupied according to their rank.

The amphitheatre called the *Coliseum* was of an elliptical form, whose longest diameter was about 581 Italian feet, and the shortest 481. The length of the diameter of the arena was about 285 feet, and the breadth 182, reserving a space for the seats and galleries of about 157 feet in breadth. The external circumference inclosed a superficies of above five acres and a half, and could scarcely be included in a parallelogram of seven acres. Three stories of arcades, adorned with columns of the Doric, Ionic, and Corinthian orders, and inclosed with a pilastrade of the Corinthian order, composed the external elevation. The first story rose about four feet from the ground, and the pavement supported the bases of the columns. The columns which supported the upper stories were placed upon pedestals. A stylobate supported the pilastrade, in which were the windows of an intermediate gallery, and in every second interpilaster was a window to illuminate the highest gallery. A cantaliver cornice, perforated with square holes, through which the erect pieces of wood passed that supported the awning to a range of corbels, about the centre of the pilastrade, crowned the building. These various columns, pilasters, and stories, appear to have been continued without interruption around the whole edifice. The height of the first story was about 30 feet, the second 38, and the third 38; the pilastrade about 44; and the whole, includiug the blocking course and the steps, was 157 feet in height. The external circumference of the whole building is 1641 Italian feet.—See *Marchese Guispe Melchiorri.*

An ellipsis of 80 open arches formed the exterior circuit of the ground plan; the piers, with three-quarter columns in front, of about 2 feet 10 inches diameter. The four which correspond to the four above-mentioned semi-diameters, were about 14 feet 2 inches, and 76 of the arches were about 13 feet 8 inches. These arches led to a large double corridor, that encircled the whole: this corridor is a magnificent and distinguishing feature in the Coliseum theatre. Square openings in the precinction above illuminated the interior corridor; and the corridor which was united with the wall of the podium appears to have been illuminated in a similar manner. A double corridor was seen on the floor of the second story, directly above the corridor of the lower floor, and an interior corridor which sent forth stairs leading to a range of vomitories on the one hand, and on the other hand an intermediate corridor which formed a mezzanine floor above the double corridor of the interior circuit. Here the stairs began to ascend to the next story, and square holes in the upper floor illuminated this gallery. A double corridor formed the third story, and it appears that here the stairs commenced that led to the galleries above. There were also some windows in the interior wall, and vomitories which opened to the uppermost cunei of benches. In a similar manner were other three stories constructed and filled above; the whole composing a most magnificent and spacious structure.

Justus Lipsius supposes that this amphitheatre was capable of containing 87,000 spectators on the benches; and Fontana adds 22,000 for the galleries and other passages. Upon a fair calculation it appears, that if fully crowded, it might contain about 80,000. This magnificent structure astonishes by its vast size, and the adaptation of its various parts to the intended use. When this amphitheatre was in its glory, and crowded with Romans, the sight must have been magnificent and striking. If the report be accurate that it was completed in two years and nine months, it affords an astonishing instance of Roman vigour and persevering industry. Besides former depredations, Michael Angelo removed nearly one-half of the external wall to build the Palazzo Farnese. To prevent these depredations, Pope Benedict XIV. consecrated these ruins, and erected several altars, which were much frequented on the Sundays and Fridays, before the revolution in France. To guard these relics, a hermit was stationed in a small dwelling near the centre.

Amphitrite ‖ Amphitryon.

Amusements.

The different kinds of amusement have already been cursorily alluded to. Gladiators contended together, or entered the lists with wild beasts. These wild animals were hunted or encountered, or left to devour each other, according to the humour of the times, or the taste of him who gave the entertainment. It appears also, that criminals were sometimes forced to fight with these ferocious creatures, for the entertainment of the people of Rome; and, in the dawn of Christianity, many of the Christians suffered death in this brutal manner. It is also reported, that artificial mountains were sometimes constructed with caves below, from whence these devouring animals rushed forth to attack their prey.

Information concerning the laws that regulated the amphitheatre is rather scanty; but the following are among the number. In the centre of one side of the podium was the emperor's seat, called the *suggestum*, and highly adorned. The remainder of the podium was occupied by senators; and when this space was not sufficient, several of the adjacent wedges were appropriated to the other senators and to persons of distinction. The equites, and the civil and military tribunes, had their places next assigned them. From this order both the liberti and the legati were excluded. The married men sat by themselves. The young men were also arranged by themselves, and their tutors sat near them to observe their conduct. The attendants and servants occupied the highest gallery. The vestals had special seats, and frequently the princesses and ladies of distinguished rank sat along with them. The front of the gallery was assigned to the women, who were placed on chairs; and the lowest order of the people stood behind them. It appears, also, that for the better accommodation of the people, the different tribes had particular cunei allotted to them. It is also proper to remark, that the arrangement in the different provinces was different from that of Rome, as circumstances varied. The general direction of the amphitheatre was under the care of an officer, named *villicus amphitheatri;* and different officers, who were called *locarii*, had the direction of the cunei. By carefully preventing any person from occupying a place to which he was not entitled, all confusion was prevented, and strict order maintained.

The means used by Pope Benedict to preserve the Coliseum at Rome have already been mentioned. Of one which was erected at Verona, only four arches of the external circuit remain. These consist of three stories of about 90 English feet. The building otherwise is almost entire. The whole building was erected without cement, and joined and secured by iron cramps, overlaid with lead. The superficies is about four acres and nearly one-third. One erected at Nismes has suffered much dilapidation; but the remains are yet worthy of the attention of the traveller. At Pola in Istria, there are the remains of an amphitheatre built on the declivity of a hill. It was erected of stone, with cramps of iron. The amphitheatre of Italica, 4 miles from Seville in Spain, is much ruined. The walls are immensely thick, and contain within them an arched passage 16 feet wide, into which the *vomitoria* opened. The diameter measures 300 feet by 195 feet.

AMPHITRITE (Αμφιτρίτη), in the *Greek Mythology*, the wife of Poseidon, and goddess of the sea; sometimes taken for the sea itself.

AMPHITRYON, son of Alcæus, and the father of Hercules, less known by his own exploits than from his wife Alcmena's adventure.

AMPHIUMA, a genus of Reptilia, found in North America. See REPTILES.

AMPHORA, in *Antiquity*, a liquid measure among the Greeks and Romans. The Roman amphora contained 48 sectari, equal to very nearly six gallons, and the Grecian or Attic amphora contained one third more.

AMPMHORA, a large vessel used by the ancients for preserving wine, oil, fruits, &c., and so called from its usually having an ear or handle on each side of the neck, whencc it was also called *diota*. It was commonly made of earthenware, but sometimes of stone, glass, or even more costly materials; its usual form was tall and narrow, diminishing below to a point. Homer and Sophocles mention amphoræ used as cinerary urns; and a discovery made in 1825 at Salona shows that they were sometimes used as coffins. The amphora was divided lengthwise to receive the corpse, then closed and deposited in the earth, thus preserving the skeletons entirc.—(Steinbüchel, *Alterthum*, p. 67.) The wicker baskets used in gathering the vintage were also called amphoræ.

AMPHORARIUM VINUM, in *Antiquity*, denotes that which is drawn or poured into *amphoræ* or pitchers; by way of distinction from *vinum doliare*, or cask wine. The Romans had a method of keeping wine in *amphoræ* for many years to ripen, by fastening the lids tight down with pitch or gypsum, and placing them either in a situation within reach of smoke, or under ground.

AMPHOTIDES, in *Antiquity*, a kind of armour or covering for the ears, worn by the ancient pugiles, to prevent their adversaries from laying hold of that part.

AMPLIATION, in a general sense, denotes the act of enlarging or extending the compass of a thing. On a medal of the emperor Antoninus Pius, we find the title *Ampliator Civium* given him, on account of his having extended the *jus civitatis*, or right of citizenship, to many states and people before excluded from that privilege. Indeed, it is generally supposed that this prince made the famous constitution whereby all the subjects of the empire were made citizens of Rome.

AMPLIATION, in *Roman Antiquity*, was the deferring to pass sentence in ccrtain causes. This the judge did by pronouncing the word *amplius;* or by writing the letters N. L. for *non liquet;* thereby signifying that, as the cause was not clear, it would be necessary to bring further evidence.

AMPLITUDE, in *Astronomy*, an arch of the horizon intercepted between the east or west point and the centre of the sun or a planet at its rising or setting; and which therefore is said to be either north and south, or *ortive* and *occasive.*

*Magnetical* AMPLITUDE, the different rising or setting of the sun from the east or west points of the compass. It is found by observing the sun, at his rising and setting, by an amplitude compass.

AMPSANCTI VALLIS, or AMSANCTI LACUS, a valley with a small sulphurous lake and cavern in the heart of the Hirpini, or Principato Ultra, about four miles from the town of Frigento (Ciccro, Pliny). It is now called *Moffeta* or *Mufiti*, from the goddess Mephitis, who had a temple there. The ancient poets imagined that this gulf led to hell. (Virg., *Æneid* vii. 563.) The Moffeta is thus described by Mr Swinburne: "We were led into a narrow valley, extending a considerable way to the south-west, and pressed in on both sides by high ridges thickly covered with copses of oak. The bottom of the dell is bare and arid: in the lowest part, and close under one of the hills, is an oval pond of muddy ash-coloured watcr, not above fifty feet in diameter; it boils up in several places with great force in irregular fits, which are always preceded by a hissing sound. The water was several times spouted up as high as our heads in a diagonal direction; a whirlpool being formed round the tube, like a basin, to receive it as it fell. A large body of vapour is continually thrown out with a loud rumbling noise. The stones on the rising ground that hang over the pool are quite yellow, being stained with the fumes of sulphur and sal-ammoniac. A most nauseous smell, rising with the steam, obliged us to watch the wind, and keep clear of it, to avoid suffocation. The water is quite insipid, both as to taste and smell; the clay at the edge is white, and carried into Puglia to rub upon scabby sheep, on which account thc lake is farmed out at 100 ducats a year. On a hill above this lake stood formerly a temple dedicatcd to the goddess Mephitis; but I perceived no remains of it."



AMPTHILL, a market town in the hundred of Redbourne Stoke, in the county of Bcdford. It is pleasantly situated in a valley between two gentle elevations. It is neatly built; has a free school, an alms-house for twelve persons, a new market-house, a bank, and an extensive brewery. In Ampthill Park, the fine domain of Lord Holland, a little westward of the town, a cross was erected in 1774, in memory of Catherine of Aragon, queen of Henry VIII. who resided there. Population in 1851, 1961. Market-day, Thursday.

AMPULLA, in *Antiquity*, a vessel of glass or earthenware bellying out like a jug, small-mouthed, and frequently covered with leather, used to contain unguents for the bath, perfumes, or any liquid. In reference to thc swollen shape of the ampulla, Horace applies the word to inflated language or bombast.

AMPULLA, among *Ecclesiastical Writers*, denotes one of the sacred vessels used at the altars. Ampullæ were also used for holding the oil used in chrismation, consecration, coronation, &c. Among the ornaments of churches we find frequent mention made of ampuls or vials.

*Knights of St* AMPULLA belong to an order instituted by Clovis I., king of France. At the coronation they bear up the canopy under which the ampulla is carried in procession.

AMPULLARIA, a Lamarckian genus of freshwater univalves. See CONCHOLOGY.

AMPURIAS, the capital of the territory of Ampurdan, in Catalonia, seated at the mouth of the river Llobregat, in Long. 2. 56. E. Lat. 42. 5. N.

AMPYX, or AMPYCTER (in Latin *Frontale*), a broad band or plate of gold worn upon the forehead in ancient times by Grecian ladies of rank, and sometimes enriched with precious stones. It was also used to adorn the heads of horses and elephants.

AMRAPHEL, the king of Shinar or Babylonia, confederated with Chedorlaomer, king of the Elamites, and two other kings, to make war against the kings of Sodom, Gomorrah, and the threc neighbouring cities. See Genesis xiv.

AMRIAL-CAIS, the most celebrated of the ancient Arabian poets, and a contemporary of Mahomet, whom he satirized. He was poisoned while attempting to avenge the death of his father, who had been murdered by his tribe. His poem was published at Leyden in 1748; and a translation of it by Sir William Jones appeared in 1782.

AMRITSIR in Northern India, a city in the British province of the Punjaub, situated within the Division of Lahore, and at an equal distance from the rivers Beas and Ravee. It is a populous and cxtensive place, having a circumference of eight miles; and though the streets are narrow, the houses are lofty and substantially built of brick. Its opulence, which is considerable, is not thc result of its manufactures, which, with the exception of fine shawls made in imitation of the Cashmere fabric, are confined to coarse cloths and inferior silks, but has been derived partly from an extensive transit trade carried on between Cashmere, Hindustan, and Central Asia, and partly from its reputation for sanctity, which has caused it to become a favourite resort for pilgrims. It is not impossible, however, that its trade may shortly be diverted to Shikarpore, Sukkur, and other towns on the Indus, where periodical commercial fairs, upon a large scale, have been recently established under the authority of the British Government. The remaining source of the prosperity of Amritsir is a reservoir or sacred basin constructed in the year 1581 by Ram Das, the fourth Guru or Spiritual Guide of the Seiks, immersion in which is supposed to purify from all sin. The reservoir is about 135 paces square, built of brick, in the centre of which stands a temple dedicated to Guru Govind Singh, in which is lodged under a silken canopy the book of laws written by this saint. From 500 to 600 priests are supported by the pious contributions of the devotees. Provision is made for an ample supply of water to the town by means of the Baree Doab Canal, now in course of execution. This canal issues from the Ravee above the town of Dinanuggur, and traversing the country in a south-westerly direction, rejoins the parent stream some distance above its junction with the Chenab. The total length of the canal and its branches is 450 miles, and its cost has been computed at L.527,000. A striking object in Amritsir is the fortress of Govindghur, built by Runjeet Sing in 1809. Measures have been recently resorted to by the British for adding to its security, and it is now a place of great strength. Distance east from Lahore 37 miles. Lat. 31. 40. N. Long. 74. 45. E. (E. T.)

AMRU-EBN-AL-AS, or Amer, one of the most famous of the first race of Saracen leaders, was descended of Aasi, of the tribe of Koreish, by a woman of infamous character. In his youth he indulged in poetry, and wrote satirical verses against the person and doctrine of Mahomet. His zeal in opposing the new religion prompted him to undertake an embassy to the king of Ethiopia, to stimulate him against the converts whom he had taken under his protection. It is uncertain by what arguments he was induced to change his religious sentiments; but he returned a convert to the Mahometan faith, and, along with Khaled, joined the fugitive prophet at Medina. The military talents of Amru had begun to attract general attention, when Abubeker resolved to make a new attack upon Syria, in which he obtained a high command. After several displays of his military valour and address in some successful enterprises, he rose to the elevated station of chief in Irak, when Khaled requested the attendance of all the Arabian generals before Damascus. During the caliphate of Omar he also served in Palestine, under Abu-Obeidah. While besieging Cæsarea, he held a memorable conference with Constantine, the son of the emperor Heraclius. Historians mention that their time was chiefly occupied in producing genealogical arguments to prove the affinity of the Greeks and Arabians, and the consequent rights of the latter as their descendants.

After the death of Obeidah, Amru assumed the chief command in Syria, in which he was confirmed by the khaliff, notwithstanding the opposition of Othman. An expedition against Egypt having been resolved upon, Amru wrote to the khaliff, informing him that he would instantly march into that country. During the progress of his march, attended by only 4000 Arabs, a messenger from Omar arrived with a letter, containing directions to return, if he should receive this letter in the territories of Syria; but if he should receive it in those of Egypt, he might advance, and all needful assistance would be instantly sent to him. Anticipating the contents, he hastened on to the frontiers of Egypt, and read the instructions of the khaliff. Then requesting some of the inhabitants to be brought before him, and inquiring of them in what country they were, and being informed that they were in Egypt, Amru replied, "Let us, then, continue our march." Having taken Pharma, he advanced to Misrah, the ancient Memphis, and besieged it for seven months. Although numerous reinforcements arrived, he would have found it very difficult to storm the place previous to the inundation of the Nile, if Mokawkas had not treacherously lessened the forces of the citadel, which was consequently taken by storm; and the Greeks who remained there were either made prisoners or put to the sword. On the same spot Amru erected a city named Fostat, the ruins of which are now known by the name of Old Cairo. The Coptic Christians, who composed the great majority of the Egyptian natives, and who were enemies to the Catholic Greeks, after this victory submitted to Amru, and engaged to provide quarters and support for the Mussulman army.



Amru pursued the Greeks to Alexandria, and, after an obstinate and bloody siege of 14 months, the city was taken A.D. 640. To Amru has generally been attributed the burning of the famous *Alexandrian Library*, by command of the khaliff Omar. But with this act of barbarism, so repugnant to the character of Omar and his general, he is for the first time charged by Abulpharagius, a Christian writer, who lived six centuries later. It is highly probable that few of the 700,000 volumes collected by the Ptolemies remained at the time of the Arab conquest, when we consider the various calamities of Alexandria from the time of Cæsar to those of Caracalla, Diocletian, and the disgraceful pillage of the library in A.D. 389 under the rule of a Christian bishop, Theophilus, a far less respectable character than the Arabian conquerors.—See Gibbon, *Decline and Fall of the Roman Empire*, c. 51.

In the year 663, of the Hegira 43, Amru died in his government of Egypt, highly esteemed, and much regretted by his countrymen. In a pathetic oration to his children on his death-bed, he bitterly lamented his youthful offence in satirizing the prophet, although Mahomet had forgiven the offence, and had frequently affirmed that "there was no Mussulman more sincere and steadfast in the faith than Amru."

AMRUM, an island of Denmark, in the German Ocean, between latitude 54. 38. and 54. 43. It contains about 15 square miles, with 600 inhabitants. It is in the barony of Westerlandfohr and Amrum, and the diocese of Ribe.

AMSDORFIANS, in *Ecclesiastical History*, a sect of Protestants in the 16th century, who took their name from Amsdorf, their leader. They maintained that good works were not only unprofitable, but were obstacles to salvation.

AMSTERDAM, or Amsteldamme, a great maritime and commercial city of Holland, capital of the canton and province of North Holland, standing in N. Lat. 52. 22. and in E. Long. 4. 53. It derives its name from the river Amstel, on the banks of which it is built, somewhat in the form of a half-moon or crescent, with the horns projecting into the river Y, an arm of the Zuyder Zee; while on the other sides it is surrounded by meadows, gardens, and country-houses.

Founded about the year 1203, Amsterdam, at the close of that century, was little more than a fishing village—its great advancement having taken place in the sixteenth century, when the persecutions of the Spaniards under the Duke of Alva drove great numbers of Flemish merchants and manufacturers to seek protection in Holland and in England; after which period it increased rapidly in wealth and importance, and during the succeeding century, and the first half of the eighteenth, maintained its pre-eminence as the metropolis of the commercial world. This city is said to be

Amsterdam.

8 miles in circumference, covering an area of 900 acres, and to contain upwards of 28,000 houses. It is surrounded by a deep fosse or canal 80 feet wide, and was regularly fortified in the fifteenth century; but the only remains of its defences are some picturesque *tetes de pont* on the Amstel, &c., and 26 bastions, each of which now supports a windmill for grinding corn. Its site having been originally a salt-marsh, all the buildings are supported on piles; whence Erasmus likened the inhabitants to storks, building on the tops of trees. These piles are from 50 to 60 feet in length; and after passing through a mixture of peat and sand of little consistence, at the depth of about 40 feet they enter a bed of firm clay, which forms a good foundation. When driven to the requisite depth, their ends are sawed level, and sometimes covered with thick planks, on which the masonry is constructed. Though many of the houses have declined from the perpendicular, they were considered to be quite secure against falling; yet that they are not altogether exempted from such a contingency was shown in 1822, by the sinking and total ruin of a large stack of warehouses heavily filled with corn. The streets in the oldest parts of the town are narrow and irregular, but the houses frequently present a picturesque sky-line, broken by fantastic gables, roofs, chimneys, towers, and turrets, of all forms and dimensions. Westward of the Amstel, which passes almost through the centre of the city, stands the more modern part, where the houses are often exceedingly handsome, the streets broad, and planted with rows of large trees between the houses and the canals. Three great canals, viz., Prinsen Gracht, Kieser's Gracht, Heeren Gracht, and a smaller one, Singel, extend in the form of polygonal crescents, nearly parallel to each other, and to the great fosse or canal that surrounds the city. Each of the three first mentioned has a length of about two miles, and the Kieser's Gracht is about 140 feet wide. Numerous smaller canals intersect the city, dividing it into 95 islets, and are traversed by no fewer than 290 bridges. All heavy burthens are transported by water. The grand bridge over the Amstel is 610 feet long, 65 in width, and supported on 36 piers, between 11 of which large vessels pass when the bridges are open. Near to this is the Amstel-sluice, by which the waters are confined and let off at pleasure. Besides the basins within the city, it has five large docks. Enclosed by the Oosterlijk Dok, is the Ryk's Maritime Dok, and the islet of Kattenburg, on which stand the arsenal, the admiralty offices, and the warehouses of the Dutch East and West India Companies. The principal shops are in the Kalver straat, the Nieuwe dyk, and Warmoes straat, and may vie with the richest of Paris or London. The chief promenade is the Plantaje or Park, near to which lie the Botanic and Zoological Gardens; and the old ramparts are now converted into boulevards. Of the public buildings, the principal is the palace, formerly the Stadhuis, an imposing structure built in 1648 by the architect Van Kampen, at the cost of 30,000,000 guelders, or L.864,200. It is supported on 13,659 piles, is 282 feet in length, 235 in breadth, and 116 feet in height, exclusive of a cupola 41 feet high. It was built for the public offices of the legislature, but was appropriated by Louis Napoleon for a palace in 1808. The great hall or council-chamber of the Republic is now a ballroom, one of the most magnificent in Europe, measuring 120 feet by 57, and 90 in height: the walls are encrusted with white Italian marble to the lofty cornice which divides the upper tier of windows from the square *mezzanine* or upper row of lights, and some good emblematic sculptures are placed over the doors of the principal apartments. In front of the palace stands the Beurs or exchange, a fine tetraprostyle Ionic building, serving as the front to a large quadrangle with a handsome peristyle of the same order. The Oude Kerk with its fine stained windows, its splendid organ, and its tombs, is an interesting object. It is 300 feet long, has three aisles, and a steeple 240 feet in height. The Nieuwe Kerk, which was commenced in 1408, is remarkable for its finely carved pulpit, and the elaborate bronze castings of the choir, the magnificent monument to the famous admiral De Ruiter, with numerous others; and a cenotaph to the memory of the gallant Van Speyk, who in the year 1831 blew up his ship and perished, rather than yield to the Belgic enemies of Holland.

Amsterdam in 1850 contained 224,235 inhabitants, of whom about 23,000 were Jews, who reside in a particular quarter of the city. There are about fifty places of public worship, viz. fifteen of the Reformed religion, sixteen Catholic, fifteen Jansenist, three Lutheran, two Anabaptist, one Moravian, one Scottish Presbyterian, one English Episcopal, one Greek, one Armenian, and four Jewish Synagogues. The charitable institutions, which are supported chiefly by voluntary contributions, amount to twenty-three, and are admirably adapted to their several ends. These include hospitals for the sick, the aged and infirm, the blind, the deaf and dumb, the insane, widows, orphans and foundlings, and an establishment for the reformation of drunkards; besides a noble institution for promoting the education and improvement of the poor, which has branches in every town in Holland. The beneficial results are very apparent; beggars and drunken people are rarely to be seen in the streets. Among the public institutions may be noticed the Spinhuis, for the punishment of delinquents; and the Rasphuis, at present used merely as a temporary arrest-house.

Notwithstanding the humidity of the atmosphere, and the deficiency of spring water, Amsterdam is healthy, and the people are robust; which must be ascribed very much to that great attention to cleanliness for which they are proverbially noted above any other nation; the only exception being in the Jews' quarter, which is dingy and dirty. This city has no good potable water but what is collected in tanks on the roofs of the houses, or brought from a distance in stone jars, and in large water-barges for the supply of those who do not possess tanks. Many of the poorer people dwell in cellars below the houses: another class live entirely on the canals, bringing up their families in comfortable apartments erected on the decks of their vessels. These vessels, which are of various sizes, according to the wealth of the proprietors, are employed in inland navigation, and are remarkable for their neatness and cleanliness, the whole domestic economy being conducted with a view to the comfort of the inmates. Sometimes may be seen even a little flower-garden on the deck. Like all the towns in Holland, Amsterdam is remarkably clean, and has an air of newness, though surpassed perhaps in these respects by Rotterdam and the Hague.

The chief literary institutions are the Athenæum or college with eleven professors, the society called "Felix Meritis," from the first words of the inscription on their place of meeting, the Scientific Institute, and the Royal Academy of the Fine Arts, in all of which lectures are delivered on science and literature. The collections of pictures and antiquities are of great value. The Museum or picture gallery in 1847 contained 386 fine pictures, chiefly of the Flemish and Dutch schools, including some by Wouvermans, Rembrandt, Vander Helst, Both, and Reubens, of wonderful power. The famous "Night-guard" of Rembrandt, and the magnificent "Banquet of the Civic Guard," by Vander Helst, are in this collection; which also possesses a fine collection of prints in 200 portfolios. Among the private collections those of MM. Six and Vander Hoop stand pre-eminent; the latter containing between 80 and 90 pictures of the old masters, besides many others. Amsterdam has a Dutch and also a German theatre, an Italian opera-house, and several minor theatres. Its industry comprises manufactures of woollen, cotton, and silk, gold lace, perfumery, and jewellery: the cutting of diamonds has long been extensively practised here by the Jews: there are refineries of borax, sugar, smalt, &c.; soap, oil, glass, iron, dye, and chemical works, distilleries, breweries, tanneries, tobacco and snuff factories, &c., &c. The commercial establishments are on a grand scale. The celebrated Bank of the Netherlands, founded in 1609, was dissolved in 1796; and the present bank, on the model of the Bank of England, was established in 1814. The commerce with all parts of the world is very extensive; though Antwerp, Rotterdam, and Hamburg, are powerful rivals. The prosperity of Amsterdam has been subject to vicissitudes: in 1785 the population is said to have amounted to 235,000; and in 1814, the epoch of its greatest depression, it had declined to 180,000; but the opening of the Helder Canal, in 1825, has done much to revive its commercial prosperity. This great work, which extends from Nieuwe Diep opposite the Texel to Amsterdam, a distance of 51 miles, has obviated the delays and dangers formerly encountered in the intricate navigation of the Zuyder Zee, and the formidable obstruction of a bar called the *Pampus* at the mouth of the Y, which obliged vessels to unload partially in the roadstead; but now the largest ships are brought direct to the city. See NAVIGATION, INLAND.

It may be noticed as a curious fact that there is not a water-mill in all Holland, owing to the flatness of the soil, which is in many parts, like Amsterdam, below the level of ocean; so that the utmost attention to the dikes is necessary to prevent the inundation of the country. The expense of keeping these dikes in repair is said to amount annually to a very large sum.

From 250 to 260 large ships belonging to Amsterdam trade to the East and West Indies, the Baltic, and Mediterranean, and the port is a scene of unceasing activity. The imports include sugar, coffee, tea, spices, tobacco, indigo, cochineal, cotton, hemp and flax, wine and brandy, linen, cotton and woollen stuffs, hides, hardwares, rock-salt, tin-plates, iron, timber, pitch and tar, whale-oil, dried fish, coal, &c. The chief exports are the produce of Holland: cheese, butter, &c.; madder, clover, rape, hemp, linseeds, rape and linseed oils, Dutch linen; the produce of East and West India possessions, and of other tropical countries; Spanish, German, and English wools, all kinds of grain, linens from Germany, gin from Schiedam, French, Rhenish, and Hungarian wines, brandy, &c. Amsterdam has a large transit trade, and a very considerable business in insurance and in bills of exchange. The number of vessels laden that entered its port in 1850 was 2000, and in ballast 28, the total tonnage being 348,082; the number that left the port laden was 1457, and in ballast 524, making a total of 347,253 tons.

There are two railways, one connecting Amsterdam with Rotterdam, the Hague, Leyden, and Haarlem; the other with Utrecht, Arnheim, and Prussia; and there is regular communication by steam-vessels with Kampen, Enkhuizen, Harlingen, and Hamburg.

AMSTERDAM, a small town in New York, United States, on the Utica Railway, 32 miles north-west of Albany. It contains 5333 inhabitants, principally employed in the manufacture of carpets, saws, scythes, &c.

AMSTERDAM, or *Tongataboo*, an island in the South Sea, discovered by Tasman, a Dutch navigator. Its greatest extent from east to west is about 21 miles, and from north to south about 13. It is broad at the east end, and tapers towards the west, where it turns, and runs to a point due north. It is about six leagues to the west of Middleburg. The shore is surrounded by coral rocks, and its most elevated parts are not above six or eight yards above the level of the sea. It is wholly laid out in plantations, in which are cultivated plantains in great variety, bread-fruit, shaddocks, yams, and the fruits of Taheite, with taro, and other esculent vegetables in great abundance. The people are familiar with the use of the bow and spear, and are dexterous fishermen. Their manners are licentious; but they have some commendable qualities, according to the missionaries; though other accounts represent them as cruel, treacherous, and vindictive. Long. 175. W. Lat. 21. 11. S.



AMSTERDAM, *New*, a seaport town of British Guiana, on the right bank of the Berbice River, near the confluence of the Canje. Lat. 6. 14. 51. S. Long. 57. 31. 8. W. It was founded by the Dutch in 1796; but is now the seat of the British Colonial Government of Berbice, formerly at Georgetown. It is a healthy town; the houses, which are generally built of wood, being separated from each other by trenches which fill and empty with the tide. The whole town is intersected by canals, communicating with the sea. The harbour is good, though the passage to it is impeded at low water by a sand-bar. Three strong batteries protect the entrance of the river. Pop. about 3000.

AMULET, a charm or preservative against mischief, witchcraft, or diseases. Amulets have been made of stone, metal, simples, animals, and, in a word, of everything that imagination could suggest. Sometimes they consisted of words, characters, sentences, ranged in a particular order, and engraved upon wood, &c., and worn about the neck, or some other part of the body. At other times they were neither written nor engraved, but prepared with many superstitious ceremonies, great regard being usually paid to the influence of the stars. The Arabians have given to this species of amulet the name of Talisman. All nations have been fond of amulets: the Jews were extremely superstitious in the use of them to drive away diseases; and the Mishna forbids them, unless received from an approved man who had cured at least three persons before by the same means. Among the Christians of the early times amulets were made of the wood of the cross, or ribands with a text of Scripture written on them, as preservatives against diseases.

AMURATH, or AMOURAD I., the third sultan of the Turks, and one of the greatest princes of the Ottoman empire, was the son of Orchan, whom he succeeded in 1360. After the capture of Gallipoli, he overran all Thrace or Romagna from the Hellespont to Mount Hæmus, and fixed the seat of the Turkish empire at Adrianople. He defeated the prince of Bulgaria, conquered Misnia, chastised his rebellious bashaws, and is said to have gained 36 battles. This prince, in order to form a body of devoted troops that might serve as the immediate guards of his person and dignity, appointed his officers to seize annually, as the imperial property, the fifth part of the Christian youth taken in war. These, after being instructed in the Mahometan religion, inured to obedience by severe discipline, and trained to warlike exercises, were formed into a body distinguished by the name of *Janizaries* or *New Soldiers*. The Janizaries soon became the chief strength and pride of the Ottoman armies, and were distinguished above all the troops whose duty it was to attend on the person of the sultan. The death of Lazarus, despot of Servia, who had endeavoured in vain to stop the progress of Amurath's arms, touched Milo, one of his servants, in so sensible a manner, that in revenge he stabbed the sultan in the midst of his troops, and killed him upon the spot, A.D. 1389, after he had reigned 23 years. He was the grandson of Othman, and was succeeded by his son Bajazet.—Gibbon, xi.

AMURATH II., the tenth emperor of the Turks, was the eldest son of Mahomet I. and succeeded his father in 1421. He besieged Constantinople and Belgrade without success; but he took Saloniki from the Venetians, and compelled the prince of Bosnia, and John Castriot, prince of Albania, to pay him tribute. He obliged the latter to send his three sons as hostages, among whom was George, celebrated in history by the name of *Scanderbeg.* John Hunniades defeated Amurath's troops, and obliged him to make peace with the Christian princes in 1442. These princes afterwards breaking the peace, Amurath defeated them in the famous battle of Varna, November 10. 1444, which proved so fatal to the Christians, and in which Ladislaus, king of Hungary, was killed. Amurath twice abdicated the throne, first in 1442, and again in 1444, in favour of his son. In his retreat he was the companion of Santons and Dervishes; practising their fasts and gyrations until the exigencies of the state again called the royal fanatic into the field. He afterwards defeated Hunniades, and killed above 20,000 of his men; but George Castriot, better known by the name of *Scanderbeg,* being re-established in the estates of his father, defeated the Turks several times, and obliged Amurath to raise the siege of Croia, the capital of Albania. Chagrined at his ill success, and infirm with age, Amurath died at Adrianople, February 11. 1451. It is observed to this prince's honour, that he always kept his treaties with the greatest fidelity.

Amurath III., son of Selim II., was born about the year 1545, and crowned A.D. 1573. Naturally weak and suspicious, he commenced his reign by putting to death his five brothers, the eldest of whom was but eight years old. His reign was distinguished by a series of enterprises ill planned and worse executed. He died A.D. 1595.

Amurath IV., surnamed the *Valiant,* was the son of Achmet I., and in the year 1622, at the age of 13, succeeded his uncle Mustapha. Baghdad fell into the hands of the Persians, and several other disastrous events clouded the commencement of his reign. The recovery of Baghdad being a favourite object, in the year 1637 he marched against it; and after thirty days of unremitting assault, with the expense of much blood, he took possession of the city. By pushing his men forward to the attack at the point of the scimitar, and by slaughtering 30,000 Persians in cold blood after the surrender, he displayed the brutal ferocity of his disposition. One person alone is reported to have moved his obdurate heart on the present occasion. A famous player upon the harp entreated those who were sent to massacre him to allow him to speak to the sultan previous to his death. Informed who he was, the sultan requested him to give a specimen of his skill in his profession: with this he readily complied, and touched his harp so melodiously, and sung in such pathetic strains the lamentations on the tragedy of Baghdad, intermixed with the praises of Amurath, that the hard heart of the cruel monarch being at length softened, he melted into tears, and saved both the musician and the remaining inhabitants.

The violence of Amurath soon enfeebled his constitution; and the fruits of his debaucheries and excesses were obvious even in the prime of life. At the age of 31 he fell a victim to an excess of revelling in the feast of Bairam, in the year 1640.

AMUSETTE, a small one pound cannon, well adapted from its lightness for mountainous regions, but no longer in use.

AMWELL, a large village in the hundred of Hertford, of the county of that name, 20 miles from London. It is at the head of the New River, conducted to the metropolis by Sir Hugh Middleton, between the years 1606 and 1612. The population in 1851 was 1652.

AMYCLÆ, a city of Laconia in ancient Greece, on the Eurotas, 20 miles south-east of Sparta. It was according to some the birthplace of Castor and Pollux.

Amyclæ, the name of a Grecian colony in Latium, between Cajeta and Terracina.

AMYGADALEÆ, a natural order of plants called also Drupaceæ. The bitter and sweet almond belong to this order, both being generally considered as produced by the *Amygdalus communis.*



AMYGDALOID, a compound rock of any base with many rounded nodules of other stones imbedded in it. The base is often some kind of trap, as basalt or greenstone.

AMYLINE. See Chemistry.

AMYNTAS. See Macedonia.

Amyntas, a Greek writer cited by Athenæus as the author of a work entitled Σταθμόι, *Stations.* The existing fragments prove it to have been of some value, as giving a description of the manners, customs, and natural products of Asia. The epoch of this writer is unknown.

AMYNTIANUS, a Greek historian in the reign of the emperor Marcus Aurelius, to whom he dedicated a life of Alexander the Great, of which no fragment remains. He also wrote lives of Philip, of Olympias, and of several other distinguished characters, but none of them are extant.

AMYOT, Jacques, bishop of Auxerre and grand almoner of France, was born of an obscure family at Melun, on the 30th of October 1514, and studied philosophy at Paris, in the college of Cardinal le Moine. He left Paris at the age of 23, and went to Bourges with the Sieur Colin, who presided over the abbey of St Ambrose in that city. At the recommendation of this abbot, a secretary of state took Amyot into his house to be tutor to his children. The great improvements they made under his direction induced the secretary to recommend him to the Princess Margaret, duchess of Berry, only sister of Francis I.; and by means of this recommendation Amyot was made public professor of Greek and Latin in the university of Bourges. It was during this time that he translated into French the *Amours of Theagenes and Charicled,* with which Francis I. was so pleased, that he conferred upon him the abbey of Bellosane. He also translated Plutarch's *Lives,* which he dedicated to the king; and afterwards undertook that of Plutarch's *Morals,* which he ended in the reign of Charles IX. and dedicated to that prince. Charles conferred upon him the abbey of St Cornelius de Compiegne, and made him grand almoner of France and bishop of Auxerre. He died in 1593, aged 79.

AMYRALDUS, or Amyraut, Moise, an eminent French Protestant divine, born at Bourgueil in Touraine in 1596. He studied at Saumur, where he was chosen professor of divinity; and his learned works gained him the esteem of Catholics as well as Protestants, particularly of Cardinal Richelieu, who consulted him on a plan of reuniting their churches, which, however, as may well be supposed, came to nothing. He published a piece, in which he attempted to explain the mystery of predestination and grace, which occasioned a controversy between him and some other divines. His doctrine on this head, which was adopted by numerous followers, consisted of the following particulars, viz., that God *desires* the happiness of all men, and that none are excluded by a divine decree; that none can obtain salvation without faith in Christ; that God refuses to none the *power of believing,* though he does not grant to *all* his assistance, that they may improve this power to saving purposes; and that many perish through their own fault. Those who embraced this doctrine were called *Universalists;* though it is evident they rendered grace *universal* in words, but *partial* in reality, and are chargeable with greater inconsistencies than the *Supralapsarians.* Amyraut also wrote *An Apology for the Protestants, A Paraphrase on the New Testament,* and several other books. This eminent divine died in 1664.

ANA, a Latin plural termination, appropriated to various collections of the observations and criticisms of eminent characters delivered in conversation and recorded by their friends, or discovered among their papers after their decease. Though the term Ana is but of modern origin, the species of composition to which it has been applied is not of such recent date as some persons have imagined. It appears, from D'Herbelot's *Bibliothèque Orientale*, that, since the earliest periods, the eastern nations have been in the habit of preserving the maxims of their sages. From them this practice passed to the Greeks and Romans. Plato and Xenophon treasured up and recorded the sayings of their master Socrates. From their example Arrian, in the concluding books of his *Enchiridion*, which have not descended to posterity, collected the casual observations which had dropped from Epictetus. The numerous apophthegms scattered in Plutarch, Diogenes Laertius, and other writers, evince that it had been customary in Greece to preserve the ideas delivered by illustrious characters. It appears that Julius Cæsar compiled a book of apophthegms, in which he related the *bon-mots* of Cicero; and Quintilian informs us, that a freedman of that celebrated wit and orator composed three books of a work entitled *De Jocis Ciceronis.* We are told by Suetonius, that Caius Melissus, originally the slave, but afterwards the freedman and librarian, of Mæcenas, collected the sayings of his master; and Aulus Gellius has filled his *Noctes Atticæ* with anecdotes which he heard from those distinguished characters whose society he frequented in Rome. Were the books compiled by the freedmen of Cicero and Mæcenas now extant, they might be entitled Ana; and it is certainly to be regretted that we possess no authentic record of the conversational remarks or hints which dropped from the sages, orators, or statesmen of Greece and Rome. How interesting would be a *Colloquia Mensalia* of Atticus or Cæsar!

But though vestiges of this species of composition may be traced in the classical ages, it is only in modern times that it has attained to full popularity and perfection. Literary anecdotes, critical reflections, and historical incidents, came to be mingled with the detail of *bon-mots* and ludicrous tales; so that instruction and entertainment were agreeably blended. The term Ana seems to have been applied to such collections as far back as the beginning of the fifteenth century. Thus, Francesco Barbaro, in a letter to Poggio, says, that the information and anecdotes which Poggio and Barthelemi Montepolitiano had picked up during a literary excursion through Germany, will be called *Ana:* "Quemadmodum mala ab Appio e Claudia gente *Appiana*, et pira a Mallio *Malliana* cognominata sunt, sic hæc literarum quæ vestra ope et opera Germania in Italiam deferentur, aliquando et *Poggiana* et *Montepolitiana* vocabuntur."

Poggio Bracciolini, to whom this letter is addressed, and to whom the world is indebted for the preservation of so many classical remains, is the first eminent person of modern times whose jests and opinions have been transmitted to posterity. Poggio was secretary to five successive popes. During the pontificate of Martin V., who was chosen in 1417, Poggio and other members of the Roman chancery were in the habit of assembling in a common hall adjoining the Vatican, in order to converse freely on all subjects. Being more studious of wit than of truth, they termed this apartment *Buggiale*, a word signifying a place of recreation where tales are related, and which Poggio himself interprets *Mendaciorum Officina*. At these meetings Poggio and his friends discussed the news and scandal of the day, and communicated to each other entertaining anecdotes; they attacked what they did not approve, and they approved of little; they also indulged in the utmost latitude of satiric remark, dealing out their sarcasms with such impartiality, that they did not spare even the pope and cardinals. The pointed jests and humorous stories which occurred in these unrestrained conversations were collected by Poggio, and formed the chief materials of his *Facetiæ*, first printed, according to De Bure, in 1470. This celebrated collection, which forms a principal part of the *Poggiana*, is chiefly valuable as recording interesting anecdotes of eminent men of the fourteenth and fifteenth centuries. It also contains a number of quibbles or *jeux-de-mots*, and a still greater number of idle and licentious stories. Many of these, however, are not original, some of them being taken from ancient authors, and a still greater number from the *Fabliaux* of the *Trouveurs.* Thus, the *Fabliau La Culotte des Cordeliers* is the *Braccæ Divi Francisci* of Poggio; *Le Meunier d'Aleus* is Poggio's *Quinque Ova; Du Vilain et de sa Femme* is his *Mulier Demersa;* and *Du Pré Tondu* is the *Pertinacia Muliebris* of the *Facetiæ.* On the other hand, Poggio has suggested much to succeeding writers. Hans Carvel's *Ring* is his *Visio Francisci Filelfi;* and Fontaine's fables, *Le Charlatan, Le Coq et le Renard*, and that of the *Wolf and Fox pleading before the Ape*, are from stories originally related by Poggio. The *Facetiæ* forms, upon the whole, the most amusing and interesting part of the *Poggiana* printed at Amsterdam in 1720; but this collection also comprehends some further anecdotes of his life, and a few scattered maxims extracted from his graver compositions.

Poggiana.

Though Poggio was the first person whose remarks and *bon-mots* were collected under the name of Ana, the *Scaligerana*, which contains the opinions of Joseph Scaliger, was the first work *published* under that appellation; and, accordingly, may be regarded as having led the way to that class of publications.

Scaligerana.

There are two collections called Scaligerana—a *prima* and *secunda* Scaligerana. The first was compiled by a physician named Francis Vertunien, Sieur de Lavau, who attended the family of the Messieurs Chateigner, in whose house Joseph Scaliger resided. He, in consequence, had frequent opportunities of meeting that celebrated critic, and was in the custom of committing to paper the learned or ingenious observations which dropped from him in the course of conversation; to which he occasionally added remarks of his own. This collection, which was chiefly Latin, remained in manuscript many years after the death of the compiler. It was at length purchased by M. de Sigogne, who published it in 1669, under the title of *Prima Scaligerana, nusquam antehac edita;* bestowing upon it the title *prima*, in order to preserve its claim of priority over another Scaligerana which had been published three years before, but had been more recently compiled. This second work, known by the name of *Secunda Scaligerana*, was collected by two brothers of the name of Vassan, who went to complete their studies at the university of Leyden, of which Scaliger was at that time one of the professors. Being particularly recommended to Scaliger, they were received in his house, and daily enjoyed his conversation; in the course of which, he gave them much information concerning various topics of history and criticism. The Vassans immediately wrote down what they had heard, and soon made up a large manuscript volume, in which, however, there was neither connection nor arrangement of any description. In this state the manuscript was delivered by one of the Vassans, on his retirement to a monastery, to M. de Puy; and after passing through various hands, it came into the possession of M. Daillé, who for his own use arranged in alphabetical order the articles which it contained. Isaac Vossius having come to Paris on a visit to M. Daillé, obtained the loan of the manuscript, which he transcribed, and afterwards published at the Hague, under the title of *Scaligerana, sive Excerpta ex ore Josephi Scaligeri*. This edition was full of inaccuracies and blunders; but a more correct impression was afterwards published by M. Daillé, with a preface complaining of the use that Vossius had made of the manuscript, which he declares was never intended for publication, and was not of a nature to be given to the world. Indeed most literary men in that age conceived that the *Scaligerana*, particularly the *second*, detracted considerably from the reputation of the great scholar whose sentiments they recorded. They are full of mistakes and contradictions; and Bayle has remarked, that the Vassans attribute to him observations which it is almost impossible he could have uttered. Joseph Scaliger, with more extensive erudition, but less genius than his father Julius Cæsar Scaliger, had inherited his ridiculous vanity and dogmatical spirit. He wished it to be thought that he knew every thing, and that his opinions were infallible. Conversing with two young students of a university, of which he formed the principal ornament, he would probably be but little cautious in the opinions he expressed, as his literary errors could not be detected or exposed. Unfortunately the blind admiration of his pupils led them to regard even his most absurd opinions as the responses of an oracle, and his most unmerited censures as just condemnations. The *Scaligerana*, accordingly, contains many falsehoods, with much unworthy personal abuse, of the most distinguished characters of the age. Thus, he calls Cardinal Bellarmin a mere atheist (*plane atheus*), and compares the duke of Sully to Sejanus. Indeed M. Daillé, in his preface to the *Secunda Scaligerana*, confesses that it contains "multa futilia, scurrilia, obscœna; quædam manifeste falsa. Ubique de se suisque magnifice, ne dicam thrasonice, loquitur; laudum parcus, conviciorum largus, in omnes contumeliosissime invehitur: denique, neminem sibi de manibus elabi patitur, cujus non errata, vitia, nævos etiam levissimos, acerrime insectetur, et plusquam cynica licentia arrodat."

In imitation of the *Scaligerana*, a prodigious number of similar works appeared in France towards the end of the seventeenth and beginning of the eighteenth century. At first these collections were confined to what had fallen from eminent men in conversation; but they were afterwards made to embrace fragments found among their papers, and even passages extracted from their works and epistolary correspondence. Of those which merely record the conversations of eminent men, the best known, the fullest, and most valuable, is the *Menagiana*. Menage was a person of good sense, of various and extensive information, and of a most communicative disposition. He lived during the greater part of his life in the best society. An assembly of literary characters met, during a long period of time, at his house every Wednesday; and, during his latter years, he daily received persons of that description. Much of his time was thus spent in conversation; and those of his friends who habitually enjoyed it were at pains to record his opinions, which were generally founded on a correct taste and judgment, and were always delivered in a manner the most interesting and lively. A collection of his oral opinions was published in 1693, soon after his death; and this collection, which was entitled *Menagiana*, was afterwards corrected and enlarged by M. la Monnoye, in an edition published by him in 1715. Among the most curious articles in the *Menagiana* may be numbered the dissertation on *Le Moyen de Parvenir*, a work attributed to Beroalde de Verreville; that on *Le Songe de Poliphile*; as also a letter of La Monnoye on the existence of a book supposed to have been entitled *De Tribus Impostoribus*, concerning which there has been much discussion and controversy.

Perroniana.

The *Perroniana*, which exhibits the opinions of Cardinal Perron, was composed from his familiar conversation by M. de Puy, and published by Vossius, by the same contrivance which put him in possession of the *Scaligerana*. Some parts of this collection are useful in illustrating the literary and ecclesiastical history of the age in which Perron lived; but it also contains many puerile, imprudent, and absurd remarks, which it is generally supposed he never uttered, and many of which were proved by M. Chevreau (*Chevræana*) to have been the interpolations of his friends. Some of his assertions,—as that Luther denied the immortality of the soul, and that every English peasant drinks from a silver goblet,—are evidently false. Nor can much reliance be placed on the judgment or taste of an author who has elsewhere declared that a page of Quintus Curtius is worth thirty of Tacitus, and that, next to Quintus Curtius, Florus is the greatest Roman historian. The *Thuana*, or observations of the president De Thou, have usually been published along with the *Perroniana*. This collection is not extensive, and by no means of such value as might have been expected from a man so able and distinguished.

Thuana.

Valesiana.

The *Valesiana* is a collection of the literary opinions of the historiographer Adrian Valois, published by his son. M. Valois was a great student of history, and the *Valesiana*, accordingly, comprehends many valuable historical observations, particularly on the works of Du Cange.

Fureteriana.

The *Fureteriana* contains the *bon-mots* of M. Furetiere, of the French academy, the stories which he was in the habit of telling, and a number of anecdotes and remarks found among his papers after his decease. This production, however, consists chiefly of short stories, and comprehends but few thoughts, opinions, or criticisms on books. Furetiere, it is well known, had a violent quarrel with the French Academy, of which he was a member, concerning his *Dictionnaire Universel de la Langue Françoise*. Having published a preliminary discourse, the further printing was interdicted by the French Academy, which accused him of purloining materials they had amassed for a similar work. This controversy subsisted during the rest of the life of Furetiere, who spent his concluding years in writing and publishing libels on his associates. The *Fureteriana*, accordingly, is replete with allusions to a subject with which his thoughts were so completely engrossed: in particular we find there the plan and outline of an allegorical and burlesque poem, entitled *Les Couches de l'Académie*; in which he has satirized different members of the academy, especially M. Charpentier, one of his bitterest foes, whom he has designated by the name of *Marmentier*.

Chevræana.

The *Chevræana*, so called from M. Chevreau, exhibits more research than most works of a similar description, and is probably more accurate, as it was published during the life of the author, and revised by himself. Among other interesting articles, it contains a learned and ingenious commentary on the works of Malherbe, to whom the French language and poetry were highly indebted for the perfection to which they attained.

Parrhasiana.

*Parrhasiana* is the work of Jean le Clerc, a professor of Amsterdam, who bestowed this appellation on his miscellaneous productions with the view of discussing various topics of philosophy and politics with more freedom than he could have employed under his own name. This work is not of the light and unconnected description of

Ana. most of the Ana which have been above enumerated, as it contains much learned philological disquisition, and a long dissertation on poetry and eloquence. In the first volume there is a list of his published works, and a bitter reply to all those who had censured them.

Huetiana. The *Huetiana*, which has always held a distinguished place among the Ana, contains the detached thoughts and criticisms of Huet, bishop of Avranches, which he himself committed to writing during his life. This author was well fitted to produce a valuable work in this department of literature. He enjoyed the friendship of a number of distinguished characters, and his reading was various and extensive. This collection, however, was not begun by him till he was far advanced in life. Huet was born in 1630, and in 1712 he was attacked by a malady which impaired his memory, and rendered him incapable of the sustained attention necessary for the completion of a long or laborious work. In this situation he employed himself during the concluding years of his life in throwing his detached observations on paper. These were published by the Abbé d'Olivet the year after his death, under the name of *Huetiana*,—a work which is not, like some other Ana, a succession of *bon-mots* or anecdotes, but forms a series of thoughts and criticisms on various topics of morals, philosophy, and literature, and also comprehends pretty long dissertations on the origin of rhyme, the comparative merit of the ancients and moderns, with similar topics. One of the most instructive discussions to a scholar, in this collection, is that on the Latinization of names and surnames; in which he points out and criticises the different modes of this process. His critical judgments on Montaigne, Rochefoucauld, and Tacitus, seem also well founded; and if some of his opinions in matters of taste betray singular or defective feelings, there are others which appear equally just and refined. But were there no other literary memorials of the bishop of Avranches, he certainly would not derive high reputation from the *Huetiana*. D'Alembert has treated this collection with contempt; and has selected some articles to show the bishop's incompetent judgment and frivolous taste. It may be suspected, indeed, from the circumstances in which the articles contained in the *Huetiana* were composed, that they do not always display that correct judgment which distinguishes many of the other works of this learned writer.

Casauboniana. The *Casauboniana* presents us with the miscellaneous observations, chiefly philological, of the celebrated Isaac Casaubon. During the course of a long life, that eminent commentator was in the daily practice of committing to paper any thing remarkable which he heard in conversation with his friends, especially if it bore on the studies in which he was engaged. He also made diurnal annotations on the works he was employed in reading, with which he connected his judgments concerning the author and his writings. This compilation, which was styled *Ephemerides*, together with his *Adversaria*, and materials amassed for a refutation of the *Ecclesiastical Annals of Baronius*, came, at his death, into the possession of his son Meric Casaubon, who bequeathed the whole to the Bodleian library at Oxford. These were shown to Christopher Wolfius during a visit which he paid to that university; and having been transcribed by him, were published under the title of *Casauboniana*. This collection consists of opinions concerning various eminent writers, illustrations of passages in Scripture, and philological observations and animadversions on the first thirty-four years of the *Annals of Baronius*. The materials and information which it contains are probably more accurate than is usually the case in works of the same description, as they were not communicated in casual conversation, and reported by others, but were daily committed to writing by Casaubon himself, while the works from which they were derived remained fresh in his recollection. Ana.

Besides the above, a great many works, under the title of Ana, appeared in France about the same period. Thus, the opinions and conversation of Charpentier, Colomesius, and St Evremond, were recorded in the *Carpenteriana*, *Colomesiana*, and *St Evremoniana;* and those of Segrais in the *Segraisiana*,—a collection formed by a person stationed behind the tapestry in a house where Segrais was accustomed to visit, and of which Voltaire has declared, "que de tous les Ana c'est celui qui merite le plus d'être mis au rang des mensonges imprimés, et surtout des mensonges insipides." The Ana, indeed, from the popularity which they now enjoyed, were compiled in such numbers, and with so little care, that they became almost proverbial for inaccuracy. About the middle of the eighteenth century they were sometimes made the vehicles of political squibs, as in the *Maupeouana*, and of heretical opinions, as in the *Longueruana*. Thus the evil naturally began to cure itself, and by a re-action, which is very general in regard to all productions of literature, the French Ana sunk in public esteem as much below their intrinsic value as they had formerly been exalted above it. Carpenteriana. Colomesiana. Evremoniana. Segraisiana. Maupeouana. Longueruana.

Although these connections have been chiefly formed from the oral opinions of eminent men on the Continent, particularly in France, England has also produced one or two examples of this species of composition, which are not altogether undeserving of attention. Of these, perhaps the most curious is the *Walpoliana*, which is a transcript of the literary conversation of Horace Walpole. That multifarious author was distinguished for his resources of anecdote, wit, and judicious remark, as well as for his epistolary qualifications. From his father, Sir Robert Walpole, he had learned many anecdotes concerning the political characters who figured during the period of his administration. He was himself personally acquainted with all the eminent literary characters of his own day in England; and his repeated visits to Paris, and constant correspondence with friends in that capital, supplied him with the most interesting information with regard to France. A great part of his life was devoted to conversation. While residing at Strawberry-hill, he generally rose from table about five o'clock, and taking his place on his drawing-room sofa, to which his gout in a great measure confined him, he passed the time, till two o'clock in the morning, in miscellaneous chit-chat, full of singular anecdotes, strokes of wit, and acute observations. As he possessed, and was daily communicating, such stores of instruction and amusement, it was suggested to him that he ought to form a collection of these anecdotes and observations. This he declined, but he furnished the editor of the *Walpoliana* with many anecdotes in his own handwriting. After his death, several specimens of this miscellany were published in the *Monthly Magazine;* and being afterwards enlarged by anecdotes retained in the memory of the editor, or communicated by others, were published in two volumes, under the title of *Walpoliana*. Most other works which, in this country, have been published under the name of *Ana*, as *Baconiana*, *Atterburyana*, are rather extracts from the writings and correspondence of eminent men, than memorials of their conversation. Walpoliana.

There are some works which, though they do not bear the title, belong more strictly to the class of Ana than many of those collections which are known under that appellation. Such are the *Mélange d'Histoire et de Littera-*

Ana.

*ture*, published under the name of *Vigneul Marville;* and the *Locorum Communium Collectanea, ex Lectionibus Philippi Melanchthonis*,—a work which was published as far back as the sixteenth century, and has obtained considerable reputation on account of its theological learning, and the information it communicates concerning the early state of the reformed church. But of those productions which belong to the class, though they do not bear the name, of Ana, the most celebrated are the *Colloquia Mensalia* of Luther, and Selden's *Table-Talk*, both of which merit particular notice. The first, which comprehends the conversation of Luther with his friends and coadjutors in the great work of the Reformation, was first published in 1566. Captain Henry Bell, who translated it into English in the time of the Commonwealth, informs us that, at the instigation of the pope, the emperor of Germany had promulgated an edict commanding the works of Luther to be destroyed. It was for some time supposed that all the copies of the *Colloquia Mensalia* had been burned in consequence of this order; but at length, in 1626, a German called Van Sparr, having occasion to build on the old foundation of a house in which his grandfather dwelt when the imperial edict was issued, he found lying in a deep hole, and wrapped up in a linen cloth, a printed copy of the *Colloquia Mensalia*. Captain Bell having formerly become acquainted with Van Sparr during a long residence in Germany, his friend transmitted the work to him in England, where he executed a translation of it; an undertaking to which he pretends that he was urged by the vision of an old man with a long white beard, arrayed in white, who spoke these words: "Sirrah, will you not take time to translate that book?" The extraordinary book translated by Bell, at the instance of this vision, is said to have been originally collected by Dr Anthony Lauterbach, "out of the holy mouth of Luther;" and was afterwards digested into common-places by Dr John Aurifaber. It chiefly contains observations and discussions on idolatry, auricular confession, mass, excommunication, clerical jurisdiction, general councils, and all the points agitated by the reformed church in those early periods. With such topics there is intermixed many diatribes against Antichrist and the Cardinals, and much sarcasm on popish miracles and relics. Occasionally, however, it must be confessed that our great reformer expresses a belief in superstitions fully as wild and monstrous as those which he derides, and which he was called to overthrow. Thus, he asserted that he was repeatedly kept from sleep by the devil cracking nuts in his chamber; and he affirmed that there was a child at Dessau, which had been substituted by the arch-fiend instead of one he had stolen away, and which child Luther earnestly advised the prince of Anhalt to throw into the river Moldaw.

Luther's Colloquia Mensalia.

Selden's Table-Talk.

If the collection of Selden's apophthegms and sayings, entitled *Table-Talk*, be regarded of good authority, we shall find in it a more genuine and undisguised expression of the sentiments of that eminent man, than in his more studied productions. This work was published, after the death of Selden, by Richard Milward, his amanuensis, who, in his dedication to Selden's executors, affirms that, for twenty years, he enjoyed the opportunity of daily hearing his discourse, during which long period he made it his practice, from time to time, faithfully to commit to writing "the excellent things that usually fell from him." Dr Wilkins, in his introductory discourse to the Works of Selden, has attempted to throw discredit on the genuineness of this compilation, asserting that it contains many things derogatory from Selden's erudition, and foreign from his manners and principles. It is not improbable, indeed, that the memory of the amanuensis may have occasionally failed him, and that he may have recorded sayings which inadvertently escaped his master in the heat of conversation, and such as he probably would not have deliberately maintained. But, on the whole, the work has completely an air of genuineness; and although the familiarity of his illustrations and parallels may appear to clash with the idea formed of so great a scholar, they are characteristic of a man who had been conversant with scenes of common life, no less than the speculations of the closet. That such was the usual manner of Selden's conversation, the editor of the *Table-Talk* recalls to the recollection of those friends of his patron to whom the work is dedicated; and this appeal forms a presumption of his veracity. The *Table-Talk* contains many curious facts and opinions concerning the political and ecclesiastical history of the interesting period during which Selden lived, and in the important events of which he bore a considerable share. To judge from this work, Selden had great contempt for the theologians of his day; and seems to have been of opinion that the state should invariably keep a rein on the church. He was partial to the Episcopal form of worship; but was evidently not very strict in doctrinal points, as appears from what he is reported to have said on the subject of *heresy*. In his political opinions he seems to have entertained a high respect for the sacredness of the social contract; and he justified the resistance to the Stewarts, on the ground that they had infringed and violated this compact between prince and people. Besides religious and political opinions, the *Table-Talk* contains much of a lighter description; in consequence of which, Selden has been accused of showing more laxness, in point of moral principle, than might have been expected from so grave and respectable a character. Many of those sentiments, however, which have been considered objectionable, may have been merely advanced as plausible deductions from principles assumed for the sake of argument. But whatever difference of opinion may exist with regard to the matter of the *Table-Talk*, the manner in which the sentiments are there expressed must be universally admitted to be perspicuous and agreeable. The style of Selden, in most of the works published under his own care, is harsh and obscure; but Clarendon, who differed from him so widely in political opinions, acknowledges that he was "a clear discourser, and that he possessed the faculty of making difficult things easy, and presenting them clearly to the understanding." Accordingly, this talent for elucidation shines chiefly in his *Table-Talk*, which is filled with the stores of his extensive reading, delivered without any pretensions to that order and method, the want of which has been attributed to his other productions.

Ana.

It thus appears that, although the compilations designated by the name of Ana belong more particularly to France, they have not been wholly unknown in this country. In their *Motti e Burle*, and sometimes in their novels, the Italians also have recorded the witticisms of their distinguished poets and artists. The novels of Sacchetti are full of repartees attributed to Dante and the painters Giotto and Buffalmacco. Almost every Italian biographical work of the sixteenth and seventeenth centuries, like Boswell's *Life of Johnson*, records at great length the conversational remarks of the individual whose life is detailed. Thus, Manso has dedicated one of the books of his life of Torquato Tasso to an account of the wise and witty sayings of that illustrious poet, who, towards the close of his days, had become the intimate friend of his biographer. The conversation of the poet, however, was neither gay nor brilliant. One of the characters in Gol-

Ana. doni's drama of Torquato Tasso thus contrasts his writings and conversation :

> Ammiro il suo talento, gradisco i carmi suoi ;
> Ma piacer non trovo a conversar con lui.

It also unfortunately happens that the greater part of the sayings recorded by Manso may be found in the Apophthegms of Erasmus, which were published before the birth of Tasso. Indeed Manso seems to have been aware of the want of originality in the *bon-mots* of his friend ; for, after mentioning one, he says, " questo motto fu da alcuni ad *Epitcto* attribuito." It was usual, indeed, among the biographers of those times to pillage Xenophon or Plutarch for good things to put into the mouths of their heroes ; a practice from which Machiavel could not abstain in his short account of the illiterate soldier Castruccio Castracani. In those ages of pedantry, however, it is not improbable that many sayings of the old philosophers might have been repeated as their own by the learned men of the times ; and that the Italian *literati* might occasionally attempt to make their hearers merry with the jests of Socrates or Diogenes. The genius and character of the people rendered any collection of this nature less agreeable than the Ana of the neighbouring nation. In Italy, gravity was numbered among the virtues, and, in the eulogy of an illustrious man, is always mentioned as one of his most commendable qualities. There seems, in that country, to have been no medium between the most fantastic buffoonery and a certain tragic solemnity. The Italians wanted that " mobility of imagination," that facility, rapidity, abandonment, and gaiety, which seems almost peculiar to the French, and forms the chief charm of social intercourse, as well as of those works in which it is represented ; though, no doubt, when reduced into writing, much of its grace and spirit must evaporate and disappear.

The existence of similar causes, and perhaps in a stronger degree, prevented the popularity of Ana among the Spaniards ; though they too have related the jests and opinions of the duke d'Ossuna, and of some others. Indeed, whatever may be the genius or disposition of a people, traces of this mode of composition may in some shape or other be discovered among them.

When presented in their most perfect form, which is that of the French Ana, these collections are certainly entertaining from their variety, and curious, as presenting a lively image of the distinguished characters whose sentiments they record. If men reason more correctly on paper, they usually display their feelings and convictions with more truth in unpremeditated conversation. Few are so cautious or hypocritical that they do not sometimes drop the mask in the society of their friends, and express what they think or feel, when they no longer entertain apprehensions that their sentiments will be communicated to the vulgar. In general, however, the Ana should rather be regarded as affording a notion of the spirit and turn of thinking of those whose conversation they detail, than as authorities for particular opinions. A spirit of contradiction, a wish to display ingenuity, to astonish by paradoxes, or even to support conversation, may often lead men to maintain opinions in colloquial intercourse which they perhaps never seriously held, or at least would be ready to disclaim on mature consideration. It also unfortunately happens that, in many of the Ana, those who collected the conversations which they presented to the world interpolated their own opinions; which, of course, greatly diminishes their authority as characteristical records. It has also been objected to this species of composition, that every subject is treated superficially ; but it should be recollected that the Ana do not profess to contain profound dissertations ; and in fact no one consults them with the view of being deeply informed on any topic. A better founded objection is, that many subjects are treated, not merely superficially, but inaccurately. Such compositions are liable to a double risk of error ; first, of the person who delivers opinions in the heat of discourse, or relates anecdotes from vague recollection ; and, secondly, of the person who records them, who must be liable to mistake what he has only heard in the course of conversation. From these causes, and from their wide and general circulation, many of the most current literary errors may be traced to the Ana. When read, however, with discrimination, they may prove highly useful in illustrating various points of literary history, as they certainly contain a great deal which is not to be found in the formal compositions of the learned.

Wolfius has given a history of the Ana in a preliminary discourse to his edition of the *Casauboniana*, published in 1710. In the *Répertoire de Bibliographies Spéciales, Curieuses, et Instructives*, by Peignot, there is a *Notice Bibliographique* of these collections ; but many of the books there enumerated consist of mere extracts from the writings of popular authors, and do not, therefore, belong to that class of literary works described in the preceding article. (J. C. D.)

Anabaptists. ANABAPTISTS, a name which has been indiscriminately applied to Christians of very different principles and practices, though many of them object to the denomination, and hold nothing in common besides the opinion, that baptism ought always to be performed by immersion, and not administered before the age of discretion.

The word Anabaptist is compounded of *ανα, a new*, and *βαπτιστης, a baptist ;* and in this sense the Novatians, the Cataphrygians, and the Donatists, may be considered as a kind of Anabaptists in the earlier ages, though not then denoted by this name ; for they contended that those Christians of the Catholic church who joined themselves to their respective parties should be rebaptized. But we must not class under the same denomination those bishops of Asia and Africa who, in the third century, maintained that baptism administered by those whom they called heretics was not valid, and therefore that such of them as returned into their churches ought to be rebaptized. Nor do the English and Dutch Baptists consider the denomination as at all applicable to their sect, by whom the baptism appointed by Christ is held to be " nothing short of *immersion upon a personal profession of faith ;*" of which profession infants being incapable, and sprinkling being no adequate symbol of the thing included, the baptizing of proselytes to their communion, who in their infancy had undergone the ceremony of sprinkling, cannot, it is urged, be interpreted a repetition of the baptismal ordinance.

Anabaptists, in a strict and proper sense, appear to be those who not only rebaptize, when they arrive at an adult age, persons that were baptized in their infancy, but also, as often as any person comes from one of their sects to another, or as often as any one is excluded from their communion and again received into the bosom of the church, they baptize him. And such were many of the German Baptists. But the single opinion common to all the sects to which the name of *Anabaptists* has been indiscriminately applied, is that of the invalidity of *infant baptism*, in whatever way administered ; and hence the general denomination of *Antipædobaptists*, which included Anabaptists, Baptists, Mennonites, Waterlandians, &c., as distinguished by their respective peculiarities ; though *Anabaptists* seems to have been adopted by most writers as the general term.

Anabaptists.

To the above peculiar notion concerning the baptismal sacrament, the Anabaptists added principles of a different nature, depending upon certain ideas which they entertained concerning a perfect church establishment, pure in its members, and free from the institutions of human policy.

The Anabaptists appear to have made little noise, or to have been little noticed, before the time of the reformation in Germany. The most prudent and rational part of them considered it possible, by human wisdom, industry, and vigilance, to purify the church from the contagion of the wicked, provided the manners and spirit of the primitive Christians could but recover their lost dignity and lustre; and seeing the attempts of Luther, seconded by several persons of eminent piety, prove so successful, they hoped that the happy period was arrived in which the restoration of the church to purity was to be accomplished, under the divine protection, by the labours and counsels of pious and eminent men. Others, far from being satisfied with the plan of reformation proposed by Luther, looked upon it as much beneath the sublimity of their views, and consequently undertook a more perfect reformation, or, to express more properly their visionary enterprise, they proposed to found a new church, entirely spiritual, and truly divine.

This sect was soon joined by great numbers, and (as usually happens in sudden revolutions of this nature) by many persons whose characters and capacities were very different, though their views seemed to turn upon the same object. Their progress was rapid; for, in a very short space of time, their discourses, visions, and predictions, excited commotions in a great part of Europe, and drew into their communion a prodigious multitude, whose ignorance rendered them easy victims to the illusions of enthusiasm. The most pernicious faction of all those which composed this motley multitude, was that which pretended that the founders of the new and *perfect church* already mentioned were under the direction of a divine impulse, and were armed against all opposition by the power of working miracles. It was this faction that, in the year 1521, began their fanatical work, under the guidance of Munzer, Stubner, Storck, &c.

These persons were disciples of Luther; but well knowing that their opinions were such as would receive no sanction from him, they availed themselves of his absence to disseminate them in Wittenburg, and had the address to overreach the piety of Melanchthon. Their principal purpose was to gain over the populace, and to form a considerable party. To effect this, says Bayle, they were industrious and active, each in his own way. Storck, wanting knowledge, boasted of inspiration; and Stubner, who had both genius and erudition, laboured at commodious explications of Scripture. Not content with discrediting the court of Rome, and decrying the authority of consistories, they taught, that among Christians, who had the precepts of the gospel to direct, and the Spirit of God to guide them, the office of magistracy was not only unnecessary, but an unlawful encroachment on their spiritual liberty; that the distinctions occasioned by birth, or rank, or wealth, being contrary to the spirit of the gospel, which considers all men as equal, should be entirely abolished; that all Christians, throwing their possessions into one common stock, should live together in that state of equality which becomes members of the same family; that as neither the laws of nature nor the precepts of the New Testament had placed any restraint upon men with regard to the number of wives which they might marry, they should use that liberty which God himself had granted to the patriarchs.

They employed at first the various arts of persuasion in order to propagate their doctrine. They preached, exhorted, admonished, and reasoned, in a manner that seemed proper to impress the multitude; and related a great number of visions and revelations with which they pretended to have been favoured from above. But when they saw that these methods of making proselytes were not attended with such rapid success as they fondly expected, and that the ministry of Luther and other eminent reformers was detrimental to their cause, they then had recourse to more expeditious measures, and madly attempted to propagate their fanatical doctrine by force of arms. Munzer and his associates, in the year 1525, put themselves at the head of a numerous army, composed for the most part of the peasants of Suabia, Thuringia, Franconia, and Saxony; and declared war against all laws, government, and magistrates of every kind, under the chimerical pretext that Christ was now to take the reins of civil and ecclesiastical government into his own hands, and to rule alone over the nations. But this seditious crowd was routed and dispersed without much difficulty by the elector of Saxony and other princes; and Munzer, their ringleader, ignominiously put to death, and his factious counsellors scattered abroad in different places.

Many of his followers, however, survived and propagated their opinions through Germany, Switzerland, and Holland. In the year 1533 a party of them settled at Munster under the direction of two Anabaptist prophets, John Matthias, a baker of Haerlem, and John Bockholdt, a journeyman tailor of Leyden. Having made themselves masters of the city, they deposed the magistrates, confiscated the estates of such as had escaped, and deposited the wealth they amassed together in a public treasury for common use. They made preparations of every kind for the defence of the city; and sent out emissaries to the Anabaptists in the Low Countries, inviting them to assemble at Munster, which was now dignified with the name of Mount Sion, that from hence they might be deputed to reduce all the nations of the earth under their dominion. Matthias, who was the first in command, was soon cut off, in an act of frenzy, by the bishop of Munster's army, and was succeeded by Bockholdt, who was proclaimed, by a special designation of Heaven, as he pretended, king of Sion, and invested with legislative powers like those of Moses. The extravagancies of Bockholdt were too numerous to be recited: it will be sufficient to add, that the city of Munster was taken after a long siege and an obstinate resistance; and Bockholdt, the mock monarch, was punished with a most painful and ignominious death.

It must, however, be acknowledged, that the true rise of the numerous insurrections of this period ought not to be attributed to religious opinions. The first insurgents groaned under the most grievous oppressions—they took up arms principally in defence of their civil liberties; and of the commotions that took place, the Anabaptist leaders above mentioned seem rather to have availed themselves, than to have been the prime movers. That a great part of the main body, indeed, consisted of Anabaptists, seems indisputable; and whatever fanaticism existed among them would naturally be called forth or inflamed by particular situations or circumstances, and run riot in its wildest shapes. At the same time it appears from history, that a great part also consisted of Roman Catholics, and a still greater of persons who had scarcely any religious principles at all. Indeed, when we read of the vast numbers that were concerned in those insurrections, of whom it is reported that 100,000 fell by the sword, it appears reasonable to conclude that a great majority of them were not Anabaptists.

Before concluding this article, it must be remarked, that the Baptists or Mennonites in England and Holland are to be considered in a very different light from the enthusiasts we have been describing; and it appears equally uncandid and invidious to trace up their distinguishing tenet, as some of their adversaries have done, to those obnoxious characters, and there to stop, in order as it were to associate with it the ideas of turbulence and fanaticism, with which it certainly has no natural connection. Their coincidence with some of those oppressed and infatuated people in denying baptism to infants, is acknowledged by the Baptists; but they disavow the practice which the appellation of *Anabaptists* implies, and their doctrines seem referable to a more ancient and respectable origin. They appear supported by history in considering themselves as the descendants of the Waldenses, who were so grievously oppressed and persecuted by the despotic heads of the Roman hierarchy; and they profess an equal aversion to all principles of rebellion on the one hand, and to all suggestions of fanaticism on the other. See BAPTISTS.

ANABAS, Cuvier's name for a genus of fishes that have the faculty of climbing up and living for some time out of water. See ICHTHYOLOGY, *Acanthopterygii.*

ANABASIS (ἀνάβασις), the title of the work of Xenophon describing the expedition of Cyrus the younger against his brother Artaxerxes of Persia, 401 years B.C. Major Rennell, in an elaborate memoir, has estimated the retreat of the 10,000 Greek auxiliaries of Cyrus as equal to a distance of 3465 English miles (taking the *stadia* of Xenophon at 10 to our mile), through a difficult, and to them, unknown country. Arrian's account of the expedition of Alexander the Great is likewise called *Anabasis.*

ANABATHRA, in *Ancient Writers*, denotes a kind of steps or ladder whereby to ascend to some eminence. In this sense we read of the anabathra of theatres, pulpits, &c. Anabathra appears to have been sometimes also applied to ranges of seats rising gradually over each other.

ANABATHRA is more particularly applied to a kind of stone blocks raised by the highway sides, to assist travellers in mounting or alighting, before the use of stirrups was invented. The first author of this contrivance among the Romans was C. Gracchus, brother of Tiberius.

ANABLEPS, a Cuvierian genus of Malacopterygious fishes, with a divided pupil, cornea, and iris in each eye, giving the appearance of four eyes, from which the trivial name of the only species is derived. It inhabits the rivers of Guyana.

ANABOLÆUM, or ANABOLE, in *Antiquity*, a kind of upper coat, worn over the tunica.

ANACALYPTERIA, according to Suidas, were presents made to the bride by her husband's relations and friends, when she first uncovered her face and showed herself to men. These presents were also called ἐπαύλια; for, among the Greeks, virgins before marriage were under strict confinement, being rarely permitted to appear in public, or converse with the other sex; and when allowed that liberty, wore a veil over their faces, termed Καλύπτη, or Καλύπτρα, which was not left off in the presence of men till the third day after marriage; whence, according to Hesychius, this day was also called *anacalypterion.*

ANACAMPTIC, a name applied by the ancients to that part of optics which treats of reflection, being the same with what is now called Catoptrics.

ANACARDIACEÆ, a natural order of trees with acrid resins in their bark. The cashew nut belongs to this order.

ANACHARSIS, a Scythian philosopher, who lived about 600 years before Christ. His father was one of the chiefs of his nation, and married a woman of Greece. Instructed in the Greek language by his mother, he prevailed upon the king to intrust him with an embassy to Athens. On his arrival in that renowned city, he was introduced to Solon by one of his own countrymen, named *Foxaris.* From such a well-qualified master Anacharsis rapidly acquired a knowledge of the wisdom of Greece, and the literature then in circulation. By the influence of Solon he was introduced to the principal characters of Athens, and was the first stranger who was honoured with the title of citizen by the Athenians. After he had resided several years at Athens, he travelled through different countries in quest of knowledge, and then returned to his native country inflamed with the desire of instructing them in the laws and the religion of the Greeks. But his countrymen were not prepared to profit by his instructions; and while he was performing sacrifice to the goddess Cybele, in fulfilment of a vow which he had made on his way home, he was slain by an arrow, said to have proceeded from the hand of his own brother Saulius, the king. Thus fell the Scythian philosopher, a victim to the folly and ignorance of his countrymen who wantonly rejected the wisdom and learning of Greece. His energetic mode of expressing himself gave birth to the proverbial saying "Scythian eloquence."—*Herodot.* iv. 76, *Lucian. Scyth.* ii.

ANACHARSIS, Travels of. See BARTHELEMY.

ANACHORET, in *Eccelsiastical History*, denotes a hermit or solitary monk, who retires from the society of mankind into some desert, with a view to avoid the temptations of the world, and to be more at leisure for meditation and prayer. Such were Paul, Anthony, and Hilarian, the first founders of monastic life in Egypt and Palestine.

ANACHRONISM, in matters of literature, an error with respect to chronology, whereby an event is placed earlier than it really happened. The word is compounded of the negative ἀν, and χρόνος, *time.* Such is that of Virgil, who places Dido in Africa at the time of Æneas, though in reality she did not come thither till 300 years after the taking of Troy.

ANACLASTIC GLASSES (ἀνα, and κλάσις, *a breaking*), a kind of sonorous flat-bellied phials, resembling inverted funnels, with bottoms extremely thin, and slightly convex. They have the property of emitting a vehement noise when alternately filled with air and exhausted by the mouth. In Germany, where they are chiefly made, they are called *vexier glaser, i. e.,* vexing glasses, on account of the disturbance they occasion by their resilition.

ANACLASTICS, that part of optics which considers the refraction of light, commonly called *Dioptrics.* See OPTICS.

ANACLETERIA, in *Antiquity*, a solemn festival celebrated by the ancients when their kings or princes came of age, and assumed the reins of government. This designation was more especially applied to the inauguration of the Græco-Egyptian princes.

ANACLETICUM, in the *Ancient Art of War*, a particular blast of the trumpet, whereby the fearful and flying soldiers were rallied, and recalled to combat.

ANACLETUS, or CLETUS, bishop of Rome from the year 78 to 91. Some spurious decretals are extant under his name.

ANACLETUS, anti-pope, of Jewish extraction, was elected in 1130. He maintained his position till his death, in the face of all opposition, and was succeeded by Innocent II. in 1138.

ANACLINTERIA, in *Antiquity*, a kind of pillows on the dining couch, whereon the guests used to lean. The ancient tricliniary beds had four pillows, one at the head, another at the feet, a third at the back, and a fourth at the breast.

ANACŒNOSIS (ἀνακοίνωσις), in *Rhetoric*, a figure by which a speaker applies to his opponents for their opinion on the point in debate.

ANACOLUTHON (ἀνακόλουθον), in *Rhetoric* and *Grammar*, a want of coherency or of sequence in a sentence.

ANACONDA, in *Natural History*, is a name given in the isle of Ceylon to a very large and powerful snake, the *Python Bivittatus*.

ANACREON, the celebrated lyric poet, was born at Teos, an Ionian city in Asia Minor, about the year B.C. 560. Of his personal history little is known; but it would appear that his early youth was passed at Teos; and when Ionia fell under the Persian yoke, about B.C. 540, he migrated with many of his countrymen to Abdera in Thrace. In the same year he went to Samos, in consequence of an invitation from Polycrates the tyrant, by whom he was treated with great distinction and regard, and loaded with favours, which the poet repaid by praises in many of his songs. His residence at the splendid court of Polycrates was the happiest period of his life. On the murder of his friend and patron, in B.C. 522, he was invited to Athens by Hipparchus, the son of Pisistratus, who is said by Plato to have sent a galley of fifty oars for his conveyance. (*Hipparch.* p. 228.) At Athens he became acquainted with the younger Simonides and several other poets, and enjoyed the intimacy of many illustrious persons in that city. Anacreon is said to have perished by choking on the stone of a grape, in the 85th year of his age; and judging from the second of his two epitaphs by Simonides, that event took place at Teos, whither he is supposed to have retired on the death of Hipparchus in B.C. 514. The Athenians erected on the acropolis a statue representing Anacreon in a state of bacchanalian joyousness; and his effigy appears on several coins of Teos, which are still extant. The story of his passion for Sappho involves an anachronism that would appear to render it a fiction.

The harp of Anacreon was strung to the praises of beauty, love, and wine; and we are enabled to form some estimate of his genius from the numerous fragments of his poetry that time has spared. Though he continually alludes to wine as the source of his inspiration, Athenæus (x. 429) argues, with much propriety, that the poet merely affected inebriation in the composition of his celebrated dithyrambics. Indeed, from the tenor of his writings, it has very generally been assumed that the poet himself was the votary of voluptuousness and excess: though against this most natural inference we have the testimony of many writers, who ascribe to Anacreon the highest merits, not only as a poet, but also as a man. His rejection of the munificent presents of Polycrates, as not worthy the anxieties they entailed, is a circumstance certainly in his favour; and scarcely less so is the praise of Plato, who dignifies the poet with the epithet of "wise." Simonides, also, in a fragment still extant, places his character in a very favourable light. (See *Anthol. Palat.* vii. 25.) Yet, in spite of all this testimony, when we reflect on the inherent tendency of our nature to exalt the characters of extraordinary men, though we may allow Anacreon to have possessed many merits, it is impossible, on an impartial review of his writings, to elude the conviction that he was in fact a consummate voluptuary.

Five books of Anacreon's odes were extant in the time of Plutarch and Athenæus; and these were sung on all festive occasions to music composed by the poet himself. He also wrote elegies, hymns, satires, and epigrams; of which last several are preserved in the *Anthologia Græca*. All his poems were written in the Ionic dialect; his favourite metres being the Choriambic and the Ionic a Minore. A collection of fifty-five odes ascribed to Anacreon was first published by H. Stephens at Paris, in 1554, and subsequently by Maittaire, by Spaletti with a fac-simile of the Vatican MS., by Brunck, and others. It is now universally admitted that most, if not all, of these poems are spurious. They probably were written soon after the time of Alexander the Great, and some of them even so late perhaps as the fourth and fifth centuries of our era. Though many of these poems display considerable elegance, they are deficient in that vigour and earnest tone which characterize the genuine remains: the versification is sometimes defective, and the language occasionally barbarous; not to mention that they contain ideas altogether foreign to the age of Anacreon, and afford but one solitary example of the numerous citations from this poet by ancient writers. Some valuable observations on this subject are given by Fischer in the preface to his second edition of Anacreon, published at Leipzig in 1776, which contains this collection, together with the genuine remains. The best editions are by Mehlhorn, Glogau, 1825; Fischer, 3d edition, Leipzig, 1793; Brunck, 2d edition, Strasburg, 1786; and of the separate fragments, that of Bergk, Leipzig, 1834.



ANACREONTIC VERSE, in *Ancient Poetry*, a kind of verse, so called from its being much used by the poet Anacreon. It consists of three feet and a half, usually spondees and iambuses, and sometimes anapæsts.

ANACRISIS (ἀνάκρισις), a trial or examination which the archons or chief magistrates of Athens underwent before their admission into that office. The *anacrisis* stands distinguished from the *dokimasia*, which was a second examination in the agora. The anacrisis was performed in the senate-house. The questions here proposed to them were concerning their family, kindred, behaviour, estate, &c. It is the opinion of some that all magistrates underwent the anacrisis.

ANACRISIS, among *Civilians*, an investigation of truth, interrogation of witnesses, and inquiry made into any fact, especially by torture.

ANACRUSIS (ἀνάκρουσις), in *Antiquity*, denotes a part of the Pythian song, wherein the combat of Apollo and Python is described. The anacrusis was the first part, and contained the preparation to the fight.

ANADEMA (ἀνάδημα), among the *Ancients*, denoted an ornament of the head, wherewith victors at the sacred games had their temples bound.

ANADIPLOSIS (ἀνα and δίπλοος, *double*), in *Rhetoric* and *Poetry*, a repetition of the last word of a line, or clause of a sentence, in the beginning of the next: thus,

> Pierides, vos hæc facietis maxima Gallo:
> Gallo, cujus amor, &c.
> Et matutinis accredula vocibus instat,
> Vocibus instat, et assiduas jacit ore querelas.

ANADYOMENE APHRODITE (ἀναδυομένη, *emerging*), in *Grecian Mythology*, answered to the Sea Venus of the Romans, and described that goddess as rising from the sea. The most celebrated picture in all antiquity was the Aphrodite Anadyomene by Apelles.

ANADYR, a river in North Asiatic Russia, arising from a lake between Lat. 68° and 69°, consequently within the Arctic circle. After passing southwards, a little way beyond that circle, its general course is to the east, and it discharges itself into Behring's Strait, near the promontory of Tschutskoi Nos.

ANÆSTHESIA. See CHLOROFORME.

ANAFESTO PAOLLUCIO, of Heracleia, was elected the first Doge of Venice, A.D. 697, and was succeeded in office by Marcello Tagliana in 717.—Sismondi, *Hist. Rep. Ital.* i.; Figliasi, *Mem. de' Veneti* i.

ANAGLYPH (from ἀνά and γλύφω), any work sculptured in relief on a plane or smooth surface, as exemplified in cameos. When the object or design is produced by engraving or indenting, as in seals, the work is styled *diaglyphic*, or *intaglio*.

ANAGNIA, now AGNANI, a town of Italy, once the capital of the ancient Hernici, and still containing about 6000 inhabitants. It occupies the summit of a hill, above the *Fiume Sacco*, about 35 miles E.S.E. of Rome.

ANAGNOSTA, JOHN, a Byzantine historian of the fifteenth century. He was present at the siege of Thessalonica by Amurath in 1430, of which he gives an account in his work *De Rebus Constantinopolitanorum Macedonius.*

ANAGNOSTES (ἀναγνώστης), in *Antiquity*, a kind of literary servant, retained in the families of persons of distinction, and whose chief business was to read to them during meals, or at any other time. Cornelius Nepos relates of Atticus, that he had always an anagnostes at his meals.

ANAGOGE (ἀναγωγή), among *Ecclesiastical Writers*, the elevation of the mind to things celestial and eternal. It is particularly used where words, in their natural or primary meanings, denote something sensible, but have a further view to something spiritual or invisible.

In a more particular sense, it denotes the application of the types and allegories of the Old Testament to subjects of the New; thus called, because the veil being here drawn, what before was hidden is exposed to open sight.

ANAGRAM (from the Greek ἀνά, *backwards*, and γράμμα, *letter*), a transposition of the letters of some name, whereby a new word is formed, either to the advantage or disadvantage of the person or thing to which the name belongs. Thus the anagram of Galenus is *angelus;* that of Logica, *caligo;* that of Alstedius, *sedulitas.* Calvin, in the title of his *Institutions*, printed at Strasburg in 1539, calls himself *Alcuinus*, which is the anagram of Calvinus, and the name of the great restorer of learning in the time of Charlemagne.

Those who adhere strictly to the definition of an anagram take no other liberty than that of omitting or retaining the letter H at pleasure; whereas others make no scruple to use E for Æ, V for W, S for Z, and C for K; and *vice versa.* Besides anagrams formed as above, we meet with another kind in ancient writers, made by dividing a single word into several; thus, *sus tinea mus* are formed out of the word *sustineamus.* Anagrams are sometimes also made out of several words; such as that on the question put by Pilate to our Saviour, *Quid est veritas?* whereof we have this admirable anagram, viz., *Est vir qui adest.* A work entitled *Z. Celspirii* (Christ. Serpilii) *de Anagrammatismo, Libri II.* Ratisb. 1715, 8vo, gives numerous examples of this art.

The cabalists among the Jews are professed anagrammatists; the third part of their art, which they call *themuru, i.e.*, changing, being nothing but the art of making anagrams, or finding hidden and mystical meanings in names; which they do by changing, transposing, and differently combining the letters of those names. Thus, of נח, the letters of Noah's name, they make חן, *grace;* of משיח, *the Messiah*, they make ישמח, *he shall rejoice.*

Thomas Billon, a Provençal, was a celebrated anagrammatist, and retained by Louis XIII. with a pension of 1200 livres, in the capacity of anagrammatist to the king.

ANAGROS, in *Commerce*, a measure for grain, used in some cities in Spain, particularly at Seville. It is equal to two bushels.

ANAITIS ('Ανῖατις), an Armenian divinity, whom the Greeks sometimes identified with their own Artemis and Aphrodite. From the nature of her worship, she appears to have represented the creative powers of nature. Her name is variously written—Anaitis, Anæa, Aneitis, Tanaïs, or Nanæa.—*Vide* Plin. xxxiii.

ANAK, the father of the Anakim, was the son of Arba, who gave his name to Kirjath-arba, or Hebron. (Josh. xiv. 15.) Anak had three sons, Sheshai, Ahiman, and Talmai (chap. xv. 14, and Numb. xiii. 22), all of gigantic size; their posterity were remarkable, not only for their extraordinary stature, but for their fierceness, and were called *Anakim;* in comparison with whom, the Hebrews who were sent to view the land of Canaan reported that they were but as grasshoppers. (Numb. xiii. *ult.*) Caleb, assisted by the tribe of Judah, took Kirjath-arba, and destroyed the Anakim, A.M. 2559. (Judges i. 20, and Joshua xv. 14.)



ANALECTA (ἀνάλεκτα), in literature, is used to denote a collection of small pieces; as essays, remarks, &c.

ANALEMMA, in *Geometry*, a projection of the sphere on the plane of the meridian, orthographically made by a straight line and ellipses, the eye being supposed at an infinite distance, and in the east or west point of the horizon.

ANALEMMA denotes likewise an instrument of brass or wood, upon which this kind of projection is drawn, with an horizon or cursor fitted to it, wherein the solstitial colure, and all circles parallel to it, will be concentric circles; all circles oblique to the eye will be ellipses; and all circles whose planes pass through the eye will be right lines. The use of this instrument is to show the common astronomical problems, which, if not too large, it will do, though not very exactly.

ANALEPSIS (from ἀναλαμβάνω, *to restore*), the augmentation or nutrition of an emaciated body.

ANALEPTICS, restorative or nourishing medicines.

ANALOGY (ἀναλογία), in *Philosophy*, a certain relation and agreement between two or more things, which in other respects are entirely different. There is likewise an analogy between things that have some resemblance to one another; for example, between animals and plants; but the analogy is still stronger between different species of animals.

Analogy enters much into all our reasoning, and serves to explain and illustrate. A great part of our philosophy, indeed, has no other foundation than analogy.

"It is natural to mankind," says Dr Reid, "to judge of things less known, by some similitude, real or imaginary, between them and things more familiar or better known. And where the things compared have really a great similitude in their nature, when there is reason to think that they are subject to the same laws, there may be a considerable degree of probability in conclusions drawn from analogy. Thus, we may observe a very great similitude between this earth which we inhabit, and the other planets, Saturn, Jupiter, Mars, Venus, and Mercury. They all revolve round the sun, as the earth does, although at different distances and in different periods. They borrow all their light from the sun, as the earth does. Several of them are known to revolve round their axis like the earth, and, by that means, must have a like succession of day and night. Some of them have moons, that serve to give them light in the absence of the sun, as our moon does to us. They are all, in their motions, subject to the same law of gravitation as the earth is. From all this similitude, it is not unreasonable to think that those planets may, like our earth, be the habitation of various orders of living creatures. There is some probability in this conclusion from analogy.

"But it ought to be observed, that as this kind of reasoning can afford only probable evidence at best, so, unless great caution be used, we are apt to be led into error by it."—"No author has made a more just and a more happy use of this mode of reasoning than Bishop Butler, in his *Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature.* In that excellent work, the author does not ground any of the truths of religion upon analogy, as their proper evidence; he only makes use of analogy to answer objections against them. When objections are made against the truths of religion, which may be made with equal strength against what we know to be true in the course of nature, such objections can have no weight.

"Analogical reasoning, therefore, may be of excellent use in answering objections against truths which have other evidence. It may likewise give a greater or a less degree of probability in cases where we can find no other evidence. But all arguments drawn from analogy are still the weaker, the greater disparity there is between the things compared; and therefore must be weakest of all when we compare body with mind, because there are no two things in nature more unlike.

"There is no subject in which men have always been so prone to form their notions by analogies of this kind, as in what relates to the mind. We form an early acquaintance with material things by means of our senses, and are bred up in a constant familiarity with them. Hence we are apt to measure all things by them, and to ascribe to things most remote from matter the qualities that belong to material things. It is for this reason that mankind have, in all ages, been so prone to conceive the mind itself to be some subtile kind of matter; that they have been disposed to ascribe human figure and human organs, not only to angels, but even to the Deity." (*Essays on the Intellectual Powers.*) See Locke's *Essay*, B. iv. c. xvi. § 12; Beattie *on Truth*, part i. c. 2, § 7; and Stewart's *Philosophy of the Mind*, vol. ii. chap. ii. § 4.

Analogy, in *Grammar*, is the correspondence which a word or phrase bears to the genius and received forms of any language.

ANALYSIS (from ἀναλύω, *to resolve*), in a general sense, implies the resolution of something compounded into its original and constituent parts.

Analysis, in *Mathematics*, is properly the method of resolving problems by means of algebraical equations, whence we often find that these two words, *analysis* and *algebra*, are used as synonymous. *Analysis* is divided, with regard to its object, into that of *finites* and *infinites*. *Analysis of Finite Quantities* is what we otherwise call specious arithmetic or algebra. *Analysis of Infinites*, called also the *New Analysis*, is particularly used for the method of fluxions, or the differential calculus.

Analysis, in *Mental Philosophy*, signifies the process of decompounding our thoughts into their simplest elements, or of resolving our intellectual operations into their primary principles.

Analysis, in *Physics*, and in *Chemistry*, also denotes decomposition, that is, the separation of what is complex into its constituent parts. The different meanings of the term *Analysis*, as used in mathematics and the other branches of science, are well explained in Stewart's *Philosophy of the Mind*, vol. ii. chap. iv. § 3.

ANAM, or An-nam, a large country in the south-eastern part of Asia, between China and the Gulf of Siam, 965 miles in length from north to south, with a breadth varying from about 85 miles to 400. It has a long, winding, and much indented sea-coast, affording many safe and commodious harbours. The view which the country presents from the sea is that of a varied landscape, composed of bold headlands, picturesque valleys, well-cultivated slopes, extensive down and low plains, frequently terminating in sandhills, with a distant background of lofty mountains. Along the coast are numerous groups of islands. It is all comprised in one empire; but it is made up of three distinct territories, and part of a fourth, all formerly separate independent states, namely, Tonquin, Cochin-China, Champa, or Tsiampa, and the eastern part of Cambodia, or Camboja; which see.

ANAMNESIS, ἀνάμνησις, a rhetorical figure, the calling to remembrance of something omitted.

ANAMORPHOSIS, in *Perspective Drawing*, is a deformed or distorted figure, which appears confused and unintelligible to the common unassisted view; but when seen at a certain distance and height, or as reflected from a plane or curved mirror, appears regular and in right proportion.

ANAMOUR, Cape, in Lat. 36. 3. N. Long. 32. 50. E., is the most southern point of Asia Minor. It was the ancient Anemurium.



ANANCITIS, in *Antiquity*, a kind of figured stone, otherwise called *synochitis*, celebrated for its magical virtue of raising the shadows of the infernal gods.

ANANIAS, a Sadducee, high priest of the Jews, who put to death St James, the brother of our Lord, and was deposed by Agrippa.

Ananias, a Christian belonging to the infant church at Jerusalem, who, conspiring with his wife Sapphira to deceive and defraud the brethren, was overtaken by sudden death, and immediately buried. (Acts v. 1–11).

Ananias, a Christian of Damascus who was commanded in a vision to go and visit the newly converted Saul of Tarsus. (See Acts ix. 10; xxii. 12.)

Tradition represents Ananias as the first that published the Gospel in Damascus, over which place he was subsequently made bishop; but having roused, by his zeal, the hatred of the Jews, he was seized by them, scourged, and finally stoned to death in his own church.

ANANISABTA, or Ananisapta, a magical word frequently found inscribed on coins and other amulets, supposed to have the virtue of preserving the wearer from the plague.

ANAPÆST, in *Ancient Poetry*, a foot consisting of two short syllables and one long: such is the word scŏpŭlōs. It is just the reverse of the dactyl.

ANAPHORA, in *Rhetoric*, the repetition of the same word or words in the beginning of a sentence or verse.

ANAPHRODISIA, a medical term derived from the Greek, signifying impotence.

ANARCHY, the want of government in a nation, where no supreme authority is lodged either in the prince or other rulers, but the people live at large, and all things are in confusion. The word is derived from the Greek privative α, and ἀρχή, *command, government.*

ANASARCA, an effusion of serum into the cellular tissues, occasioning a soft, pale, inelastic swelling.

ANASTASIUS I., Emperor of the East, and the successor of Zeno, was raised from obscurity to that exalted position by the Empress Ariadne, who married him on the fortieth day of her widowhood. His reign commenced auspiciously, but was afterwards disturbed by foreign and intestine wars, and by religious distractions. In the year 500 he was anathematized by pope Symmachus for his support of the Eutychians. He died in 518 at the age of nearly 90, leaving behind a name darkened by avarice, cruelty, and cowardice.

Anastasius II., whose proper name was *Artemius*, was elevated from the humble situation of a secretary to the throne of Constantinople, by the free voice of the senate and Roman people, A.D. 713. His natural talents, improved by education and daily exertion, enabled him to manage with great prudence the affairs of the empire during the time that he was secretary to his predecessor Philippicus. The Saracens had made inroads upon Asia Minor in the beginning of his reign; but he sent a strong army to the frontiers of Syria for its protection, under the command of Leo the Isaurian, a man of great military experience. These enemies of the empire also meditated the design of taking Constantinople; but the vigilance of Anastasius defeated their purpose, by providing a formidable naval force, repairing and strengthening the walls of the city, and by forcing all the inhabitants either to provide themselves with provisions for three years, or instantly to depart from the city. Disappointed in their design, the enemy's fleet sailed to Phœnicia, and the imperial fleet assembled at Rhodes to watch the motions of the enemy. But the measures of the emperor received a severe check from the conduct of the sailors, who raised a mutiny, and slew their admiral for no other cause than his honourable endeavours to maintain proper discipline in the fleet. Justly dreading severe punishment, the seamen raised the standard of rebellion, declared Anastasius unworthy to reign, and conferred the purple upon one Theodosius, a person of mean birth. Informed of this sedition, Anastasius fled from his tottering throne to Nice. The new emperor hastened to besiege Constantinople, which, after a vigorous resistance of six months, was reduced to subjection. The late emperor being assured of his life, abandoned his claim to the crown, assumed the character of a monk, and was banished to Thessalonica, having worn the purple only during the space of two years. Having, however, prevailed upon the Bulgarians to espouse his cause, he laid aside the habit of the monk for that of the warrior, and, in the year 721, in the time of the Emperor Leo, he resumed his claim to the throne. A numerous army of these barbarians hastened to the capital; but being unable to reduce it, they delivered up the unhappy Anastasius to the emperor, who put him to death, along with his principal associates.

ANASTASIUS, surnamed *Bibliothecarius*, a Roman abbot, library-keeper of the Vatican, and one of the most learned men of the ninth century, assisted in 869 at the fourth general council, the acts and canons of which he translated from the Greek into Latin. He also composed the lives of several popes, and other works: the best edition of which is that of the Vatican.

ANASTOMATICS, medicines supposed to have the power of opening the mouths of vessels, and promoting the circulation; such as deobstruents, cathartics, and sudorifics.

ANASTOMOSIS. See ANATOMY.

ANASTROPHE, in *Rhetoric* and *Grammar*, denotes the inversion of the natural order of the words: such is *saxa per et scopulos*, for *per saxa et scopulos*.

ANATHEMA (ἀνάθεμα), among *Ecclesiastical Writers*, imports whatever is set apart, separated, or divided; but is most usually meant to express the cutting off a person from the privileges of communion with the faithful. The anathema differs from excommunication in the circumstances of being attended with curses and execrations. It was practised in the primitive church against notorious offenders. Several councils also have pronounced anathemas against such as they thought corrupted the purity of the faith. There are two kinds of anathemas, the one judiciary and the other abjuratory. The former can only be denounced by a council, a pope, or a bishop; the latter makes a part of the ceremony of abjuration, the convert being obliged to anathematize the heresy he abjures.

ANATHEMA (ἀνάθημα), in *Heathen Antiquity*, was an offering or present made to some deity, and hung up in the temple. Whenever a person left off his employment, it was usual to dedicate the tools to the patron deity of the trade. Persons, too, who had escaped from imminent danger, as shipwreck and the like, or had met with any other remarkable instance of good fortune, seldom failed to testify their gratitude by some present of this kind.

ANATOCISMUS (from ἀνα and τόκος), in *Antiquity*, a kind of usury corresponding to what we call *compound interest*. This is the worst kind of usury, and has been severely condemned by the Roman law, as well as by the common laws of most other countries.

ANATOLIA. See NATOLIA.

# ANATOMY.

ANATOMY (Ανατομη), signifying literally dissection, or separation of parts by cutting, applied to organized bodies, is used to denote the artificial separation of their component parts in order to obtain an exact knowledge of their situation, shape, and structure.

A more just idea of the nature and objects of anatomy may be given by defining it as that science, the province of which is to ascertain the structure of living and organized bodies.

All the objects of the material world may be arranged in two great divisions, according as they are organized or void of organization. Inorganic bodies (*corpora bruta*) are distinguished by the homogeneous characters of their internal structure, any one portion of which, in the same mass, presents the same appearance and properties as any other. Endowed also with the general properties of matter, as weight, cohesion, impenetrability, and atomic attraction, or that resident in the constituent particles, they are subject to physical laws only. All the changes which inorganic bodies undergo consist either in mechanical changes of place or shape, or in change of chemical constitution; and the consideration of the mode in which these changes take place, of the agents by which they are effected, and the laws by which they are regulated, constitutes the sciences of MECHANICS and CHEMISTRY.

In organic bodies (*corpora organica, c. viva*), on the contrary, we recognise a peculiar structure, in which the parts, though arranged in a certain order, are heterogeneous, or consist of different kinds of matter. In other words, not only do organized bodies consist of different kinds of substance, but these component substances may be again resolved into material elements, differing from each other in mechanical, chemical, and vital properties.

Observation further shows, that organic are distinguished from inorganic bodies by the presence of a series and combination of actions and processes, which are collectively known under the abstract denomination of *Life*. Of this term, however familiar it may appear, it has been found difficult to give a satisfactory and unobjectionable definition; and physiological authors have found it requisite, in order to avoid obscurity, to define it from its tendency, its obvious effects, or, negatively, from what experience shows to ensue upon its termination. Life is an attribute of living bodies, and is known only as it manifests its presence in these; and hence, instead of saying what it is, we are compelled to specify only the circumstances which denote its existence. Attentively considered, all the varieties of organized and living bodies may be said to be distinguished from those which are inorganic by two great characters,—growth or the reproduction of the individual, and generation or the reproduction of the species. Growth, or increase of size, includes the general processes of assimilation and nutrition, with all the subordinate actions of which these are composed; and since it consists in the conversion of brute or inorganic into living or organic matter, it constitutes one of the most essential characters of life and organization. By virtue of this, living bodies are the seat of an incessant change in their interior structure; whereas inorganic bodies remain in the same state, unless from the operation of chemical laws. The formation of a new body similar to others of the same class, order, and kind, however various in its mode, is also a uniform attribute of all living and organized bodies. To one or other of these two general purposes, then, all the actions and processes of living bodies, however complex and multifarious they seem, may be ultimately referred. To these two characters of living bodies Cuvier adds a third,—death, or the termination of life; but as this is a negative circumstance, and is included in the idea of life as a process having beginning and end, it is superfluous in the general idea of the term. The knowledge of the actions and processes of living and organized bodies, and of the laws to which they are subject, constitutes the science of PHYSIOLOGY, or, as it has been also denominated, ZOONOMY (ζωη and νομος, *laws of life*,) or BIOLOGY (βιος and λογος, *doctrine of life*).

Life supposes organization or the arrangement of matter and material particles peculiar to living bodies; and, reciprocally, organization, though not the cause of life and living processes, invariably implies their existence, either present or previous. In other words, every organized body either is or must have been living; and every living body is endowed with the peculiar internal structure termed *organic*. Though it is difficult to specify by definition the characters of this structure, some idea of it may be communicated by stating, that all living bodies possess material organs of definite shape, substance, and structure, consisting of certain parts, and placed in proper positions. While it is the province of PHYSIOLOGY to study the actions and processes of living bodies, and to investigate the laws by which they are regulated, the exclusive object of ANATOMY is to distinguish and describe their constituent parts,—to determine the shape, position, and structure of their organs,—and, in short, to develope their structure. The term is not free from objection, since it literally denotes one only of the means employed to acquire the information requisite. But the objection is not obviated by the substitution of such terms as *morphology* and *organology*, in so far as the study of anatomy is not confined either to the shapes of parts or the knowledge of organs alone, but considers their position, their intimate structure, and their organization; in short, all the circumstances relating to the material constitution of living bodies.

All living and organized bodies, though agreeing in the general character of possessing organs for assimilation and nutrition, and organs of reproduction, differ nevertheless in the possession or the want of organs for two other functions, viz. those for recognising the presence of foreign bodies, or organs of *sensation*, and those for changing place, or organs of *locomotion*. The possession of these organs distinguishes those living beings denominated ANIMALS; the want of them in like manner characterizes those termed PLANTS or VEGETABLES. Upon this principle anatomy, or the science of organic structures, resolves itself into two great divisions,—ANIMAL ANATOMY, or ZOOTOMY (ζωον and τομη), the object of which is the investigation of the structure of animal bodies; and VEGETABLE ANATOMY, or PHYTOTOMY (φυτον and τομη), the object of which is to explain the structure peculiar to the vegetable tribes.

Animal anatomy, again, naturally resolves itself into several divisions, according as the object is to explain the structure of the animal kingdom at large, or that of certain classes, orders, tribes, families, or genera only. The most ordinary and convenient division, however, is into that which treats of the anatomy of the known animal tribes in general, and that which treats of the structure peculiar to the human subject. The accidental circumstance of the former being studied chiefly in comparison with the latter, the organic forms of which are regarded as the standard of reference, has given it the denomination of COMPARATIVE ANATOMY, though that of ANIMAL ANATOMY or ZOOTOMY would be more appropriate. The latter has generally been named ANATOMY simply, or the Anatomy of the Human Body, and occasionally ANTHROPOTOMY or HUMAN ANATOMY.

The connection which subsists between the latter and the several divisions of the art of healing, renders it interesting to the medical, the surgical, and the philosophical reader generally, and invests it with the highest importance to all. Comparative Anatomy, nevertheless, possesses the peculiar advantage of directing the mind of the inquirer to general resemblances, to universal facts, and to comprehensive analogies. Independent of the important services which its knowledge renders to several of the arts, it is of the greatest use in throwing light on some of the obscurest parts of physiology; by the extensive chain of analogical facts which it traces, it tends to explain difficulties in organization and function, which could not otherwise be intelligible; and by establishing the connection between external characters and habits with peculiarities of internal structure, it affords the only rational basis for the classifications and distinctions of zoology. Comparative or Animal Anatomy constitutes the great source of what may be termed the Philosophy of Animal Life.

Of the present treatise, the greater part will be devoted to the subject of HUMAN ANATOMY, or the explanation of the structure of the human frame in the healthy state. In a smaller proportion, it is proposed to give a view of the structure of animal bodies generally, with occasional observations on those peculiarities in configuration and structure which distinguish classes, orders, and genera, from each other. This will constitute COMPARATIVE ANATOMY.

The subject of VEGETABLE ANATOMY, unfolding the peculiarities of structure observed in plants, will be treated of in the article BOTANY.

Previous to entering on the subject of Animal Anatomy, however, and its two divisions, Human and Comparative Anatomy, it is requisite to take a historical view of the progress of the science from its origin to the present time.

History.

In tracing the history of the origin of anatomy, it may be justly said that more learning than judgment has been displayed. Some writers claim for it the highest anti- B.C. 1957–
quity, and pretend to find its first rudiments alternately in 1537.
the animal sacrifices of the shepherd kings, the Jews, and other ancient nations; and in the art of embalming, as practised by the Egyptian priests. Even the descriptions 1184.
of wounds in the Iliad have been supposed adequate to prove that, in the time of Homer, mankind had distinct notions of the structure of the human body. Of the first, it may be said that the rude information obtained by the slaughter of animals for sacrifice does not imply profound anatomical knowledge; and those who adduce the second as evidence, are deceived by the language of the poet of the Trojan war, which, distinguishing certain parts by their ordinary Greek epithets, as afterwards used by Hippocrates, Galen, and all anatomists, has been rather too easily supposed to prove that the poet had studied systematically the structure of the human frame.

With not much greater justice has the cultivation of anatomical knowledge been ascribed to Hippocrates, who, because he is universally allowed to be the father of medicine, has also been thought to be the creator of the science of anatomy. Of the seven individuals of the fa- 460–377.
mily of the Heracleidæ who bore this celebrated name, the second, who was son of Heraclides and Phenarita, and grandson of the first Hippocrates, was indeed distinguished

History. as the author of medical observation and experience, and the first who appreciated the value of studying accurately the phenomena, effects, and terminations of disease. It does not appear, however, notwithstanding the vague and general panegyrics of Riolan, Bartholin, Le Clerc, and Portal, that the anatomical knowledge of this illustrious person was either accurate or profound. Of the works ascribed to Hippocrates, five only are genuine. Most of them were written either by subsequent authors of the same name, or by one or other of the numerous impostors who took advantage of the zealous munificence of the Ptolemies, by fabricating works under that illustrious name. Of the few which are genuine, there is none expressly devoted to anatomy; and of his knowledge on this subject, the only proofs are to be found in the exposition of his physiological opinions, and his medical or surgical instructions. From these it appears that he had some accurate notions on osteology; but that of the structure of the human body in general, his ideas were at once superficial and erroneous. In his book on injuries of the head, and in that on fractures, he shows that he knew the sutures of the cranium, and the relative situation of the bones; and that he had some notion of the shape of the bones in general, and of their mutual connections. Of the muscles, of the soft parts in general, and of the internal organs, his ideas are confused, indistinct, and erroneous. The term φλεβς he seems, in imitation of the colloquial Greek, to have used generally to signify a blood-vessel, without being aware of the distinction of vein and artery; and the term αρτηρια, or air-holder, is restricted to the windpipe. He appears to have been unaware of the existence of the nervous chords; and the term is used by him, as by Grecian authors in general, to signify a *sinew* or *tendon*. On other points his knowledge is so much combined with peculiar physiological doctrines, that it is impossible to assign them the character of anatomical facts; and even the works in which these doctrines are contained are with little probability to be ascribed to the second Hippocrates. If, however, we overlook this difficulty, and admit what is contained in the genuine Hippocratic writings to represent at least the sum of knowledge possessed by Hippocrates and his immediate descendants, we find that he represents the brain as a gland, from which exudes a viscid fluid; that the heart is muscular and of pyramidal shape, and has two ventricles separated by a partition, the fountains of life—and two auricles, receptacles of air; that the lungs consist of five ash-coloured lobes, the substance of which is cellular and spongy, naturally dry, but refreshed by the air; and that the kidneys are glands, but possess an attractive faculty, by virtue of which the moisture of the drink is separated, and descends into the bladder. He distinguishes the bowels into colon and rectum (ὁ αρχος).

374. The knowledge possessed by the second Hippocrates was transmitted in various degrees of purity to the descendants and pupils, chiefly of the family of the Heracleidæ, who succeeded him. Several of these, with feelings of grateful affection, appear to have studied to preserve the written memory of his instructions, and in this manner to have contributed to form part of that collection of treatises which have long been known to the learned world under the general name of the *Hippocratic writings*. Though composed, like the genuine remains of the physician of Cos, in the Ionian dialect, all of them differ from these in being more diffuse in style, more elaborate in form, and in studying to invest their anatomical and medical matter with the fanciful ornaments of the Platonic philosophy. Hippocrates had the merit of early recognising the value of facts apart from opinions, and of those facts especially which lead to general results; and in the few genuine writings which are now extant, it is easy to perceive that he has recourse to the simplest language, expresses himself in terms which, though short and pithy, are always precise and perspicuous, and is averse to the introduction of philosophical dogmas. Of the greater part of the writings collected under his name, on the contrary, the general character is verboseness, prolixity, and a great tendency to speculative opinions. For these reasons, as well as for others derived from internal evidence, while the Aphorisms, the Epidemics, and the works above mentioned, bear distinct marks of being the genuine remains of Hippocrates, it is impossible to regard the book περι Φυσιος Ανθρωπου as entirely the composition of that physician; and it appears more reasonable to view it as the work of some one of the numerous disciples to whom the author had communicated the results of his observation, which they unwisely attempted to combine with the philosophy of the Platonic school and their own mysterious opinions.

Among those who aimed at this distinction, the most 374.
fortunate in the preservation of his name is Polybus, the son-in-law of the physician of Cos. This person, who must not be confounded with the monarch of Corinth immortalized by Sophocles in the tragic story of Œdipus, is represented as a recluse, severed from the world and its enjoyments, and devoting himself to the study of anatomy and physiology, and to the composition of works on these subjects. To him has been ascribed the whole of the book on *the Nature of the Child*, and most of that *on Man;* both physiological treatises, interspersed with anatomical sketches. His anatomical information, with which at present is our chief concern, appears to have been rude and inaccurate, like that of his preceptor. He represents the large vessels of the body to consist of four pairs: the first proceeding from the head by the back of the neck and spinal chord to the hips, lower extremities, and outer ankle; the second, consisting of the jugular vessels (αἰ σφαγιτιδες), proceeding to the loins, thighs, hams, and inner ankle; the third proceeding from the temples by the neck to the *scapula* and lungs, and thence by mutual intercrossings to the spleen and left kidney, and the liver and right kidney, and finally to the rectum; and the fourth from the fore-part of the neck to the upper extremities, the fore-part of the trunk, and the organs of generation.

This specimen of the anatomical knowledge of one of 363.
the most illustrious of the Hippocratic disciples differs not essentially from that of Syennesis, the physician of Cyprus, and Diogenes, the philosopher of Apollonia, two authors, for the preservation of whose opinions we are indebted to Aristotle.[1] They may be admitted as representing the state of anatomical knowledge among the most enlightened men at that time, and they only show how rude and erroneous were their ideas on the structure of the animal body. It may indeed, without injustice, be said, that the anatomy of the Hippocratic school is not only erroneous, but fanciful and imaginary, in often substituting mere supposition and assertion for what ought to be matter of fact. From this censure it is impossible to exempt even the name of Plato himself, for whom some notices in the Timæus on the structure of the animal body, as taught by Hippocrates and Polybus, have procured a place in the history of the science.

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[1] Περι Ζωων Ἱστοριας, lib. iii. cap. ii.

History.

Amidst the general obscurity in which the early history of anatomy is involved, only two leading facts may be admitted with certainty. The first is, that previous to the time of Aristotle there was no accurate knowledge of anatomy; and the second, that all that was known was derived from the dissection of the lower animals only. By the appearance of Aristotle, this species of knowledge, which was hitherto acquired in a desultory and irregular manner, began to be cultivated systematically and with a definite object; and among the services which the philosopher of Stagira rendered to mankind, one of the greatest and most substantial is, that he was the founder of Comparative Anatomy, and was the first to apply its facts to the elucidation of zoology. The works of this ardent and original naturalist show that his zootomical knowledge was extensive, and often accurate; and from several of his descriptions it is impossible to doubt that they were derived from frequent personal dissection.

384. Aristotle, who was born 384 years before the Christian era, or in the first year of the 99th Olympiad, was, at the age of 39, requested by Philip to undertake the education of his son Alexander. During this period, it is said, he composed several works on anatomy, which however are now lost. The military expedition of his royal pupil into Asia, by laying open the animal stores of that vast and little known continent, furnished Aristotle with the means of extending his knowledge, not only of the animal tribes, but of their structure, and of communicating more accurate and distinct notions than were yet accessible to the world. A sum of 800 talents, and the concurrent aid of numerous
334–327. intelligent assistants in Greece and Asia, were intended to facilitate his researches in composing a system of zoological knowledge; but it has been observed, that the number of instances in which he was thus compelled to trust to the testimony of other observers, led him to commit errors in description, which personal observation might have enabled him to avoid.

The first three books of the *History of Animals*, a treatise consisting of ten books, and the four books on the *Parts of Animals*, constitute the great monument of the *Aristotelian Anatomy*. From these we find that Aristotle was the first who corrected the erroneous statements of Polybus, Syennesis, and Diogenes, regarding the blood-vessels, which they made, as we have seen, to arise from the head and brain. These he represents to be two in number, placed before the spinal column, the larger on the right, the smaller on the left, which, he also remarks, is by some called *aorta* (αορτη), the first time, we observe, which this epithet occurs in the history. Both he represents to arise from the heart, the larger from the largest upper cavity, the smaller or aorta from the middle cavity, but in a different manner, and forming a narrower canal. He also distinguishes the thick, firm, and more tendinous structure of the aorta from the thin and membranous structure of the vein. In describing the distribution of the latter, however, he confounds the *vena cava* and pulmonary artery, and, as might be expected, he confounds the ramifications of the former with those of the arterial tubes in general. While he represents the lung to be liberally supplied with blood, he describes the brain as an organ almost destitute of this fluid. His account of the distribution of the aorta is wonderfully correct. Though he does not notice the cœliac, and remarks that the aorta sends no direct branches to the liver and spleen, he had observed the mesenteric, the renal, and the common iliac arteries. It is nevertheless singular, that though he remarks particularly that the renal branches of the aorta go to the substance and not the *pelvis* (κοιλια) of the kidney, he appears to mistake the ureters for branches of the aorta.

History.

Of the nerves (νευρα) he appears to have the most confused notions. Making them arise from the heart, which he says has nerves (tendons) in its largest cavity, he represents the aorta to be a nervous or tendinous vein (νευρωδης φλεβς). By afterwards saying that all the articulated bones are connected by *nerves*, he makes them the same as ligaments; while the character of divisibility in the long direction identifies them rather with tendons; and the assertion that no part destitute of them has sensation, makes them approach to the nervous chords of the modern anatomists. He distinguishes suet, fat, and marrow, from each other; and though he admits the spinal chord to consist of the latter substance, he differs from those authors who regard the brain of the same nature, because while brain is cold, marrow is hot.

He distinguishes the windpipe or air-holder (αρτηρια) from the œsophagus, because it is placed before the latter, because food or drink passing into it causes distressing cough and suffocation, and because there is no passage from the lung to the stomach. He knew the situation and use of the epiglottis, seems to have had some indistinct notions of the larynx, represents the windpipe to be necessary to convey air to and from the lungs, and appears to have a tolerable understanding of the structure of the lungs. He repeatedly represents the heart, the shape and site of which he describes accurately, to be the origin of the blood-vessels, in opposition to those who made them descend from the head; yet, though he represents it as full of blood, and the source and fountain of that fluid, and even speaks of the blood flowing from the heart to the veins,[1] and thence to every part of the body,[2] he says nothing of the circular motion of the blood.

The diaphragm he distinguishes by the name διαζωμα, and ὑποζωμα. With the liver and spleen, and the whole alimentary canal, he seems well acquainted. The several parts of the quadruple stomach of the ruminating animals are distinguished and named; and he even traces the relations between the teeth and the several forms of stomach, and the length or brevity, the simplicity or complication, of the intestinal tube. Upon the same principle he distinguishes the *jejunum* (ἡ νηστις), or the empty portion of the small intestines in animals (το εντερον λεπτον), the *cœcum* (τυφλον τι και ογκωδες), the colon (το κωλον), and the sigmoid flexure (στενωτερον και ειλιγμενον). The modern epithet of *rectum* is the literal translation of his description of the straight progress (ευθυ) of the bowel to the anus (πρωκτος). He knew the nasal cavities and the passage from the tympanal cavity of the ear to the palate, afterwards described by Eustachius.

Next to Aristotle occur the names of Diocles of Carys- 354.
tus, and Praxagoras of Cos, the last of the family of the
Asclepiadæ. The latter is remarkable for being the first 341.
who distinguished the arteries from the veins, and the author of the opinion that the former were air-vessels.

Hitherto anatomical inquiry was confined to the examination of the bodies of brute animals. We have, indeed,

[1] Εκ της καρδιας γαρ εποχετευεται εις τας φλεβας. Αὑται γαρ ἐκ της καρδιας δεχονται το αἱμα. (Περι Ζωων Μοριων, lib. iii. cap. iv. v.)

[2] Συνισταμενων δε των μοριων εκ του αἱματος, καθαπερ ειπομεν, ευλογως ἡ των φλεβων ῥυσις δια παντος του σωματος πεφυκε. δει γαρ και το αἱμα δια παντος και περι παν ειναι, ειπερ των μοριων ἑκαστον εκ τουτου συνεστηκεν. εοικε δ᾽ ὡσπερ εν τε τοις κηποις αἱ ὑδραγωγιαι κατασκευαζονται απο μιας αρχης και πηγης, εις πολλους οχετους και αλλους αιει προς το παντη μεταδιδοναι. (*Ibid.* lib. iii. cap. v.)

History. no testimony of the human body being submitted to examination previous to the time of Erasistratus and Herophilus; and it is vain to look for authentic facts on this point before the foundation of the Ptolemaic dynasty of sovereigns in Egypt. This event, which, as is generally known, succeeded the death of Alexander, 320 years before the Christian era, collected into one spot the scattered embers of literature and science, which were beginning to languish in Greece under a weak and distracted government, and an unsettled state of society. The children of her divided states, whom domestic discord and the uncertainties of war rendered unhappy at home, wandered into Egypt, and found, under the fostering hand of the Alexandrian monarchs, the means of cultivating the sciences, and repaying with interest to the country of Thoth and Osiris, the benefits which had been conferred on the infancy of Greece by Thales and Pythagoras. Alexandria became in this manner the depository of all the learning and knowledge of the civilized world; and while other nations were sinking under the effects of internal animosities and mutual dissensions, or ravaging the earth with the evils of war, the Egyptian Greeks kept alive the sacred flame of science, and preserved mankind from relapsing into their original barbarism.

These happy effects are to be ascribed in an eminent degree to the enlightened government and liberal opinions
285. of Ptolemy Soter, and his immediate successors Philadelphus and Euergetes. The two latter princes, whose authority was equalled only by the zeal with which they patronised science and their professors, were the first who enabled physicians to dissect the human body, and prevented the prejudices of ignorance and superstition from compromising the welfare of the human race. To this happy circumstance Herophilus and Erasistratus are indebted for the distinction of being known to posterity as the first anatomists who dissected and described the parts of the human body. Both of these physicians flourished under Ptolemy Soter, and probably Ptolemy Philadelphus, and were indeed the principal supports of what has been named in medical history the Alexandrian School, to which their reputation seems to have attracted numerous pupils.

But though the concurrent testimony of antiquity assigns to these physicians the merit of dissecting the human body, time, which wages endless war with the vanity and ambition of man, has dealt hardly with the monuments of their labours. As the works of neither have been preserved, great uncertainty prevails as to the respective merits of these ancient anatomists; and all that is now known of their anatomical researches is obtained from the occasional notices of Galen, Oribasius, and some other wri-
304. ters. From these it appears that Erasistratus recognised the valves of the heart, and distinguished them by the names of *tricuspid* and *sigmoid;* that he studied particularly the shape and structure of the brain, and its divisions, and cavities, and membranes, and likened the convolutions to the folds of the jejunum; that he first formed a distinct idea of the nature of the nerves, which he made issue from the brain; and that he discovered lymphatic vessels in the mesentery, first in brute animals, and afterwards, it is said, in man. It is not uninteresting to observe, that he appears to have distinguished the nerves into those of sensation and those of motion.

Of Herophilus it is said that he had extensive anatomical knowledge, acquired by dissecting, not only brutes, but human bodies. Of these he probably dissected more than any of his predecessors or contemporaries. But it is History. almost superfluous to remind the classical reader, that the passage of Tertullian, in which he is said to have dissected 600 corpses, is not to be understood literally, and means only that he had dissected many; and that this language is employed by an author who speaks of him in terms of execration, and who evidently exaggerates in order to prejudice the reader against the anatomist. Devoted to the assiduous cultivation of anatomy, he appears to have studied with particular attention those parts which were least understood. He recognised the nature of the pulmonary artery, which he denominates *arterious vein;* he knew the vessels of the mesentery, and showed that they did not go to the *vena portæ*, but to certain glandular bodies; and he first applied the name of *twelve-inch* or *duodenum* (δωδεκαδακτυλος) to that part of the alimentary canal which is next to the stomach. Like Erasistratus, he appears to have studied carefully the configuration of the brain; and we learn from Galen that he first compared the linear furrow at the bottom of the fourth ventricle to the cavity of a writing pen; and though like him he distinguishes the nerves into those of sensation and those of voluntary motion, he adds to them the ligaments and tendons. A tolerable description of the liver by this anatomist is preserved in the writings of Galen.[1] He first applied the name of choroid or vascular membrane to that which is found in the cerebral ventricles; he knew the fourth or straight sinus, which still bears his name; he described the posterior end of the vault or fornix as the principal seat of the sensations; and to him the linear furrow at the bottom of the fourth ventricle is indebted for its name of *calamus scriptorius.*

The celebrity of these two great anatomists appears to have thrown into the shade, for a long period, the names of all other inquirers; for among their numerous and rather celebrated successors in the Alexandrian school, it is impossible to recognise a name which is entitled to distinction in the history of anatomy. In a chasm so wide it is not uninteresting to find, in one who combined the character of the greatest orator and philosopher of antiquity, the most distinct traces of attention to anatomical knowledge. Cicero, in his treatise *De Natura Deorum*, in a 44.
short sketch of physiology, such as it was taught by Aristotle and his disciples, introduces various anatomical notices, from which the classical reader may form some idea of the state of anatomy at that time. The Roman orator appears to have formed a pretty distinct idea of the shape and connections of the windpipe and lungs; and though he informs his readers that he knows the alimentary canal, he omits the details through motives of delicacy. In imitation of Aristotle, he talks of the blood being conveyed by the veins (*venæ*), that is, blood-vessels, through the body at large; and, like Praxagoras, of the air inhaled by the lungs being conveyed through the arteries.

Aretæus, though chiefly known as a medical author, makes some observations on the lung and the pleura, maintains the glandular structure of the kidney, and describes the anastomosis or communications of the capillary extremities of the *vena cava* with those of the portal vein.

The most valuable depository of the anatomical know- A. D. 3-5.
ledge of these times is the work of Celsus, one of the most judicious medical authors of antiquity. He left, indeed, no express anatomical treatise; but from the introductions to his 4th and 8th books, *De Medicina*, with incidental remarks in his 7th, the modern reader may

[1] Περι Ανατομικων Εγχειρησεων, lib. vi.

form very just ideas of the anatomical attainments of the Roman physician. From these it appears that Celsus was well acquainted with the windpipe and lungs, and the heart; with the difference between the windpipe and œsophagus (*stomachus*), which leads to the stomach (*ventriculus*); and with the shape, situation, and relations of the diaphragm. He enumerates also with accuracy the principal facts relating to the situation of the liver, the spleen, and the kidneys. His description of the situation and connections of the stomach is interesting. He appears, however, to have been unaware of the distinction of *duodenum* or twelve-inch bowel, already admitted by Herophilus, and represents the stomach as directly connected by means of the *pylorus* with the *jejunum* or upper part of the small intestine. His account of the rest of the alimentary canal, though brief and cursory, is accurate; and his subsequent descriptions of diseases seated in these parts show that he had formed ideas, upon the whole very just, of the relative positions of these parts.

The 7th and 8th books, which are devoted to the consideration of those diseases which are treated by manual operation, contain sundry anatomical notices necessary to explain the nature of the diseases, or mode of treatment. Of these, indeed, the merit is unequal; and it is not wonderful that the ignorance of the day prevented Celsus from understanding rightly the mechanism of the pathology of hernia. He appears, however, to have formed a tolerably just idea of the mode of cutting into the urinary bladder; and even his obstetrical instructions show that his knowledge of the uterus, vagina, and appendages was not contemptible. It is in osteology, however, that the information of Celsus is chiefly conspicuous. He enumerates the sutures and several of the holes of the cranium, and describes at great length the superior and inferior maxillary bones and the teeth. With a good deal of care he describes the vertebræ and the ribs, and gives very briefly the situation and shape of the *scapula, humerus, radius,* and *ulna,* and even the carpal and metacarpal bones, and then of the different bones of the pelvis and lower extremities. He had formed a just idea of the articular connections, and is desirous to impress the fact, that none is formed without cartilage. From his mention of many minute holes (*multa et tenuia foramina*), in the recess of the nasal cavities, it is evident that he was acquainted with the perforated plate of the ethmoid bone; and from saying that the straight part of the auditory canal becomes flexuous, and terminates in numerous minute cavities (*multa et tenuia foramina diducitur*), it is inferred by Portal that he knew the semicircular canals.

54–81. Though the writings of Celsus show that he cultivated anatomical knowledge, it does not appear that the science was much studied by the Romans; and there is reason to believe, that after the decay of the school of Alexandria it languished in neglect and obscurity. It is at least certain that the appearance of Marinus during the reign of Nero is mentioned by authors as an era remarkable for anatomical inquiry, and that this person is distinguished by Galen as the restorer of a branch of knowledge which had been before him suffered to fall into undeserved neglect. From Galen also we learn that he gave an accurate account of the muscles, that he studied particularly the glands, that he discovered those of the mesentery, and that he improved much the anatomical history of the nerves. The number of the latter he fixed at seven; he observed the palatine nerves, which he rated as the fourth pair; and described as the fifth the auditory and facial, which he regards as one pair; and the hypoglossal as the sixth.

Not long after Marinus, appeared Ruffus of Ephesus, a Greek physician, who in the reign of Trajan was much attached to physiology, and as a means of cultivating this science studied Comparative Anatomy, and made sundry experiments on living animals. Of the anatomical writings of this author, there remains only a list or catalogue of names of different regions and parts of the animal body. He appears, however, to have directed the attention particularly to the tortuous course of the uterine vessels, and to have recognised even at this early period the Fallopian tube. He distinguishes the nerves into those of sensation and those of motion. He knew the recurrent nerve. His name is further associated with the ancient experiment of compressing in the situation of the carotid arteries the pneumogastric nerve, and thereby inducing insensibility and loss of voice.

Of all the authors of antiquity, however, none possesses so just a claim to the title of anatomist as Claudius Galenus, the celebrated physician of Pergamus. This person, who was born about the 131st year of the Christian era, and lived under the reigns of Trajan, Antoninus, Commodus, and Ælius, was trained by his father Nicon, whose memory he embalms as an eminent mathematician, architect, and astronomer, to all the learning of the day, and initiated particularly into the mysteries of the Aristotelian philosophy. In an order somewhat whimsical he afterwards studied philosophy successively in the schools of the Stoics, the Academics, the Peripatetics, and the Epicureans. While at the age of 17, his father, he informs us, was admonished by a dream to devote his son to the study of medicine; but it was fully two years after, that Galen entered on this pursuit, under the auspices of an instructor, whose name he has thought proper to conceal. Shortly after, he betook himself to the study of anatomy under Satyrus, a pupil of Quintus, and of medicine under Stratonicus, a Hippocratic physician, and Æschrion, an empiric. He had scarcely attained the age of 20, when he had occasion to deplore the loss of the first and most affectionate guide of his studies; and soon after he proceeded to Smyrna to obtain the anatomical instructions of Pelops, who, though mystified by some of the errors of Hippocrates, is commemorated by his pupil as a skilful anatomist. After this he appears to have visited various cities, distinguished for philosophical or medical teachers; and, finally, to have gone to Alexandria with the view of cultivating more accurately and intimately the study of anatomy under Heraclianus. Here he remained till his 28th year, when he regarded himself as possessed of all the knowledge then attainable through the medium of teachers. He now returned to Pergamus, to exercise the art which he had so anxiously studied, and received, in his 29th year, an unequivocal testimony of the confidence which his fellow-citizens reposed in his skill, by being intrusted with the treatment of the wounded gladiators; and in this capacity he is said to have treated with success several wounds which used to be fatal. A seditious tumult appears to have caused him to form the resolution of quitting Pergamus and proceeding to Rome, at the age of 32. Here, however, he remained only five years; and returning once more to Pergamus, after travelling for some time, finally settled in Rome as physician to the emperor Commodus.

The anatomical writings ascribed to Galen, which are numerous, are to be viewed not merely as the result of personal research and information, but as the common depository of the anatomical knowledge of the day, and as combining all that he had learnt from the several teachers under whom he successively studied, with whatever personal investigation enabled him to acquire. It is on this account not always easy to distinguish what Galen had himself ascertained by personal research, from that which

History. was known by other anatomists. This, however, though of moment to the history of Galen as an anatomist, is of little consequence to the science itself; and, from the anatomical remains of this author, a pretty just idea may be formed, both of the progress and of the actual state of the science at that time.

The osteology of Galen is undoubtedly the most perfect of the departments of the anatomy of the ancients. He names and distinguishes the bones and sutures of the cranium nearly in the same manner as at present. Thus he notices the quadrilateral shape of the parietal bones; he distinguishes the squamous, the styloid, and the mastoid portions, and the lithoid or petrous portions of the temporal bones; and he remarks the peculiar situation and shape of the wedge-like or sphenoid bone. Of the ethmoid, which he omits at first, he afterwards speaks more at large in another treatise. The malar he notices under the name of zygomatic bone; and he describes at length the upper maxillary and nasal bones, and the connection of the former with the sphenoid. He gives the first clear account of the number and situation of the vertebræ, which he divides into *cervical*, *dorsal*, and *lumbar*, and distinguishes from the sacrum and coccyx. Under the head *Bones of the Thorax*, he enumerates the sternum, the ribs (αἱ πλευραι), and the dorsal vertebræ, the connection of which with the former he designates as a variety of *diarthrosis*. The description of the bones of the extremities and their articulations concludes the treatise.

Though in myology Galen appears to less advantage than in osteology, he nevertheless had carried this part of anatomical knowledge to greater perfection than any of his predecessors. He describes a frontal muscle, the six muscles of the eye, and a seventh proper to animals; a muscle to each *ala nasi*, four muscles of the lips, the thin cutaneous muscle of the neck, which he first termed *platysma myoides*, or muscular expansion, two muscles of the eyelids, and four pairs of muscles of the lower jaw, the temporal to raise, the masseter to draw to one side, and two depressors, corresponding to the digastric and internal pterygoid muscles. After speaking of the muscles which move the head and the scapula, he adverts to those by which the windpipe is opened and shut, and the intrinsic or proper muscles of the larynx and hyoid bone. Then follow those of the tongue, pharynx, and neck, those of the upper extremities, the trunk, and the lower extremities successively; and in the course of this description he swerves so little from the actual facts, that most of the names by which he distinguishes the principal muscles have been retained by the best modern anatomists. It is chiefly in the minute account of these organs, and especially in reference to the minuter muscles, that he appears inferior to the moderns.

The angiological knowledge of Galen, though vitiated by the erroneous physiology of the times, and ignorance of the separate uses of the arteries and veins, exhibits, nevertheless, some accurate facts which show the diligence of the author in dissection. Though, in opposition to the opinions of Praxagoras and Erasistratus, he proved that the arteries in the living animal contain not air, but blood, it does not appear to have occurred to him to determine in what direction the blood flows, or whether it was movable or stationary.[1] Representing the left ventricle of the heart as the common origin of all the arteries, though he is misled by the pulmonary artery, he nevertheless traces the distribution of the branches of the aorta with some accuracy. The *vena azygos* also, and the jugular veins, have contributed to add to the confusion of his description, and to render his angiology the most imperfect of his works. History.

In neurology we find him to be the author of the dogma, that the brain is the origin of the nerves of sensation, and the spinal chord of those of motion; and he distinguishes the former from the latter by their greater softness or less consistence. Though he admits only seven cerebral pairs, he has the merit of distinguishing and tracing the distribution of the greater part of both classes of nerves with great accuracy.

His description of the brain, though derived from dissection of the lower animals, is accurate; and his distinctions of the several parts of the organ have been retained by modern anatomists. His mode of demonstrating this organ, which indeed is clearly described, consists of five different steps. In the first the bisecting membrane, *i. e.* the falx (μηνιγξ διχοτομουσα), and the connecting blood-vessels are removed; and the dissector, commencing at the anterior extremity of the great fissure, separates the hemispheres gently as far as the *torcular*, and exposes a smooth surface (την χωραν τυλωδη πως ουσαν), the mesolobe of the moderns, or the middle band. In the second he exposes by successive sections the ventricles, the choroid plexus, and the middle partition. The third exhibits the conoid body (σωμα κωνοειδες) or conarium, concealed by a membrane with numerous veins, meaning that part of the plexus which is now known by the name of *velum interpositum*, and a complete view of the ventricles. The fourth unfolds the third ventricle (τις αλλη τριτη κοιλια), the communication between the two latter ones, the psalloid or arch-like body (σωμα ψαλιδοειδες) *fornix*, and the passage from the third to the fourth ventricle. In the fifth he gives an accurate description of the relations of the third and fourth ventricle, of the situation of the two pairs of eminences, *nates* (γλουτα) and *testes* (διδυμια vel ορχεις), the scolecoid or worm-like process, anterior and posterior, the tendons or processes, and lastly the linear furrow, called by Herophilus *calamus scriptorius*.[2] He appears not to have known the inferior recesses. Morgagni however concludes, from a passage of the 7th book περι Δογματων, that he did; but after accurately examining this and others of his anatomical writings, I cannot see any good reason for admitting the inference.

In the account of the thoracic organs equal accuracy may be recognised. He distinguishes the *pleura* by the name of inclosing membrane (ὑμην ὑπεζωκως, *membrana succingens*), and remarks its similitude in structure to that of the peritoneum, and the covering which it affords to all the organs.[3] The pericardium also he describes as a membranous sac with a circular basis corresponding to the base of the heart, and a conical apex; and after an account of the tunics of the arteries and veins, he speaks shortly of the lung, and more at length of the heart, which, however, he takes some pains to prove not to be muscular, because it is harder, its fibres are differently arranged, and its action is incessant, whereas that of muscle alternates with the state of rest. In the particular description of the parts of the organ he ascribes to the auricles a more cuticular structure than to the other parts; he gives a good account of the valves and of the vessels; and notices especially the bony ring formed in the heart of the horse, elephant, and other large animals.

The description of the abdominal organs, and of the

[1] Περι Ανατομικων Εγχειρησεων, lib. vii.

[2] Περι Ανατομικων Εγχειρησεων, lib. ix.

[3] Αλλ' ὁ ὑπεζωκως οὑτως ὑποτεινεται πασι τοις ενδον του θωρακος οργανοις, ὡς ὁ περιτοναιος ελεχθη, και εδειχθη τοις κατω των φρενων. *Ibid.*

kidneys and urinary apparatus, is still more minute, and in general very accurate. Our limits, however, do not permit us to give any abstract of them; and it is sufficient in general to say, that Galen gives correct views of the structure and distribution of the peritoneum and omentum, and distinguishes accurately the several divisions of the alimentary canal, and the internal structure of its component tissues. In the liver, which he allows to receive an envelope from the peritoneum, he admits, in imitation of Erasistratus, a proper substance or *parenchyma*, interposed between the vessels, and capable of removal by suitable dissection.

His description of the organs of generation is rather brief, and is, like most of his anatomical sketches, too much blended with physiological dogmas.

This short sketch may communicate some idea of the condition of anatomical knowledge in the days of Galen, who indeed is justly entitled to the character of rectifying and digesting, if not of creating, the science of anatomy among the ancients. Though evidently confined, perhaps entirely, by the circumstances of the times, to the dissection of brute animals, so indefatigable and judicious was he in the mode of acquiring knowledge, that many of his names and distinctions are still retained with advantage in the writings of the moderns. Galen was a practical anatomist, and not only describes the organs of the animal body from actual dissection, but gives ample instructions for the proper mode of exposition. His language is in general clear, his style as correct as in most of the authors of the same period, and his manner is animated. It is indeed impossible to imagine any thing so interesting as the description of the process for demonstrating the brain and other internal organs, which is given by this patient and enthusiastic observer of nature. To some it may appear absurd to speak of any thing like good anatomical description in an author who writes in the Greek language, or any thing like an interesting and correct manner in a writer who flourished at a period when taste was depraved or extinct, and literature corrupted,—when the philosophy of Antoninus, and the mild virtues of Aurelius, could do little to soften the iron sway of Lucius Verus and Commodus; but the habit of faithful observation in Galen seems to have been so powerful, that, in the description of material objects, his genius invariably rises above the circumstances of his age. Though not so directly connected with this subject, it is nevertheless proper to mention, that he appears to have been the first anatomist who can be said, on authentic grounds, to have attempted to discover the uses of organs by vivisection and experiments on living animals. In this manner he ascertained the position and demonstrated the action of the heart; and he mentions two instances in which, in consequence of disease or injury, he had an opportunity of observing the motions of this organ in the human body.[1] In short, without eulogizing an ancient author at the expense of critical justice, or commending his anatomical descriptions as superior to those of the moderns, it must be admitted that the anatomical writings of the physician of Pergamus form a remarkable era in the history of the science; and that by diligence in dissection, and accuracy in description, he gave the science a degree of importance and stability which it has retained through the lapse of many centuries.

The death of Galen, which took place at Pergamus in the 90th year of his age, and the 193d of the Christian era, may be regarded as the downfall of anatomy in ancient times. After this period we recognise only two names of any celebrity in the history of the science,—those of Soranus and Oribasius, with the more obscure ones of Meletius and Theophilus, the latter the chief of the imperial guard of Heraclius.



Soranus, who was an Ephesian, and flourished under the emperors Trajan and Hadrian, distinguished himself by his researches on the female organs of generation. He appears to have dissected the human subject; and this perhaps is one reason why his descriptions of these parts are more copious and more accurate than those of Galen, who derived his knowledge from the bodies of the lower animals. He denies the existence of the hymen, but describes accurately the clitoris. Soranus the anatomist must be distinguished from the physician of that name, who was also a native of Ephesus.

Oribasius, who was born at Pergamus, is said to have been at once the friend and physician of the emperor
Julian, and to have contributed to the elevation of that 361–363.
apostate to the imperial throne. For this he appears to have suffered the punishment of a temporary exile under Valens and Valentinian; but was soon recalled, and lived
in great honour till the period of his death. By Le Clerc, 387.
Oribasius is regarded as a compiler; and indeed his anatomical writings bear so close a correspondence with those of Galen, that the character is not altogether groundless. In various points, nevertheless, he has rendered the Galenian anatomy more accurate; and he has distinguished himself by a good account of the salivary glands, which were overlooked by Galen.

To the same period generally is referred the anatomical introduction of an anonymous author, first published in 1618 by Lauremberg, and more recently by Bernard. It is to be regarded as a compilation formed on the model of Galen and Oribasius. The same character is applicable to the treatises of Meletius and Theophilus.

The decline indicated by these languid efforts soon sunk into a state of total inactivity; and the unsettled state of society during the latter ages of the Roman empire became extremely unfavourable to the successful cultivation of science. The sanguinary conflicts in which the southern countries of Europe were repeatedly engaged with their northern neighbours, between the second and eighth centuries, tended gradually to estrange their minds from scientific pursuits; and the hordes of barbarians by which the Roman empire was latterly overrun, while they urged them to the necessity of making hostile resistance, and adopting means of self-defence, introduced such habits of ignorance and barbarism, that science was almost universally forgotten; and the art most essential to the success of military operations was either neglected or debased by the grossest ignorance. While the art of healing was professed only by some few ecclesiastics, or by itinerant practitioners, anatomy was utterly neglected; and no name of anatomical celebrity occurs to diversify the long and uninteresting period commonly distinguished as the middle ages.

Anatomical learning, thus neglected by European nations, is believed to have received a temporary cultivation from the Asiatics. Of these, several nomadic tribes, known to Europeans under the general denomination of Arabs and Saracens, had gradually coalesced under various leaders; and by their habits of endurance, as well as of enthusiastic valour, in successive expeditions against the eastern division of the Roman empire, had acquired such military reputation, as to render them formidable where-

[1] Περι Ανατομικων Εγχειρησεων, lib. vii.

ever they appeared. After a century and a half of foreign warfare or internal animosity, under the successive dynasties of the Ommiades and Abassides, in which the propagation of Islamism was the pretext for the extinction of learning and civilisation, and the most remorseless system of rapine and destruction, the Saracens began, under the latter dynasty of princes, to recognise the value of science, and especially of that which prolongs life, heals disease, and alleviates the pain of wounds and injuries. The caliph Almansor combined with his official knowledge of Moslem law, the successful cultivation of astronomy; but to his grandson Almamon, the seventh prince of the line of the Abassides, belongs the merit of undertaking to render his subjects philosophers and physicians. By the directions of this prince, the works of the Greek and Roman authors were translated into Arabic; and the favour and munificence with which literature and its professors were patronised, speedily raised a succession of learned Arabians. The residue of the rival family of the Ommiades, already settled in Spain, was prompted by motives of rivalry or honourable ambition to adopt the same course; and while the academy, hospitals, and library of Bagdad bore testimony to the zeal and liberality of the Abassides, the munificence of the Ommiades was not less conspicuous in the literary institutions of Cordova, Seville, and Toledo.

Notwithstanding the efforts of the Arabian princes, however, and the diligence of the Arabian physicians, little was done for anatomy, and the science made no substantial acquisition. The Koran denounces as unclean the person who touches a corpse; the rules of Islamism forbid dissection; and whatever their instructors taught was borrowed from the Greeks. Abu Bekr Al-Rasi, Abu-Ali Ibn-Sina, Abul-Casem, and Abu-Walid Ibn-Roschd, the Razes, Avicenna, Albucasis, and Averhoes of European authors, are their most celebrated names in medicine; yet to none of these can the historian with justice ascribe any anatomical merit. Al-Rasi has indeed left descriptions of the eye, of the ear and its *meatus*, and of the heart; and Ibn-Sina, Abul-Casem, and Ebn-Roschd, give anatomical descriptions of the parts of the human body. But of these the general character is, that they are copies from Galen, sometimes not very just, and in all instances mystified with a large proportion of the fanciful and absurd imagery and inflated style of the Arabian writers. The chief reason of their obtaining a place in anatomical history is, that, by the influence which their medical authority enabled them to exercise in the European schools, the nomenclature which they employed was adopted by European anatomists, and continued till the revival of ancient learning restored the original nomenclature of the Greek physicians. Thus, the *cervix*, or nape of the neck, is *nucha;* the œsophagus is *meri;* the umbilical region is *sumen*, or *sumac;* the abdomen is *myrach;* the peritoneum is *siphac;* and the omentum, *zirbus*.

From the general character now given, justice requires that we except Abdollatiph, the annalist of Egyptian affairs. This author, who maintains that it is impossible to learn anatomy from books, and that the authority of Galen must yield to personal inspection, informs us, that the Moslem doctors did not neglect opportunities of studying the bones of the human body in cemeteries; and that he himself, by once examining a collection of bones in this manner, ascertained that the lower jaw is formed of one piece; that the sacrum, though sometimes composed of several, is most generally of one; and that Galen is mistaken when he asserts that these bones are not single.

The era of Saracen learning extends to the 13th century; and after this we begin to approach happier times. The university of Bologna, which, as a school of literature and law, was already celebrated in the twelfth century, became, in the course of the following one, not
less distinguished for its medical teachers. Though the 1222-1224.
misgovernment of the municipal rulers of Bologna had disgusted both teachers and students, and given rise to the foundation of similar institutions in Padua and Naples, —and though the school of Salerno, in the territory of
the latter, was still in high repute,—it appears, from the 1241-1271.
testimony of Sarti, that medicine was in the highest esteem in Bologna, and that it was in such perfection as to require a division of its professors into physicians, surgeons, physicians for wounds, barber-surgeons, oculists, and even some others. Notwithstanding these indications of refinement, however, anatomy was manifestly cultivated rather as an appendage of surgery than a branch of medical science; and, according to the testimony of Guy de Chauliac, the cultivation of anatomical knowledge was confined to Roger, Roland, Jamerio, Bruno, and Lanfranc; and this they borrowed chiefly from Galen. For this and similar reasons, physicians were not in all instances respected by the best informed men of the age; and they fell, perhaps not altogether undeservedly, under the bitter lash of the satirical Petrarch.

In this state matters appear to have proceeded with the medical school of Bologna till the commencement of the fourteenth century, when the circumstance of possessing a teacher of originality enabled this university to be the agent of as great an improvement in medical science as she had already effected in jurisprudence. This era, indeed, is distinguished for the appearance of Mondino, under whose zealous cultivation the science first began to rise from the ashes in which it had been buried. This father of modern anatomy, who taught in Bologna about the year 1315, quickly drew the curiosity of the medical profession, by well-ordered demonstrations of the different parts of the human body. In 1315 he dissected and demonstrated the parts of the human body in two female subjects; and in the course of the following year he accomplished the same task on the person of a single female. But while he seems to have had sufficient original force of intellect to direct his own route, Riolan accuses him of copying Galen; and it is certain that his descriptions are corrupted by the barbarous leaven of the Arabian schools, and his Latin defaced by the exotic nomenclature of Ebn-Sina, and Abu-Bekr Al-Rasi. He died, according to Tiraboschi, in 1325.

Mondino divides the body into three cavities (*ventres*), the upper containing the animal members, as the head, the lower containing the natural members, and the middle containing the spiritual members. He first delivers the anatomy of the lower cavity or the abdomen, then proceeds to the middle or thoracic organs, and concludes with the upper, comprising the head, and its contents and appendages. His general manner is to notice shortly the situation and shape or distribution of textures or membranes, and then to mention the disorders to which they are subject. The peritoneum he describes under the name of *siphac*, in imitation of the Arabians, the omentum under that of *zirbus*, and the mesentery or *eucharus* as distinct from both. In speaking of the intestines, he treats first of the rectum, then the colon, the left or sigmoid flexure of which, as well as the transverse arch and its connection with the stomach, he particularly remarks; then the cæcum or *monoculus*, after this the small intestines in general under the heads of ileum and jejunum, and latterly the duodenum, making in all six bowels. The liver and its vessels are minutely, if not accurately examined; and the *cava*, under the name *chilis*, a corruption from the Greek κοιλη, is treated at length, with the emulgents and kidneys. His anatomy of the heart is wonderfully accurate; and it is a remarkable fact, which seems to be omitted by all subsequent authors, that his description contains the rudiments of the circulation of the blood. "Postea vero versus pulmonem est aliud orificium venæ arterialis, quæ *portat* sanguinem ad pulmonem a corde; quia cum pulmo deserviat cordi secundum modum dictum ut ei recompenset, cor ei *transmittit* sanguinem per hanc venam, quæ vocatur vena arterialis, et vena quæ portat sanguinem, et arterialis, quia habet duas tunicas; et habet duas tunicas, primo quia vadit ad membrum quod existit in continuo motu, et secundo quia portat sanguinem valde subtilem et cholericum." The merit of these distinctions, however, he afterwards destroys, by repeating the old assertion, that the left ventricle ought to contain spirit or air, which it generates from the blood.

His osteology of the scull is erroneous. In his account of the cerebral membranes, though short, he notices the principal characters of the *dura mater*. He describes shortly the lateral ventricles, with their anterior and posterior *cornua*, and the choroid plexus as a blood-red substance, like a long worm. He then speaks of the third or middle ventricle, and one posterior, which seems to correspond with the fourth; and describes the infundibulum under the names of *lacuna* and *emboton*. The inferior recesses he appears to have omitted. In the base of the organ he remarks, first, two mammillary caruncles, the origins of the olfactory nerves, which, however, he overlooks; the optic nerves, which he reckons the first pair; the oculo-muscular, which he accounts the second; the third, which appears to be the sixth of the moderns; the fourth; the fifth, evidently the seventh; a sixth, the *nervus vagus;* and a seventh, which is the ninth of the moderns.

Notwithstanding the misrepresentations into which this early anatomist was betrayed, his book is valuable, and has been illustrated by the successive commentaries of Achillini, Berenger, and Dryander.

1480. Matthew de Gradibus, a native of Gradi, a town in Friuli, near Milan, distinguished himself by composing a series of treatises on the anatomy of various parts of the human body. He is the first who represents the ovaries of the female in the correct light in which they were subsequently regarded by Steno.

Similar objections to those already urged in speaking of Mondino apply to another eminent anatomist of those times. Gabriel de Zerbis, who flourished at Verona to-
1495. wards the conclusion of the 15th century, is celebrated as
1505. the author of a system, in which he is obviously more anxious to astonish his readers by the wonders of a verbose and complicated style, than to instruct by precise and faithful description. In the vanity of his heart he assumed the title of *Medicus Theoricus;* but though like Mondino he derived his information from the dissection of the human subject, he is not entitled to the merit either of describing truly or of adding to the knowledge previously acquired. He is superior to Mondino, however, in knowing the olfacient nerves.

1463. Eminent in the history of the science, but more distin-
1512. guished than any of this age in the history of cerebral anatomy, Alexander Achillini of Bologna, the pupil and commentator of Mondino, appeared at the close of the 15th century. Though a follower of the Arabian school, the assiduity with which he cultivated anatomy has rescued his name from the inglorious obscurity in which the Arabesque doctors have in general slumbered. He is known in the history of anatomical discovery as the first who described the two tympanal bones, termed *malleus* and *incus*. In 1503 he showed that the tarsus consists of seven bones; he re-discovered the fornix and the infundibulum; and he was fortunate enough to observe the course of the cerebral cavities into the inferior *cornua*, and to remark peculiarities to which the anatomists of a future age did not advert. He mentions the orifices of the ducts afterwards described by Wharton. He knew the ileo-cæcal valve; and his description of the duodenum, ileum, and colon, shows that he was better acquainted with the site and disposition of these bowels than any of his predecessors or contemporaries.

Not long after, the science boasts of one of its most 1518.
distinguished founders. James Berenger of Carpi, in the Modenese territory, flourished at Bologna at the beginning of the 16th century. In the annals of medicine his name will be remembered not only as the most zealous and eminent in cultivating the anatomy of the human body, but as the first physician who was fortunate enough to calm the alarms of Europe, suffering under the ravages of syphilis, then raging with uncontrollable virulence. In the former character he surpassed both predecessors and contemporaries; and it was long before the anatomists of the following age could boast of equalling him. His assiduity was indefatigable; and he declares that he dissected above 100 human bodies. He is the author of a compendium, of several treatises which he names introductions (*Isagogæ*), and of commentaries on the treatise of Mondino. Like him, he is tinged with the mysticism of the Arabian doctrines; and though he employs the Grecian nomenclature in general, he never forgets to give the Arabian terms, and often uses them exclusively. In his commentaries on Mondino, which constitute the most perspicuous and complete of his works, he not only rectifies the mistakes of that anatomist, but delivers minute and in general accurate anatomical descriptions.

He is the first who undertakes a systematic view of the several textures of which the human body is composed; and in a preliminary commentary he treats successively of the anatomical characters and properties of fat, of membrane in general (*panniculus*), of flesh, of nerve, of *villus* or fibre (*filum*), of ligament, of sinew or tendon, and of muscle in general. He then proceeds to describe with considerable precision the muscles of the abdomen, and illustrates their site and connections by wooden cuts, which, though rude, are spirited, and show that anatomical drawing was in that early age beginning to be understood. In his account of the peritoneum, he admits only the intestinal division of that membrane, and is at some pains to prove the error of Gentilis, who justly admits the muscular division also. In his account of the intestines, he is the first who mentions the vermiform process of the cæcum; he remarks the yellow tint communicated to the jejunum by the gall-bladder; and he recognises the opening of the common biliary duct into the duodenum (*quidam porus portans choleram*). In the account of the stomach he describes the several tissues of which that organ is composed, and which, after Almansor, he represents to be three, and a fourth from the peritoneum; and afterwards notices the *rugæ* of its villous surface. He is at considerable pains to explain the organs of generation in both sexes, and gives a long account of the anatomy of the fœtus. He was the first who recognised the larger proportional size of the chest in the male than in the female, and conversely the greater capacity of the female than of the male pelvis. In the larynx he discovered the two arytenoid cartilages. He gives the first good description of the thymus; distinguishes the oblique situa-

History. tion of the heart; describes the pericardium, and maintains the uniform presence of pericardial liquor. He then describes the cavities of the heart; but perplexes himself, as all the anatomists of that age, about the spirit supposed to be contained. The aorta he properly makes to arise from the left ventricle; but confuses himself with the *arteria venalis* (pulmonary vein), and the *vena arterialis*, the pulmonary artery. His account of the brain is better. He gives a minute and clear account of the ventricles, remarks the *corpus striatum*, and has the sagacity to perceive that the choroid plexus consists of veins and arteries; he then describes the middle or third ventricle, the infundibulum or *lacuna* of Mondino, and the pituitary gland; and, lastly, the passage to the fourth ventricle, the *conarium* or pineal gland, and the fourth or posterior ventricle itself, the relations of which he had studied accurately. He rectifies the mistake of Mondino as to the olfactory or first pair of nerves, gives a good account of the optic and others, and is entitled to the praise of originality in being the first observer who contradicts the fiction of the wonderful net, and indicates the principal divisions of the carotid arteries. He enumerates the tunics and humours of the eye, and gives an account of the internal ear, in which he notices the *malleus* and *incus*.

It had been written in the book of the destinies, that the science of anatomy was to be cultivated first in Italy; and that the country, already so illustrious in literature, should be honoured in giving birth to the first eminent anatomists in Europe. This distinction she long retained; and the glory she acquired in the names of Mondino, Achillini, Carpi, and Massa, was destined to become more conspicuous in the labours of Columbus, Fallopius, and Eustachius. While Italy, however, was thus advancing the progress of science, the other nations of Europe were either in profound ignorance or in the most supine indifference to the brilliant career of their zealous neighbours. The sixteenth century had commenced before France began to acquire any anatomical distinction in the names of Dubois, Fernel, and Etienne; and even these celebrated teachers were less solicitous in the personal study of the animal body, than in the faithful explanation of the anatomical writings of Galen. The infancy of the French school had to contend with other difficulties. The small portion of knowledge which had been hitherto diffused in the country was so inadequate to eradicate the prejudices of ignorance, that it was either difficult or absolutely impossible to procure human bodies for the purposes of science; and we are assured, on the testimony of Vesalius and other competent authorities, that the practical part of anatomical instruction was obtained entirely from the bodies of the lower animals. The works of the Italian anatomists were unknown; and it is a proof of the tardy communication of knowledge, that while the structure of the human body had been taught in Italy for more than a century by Mondino and his followers, they are never mentioned by Etienne, who flourished long after.

Such was the aspect of the times at the appearance of Jacques Dubois, who, under the Romanized name of Jacobus Sylvius, according to the fashion of the day, has been fortunate in acquiring a reputation to which his researches do not entitle him. For the name of James Dubois, the history of anatomy, it is said, is indebted to his inordinate love of money. At the instance of his brother Francis, who was professor of eloquence in the College of Tournay at Paris, he repaired to this university, and devoted himself to the study of the learned languages and mathematics; but discovering that these elegant accomplishments do not invariably reward their cultivators with the goods of fortune, Dubois betook himself to medicine. After the acquisition of a medical degree in the university of Montpellier, at the ripe age of fifty-one Dubois returned to Paris to resume a course of anatomical instructions which had been interrupted by the canonical interference of the medical faculty. Here he taught anatomy to a numerous audience in the college of Trinquet; and, on the departure of Vidus Vidius for Italy, was appointed to succeed that physician as professor of surgery to the Royal College. His character is easily estimated. With a greater portion of coarseness in his manners and language than even the rude state of society can palliate, with much varied learning and considerable eloquence, he was a blind, indiscriminate, and irrational admirer of Galen, and interpreted the anatomical and physiological writings of that author, in preference to giving demonstrations from the subject. Without talent for original research or discovery himself, his envy and jealousy made him detest every one who gave proofs of either. We are assured by Vesalius, who was some time his pupil, that his manner of teaching was calculated neither to advance the science nor to rectify the mistakes of his predecessors. A human body was never seen in the theatre of Dubois; the carcasses of dogs and other animals were the materials from which he taught; and so difficult even was it to obtain human bones, that unless Vesalius and his fellow-students had collected assiduously from the Innocents and other cemeteries, they must have committed numerous errors in acquiring the first principles. This assertion, however, is contradicted by Riolan, and more recently by Sprengel and Lauth, the last of whom decidedly censures Vesalius for this ungrateful treatment of his instructor. It is certain that opportunities of inspecting the human body were by no means so frequent as to facilitate the study of the science. Though his mention of injections has made him be thought the discoverer of that art, he appears to have made no substantial addition to the information already acquired; and the first acknowledged professor of anatomy to the university of Paris appears in history as one who lived without true honour, and died without just celebrity. He must not be confounded with Franciscus Sylvius (De le Boe), who is mentioned by Ruysch and Malacarne as the author of a particular method of demonstrating the brain.

Almost coeval may be placed Charles Etienne, a younger 1503–64. brother of the celebrated printers, and son to Henry, who Hellenized the family name by the classical appellation of Stephen; (Στεφανος). It is uncertain whether he taught publicly. But his tranquillity was disturbed, and his pursuits interrupted, by the oppressive persecutions in which their religious opinions involved the family; and Charles Etienne drew the last breath of a miserable life in a dungeon in 1564. Etienne, though sprung of a family whose classical taste has been their principal glory, betrays not the same servile imitation of the Galenian anatomy with which Dubois is charged, and is the first anatomical author who deviates from the beaten path. He appears to have been the first to detect valves in the orifice of the hepatic veins. He was ignorant, however, of the researches of the Italian anatomists; and his description of the brain is inferior to that given 60 years before by Achillini. His comparison of the cerebral cavities to the human ear has persuaded Portal that he knew the inferior *cornua*, and *hippocampus*, and its prolongations; but this is no reason for giving him that honour, to the detriment of the reputation of Achillini, to whom, so far as historical testimony goes, the first knowledge of this fact is due. The researches of Etienne into the structure of the nervous system are, however, neither useless nor inglorious; and the circumstance of demonstrating a canal through the entire length of the spinal chord, which had neither been suspected by contemporaries nor noticed by successors, till M. Senac made it known, is sufficient to place him high among the class of anatomical discoverers.

The French anatomy of the sixteenth century was distinguished by two circumstances unfavourable to the advancement of the science,—extravagant admiration of antiquity, with excessive confidence in the writings of Galen, and the general practice of dissecting principally the bodies of the lower animals. Both of these errors were much amended, if not entirely removed, by the exertions of a young Fleming, whose appearance forms a conspicu-
1514. ous era in the history of cerebral anatomy. Andrew Vesalius, a native of Brussels, after acquiring at Louvain the ordinary classical attainments of the day, began, at the age of 14, to study anatomy under the auspices of Dubois. Though the originality of his mind soon led him to abandon the prejudices, by which he was environed, and take the most direct course for attaining a knowledge of the structure of the human frame; yet he neither underrated the Galenian anatomy, nor was he indolent in the dissection of brute animals. The difficulties, however, with which the practical pursuit of human anatomy was beset in France, and the dangers with which he had to contend, made him look to Italy as a suitable field for the cultivation of the science; and in 1536 we find him at Venice, at once pursuing the study of human anatomy with the utmost zeal, and requested, ere he had attained his 22d year, to demonstrate publicly in the university of Padua. After remaining here about seven years, he went by express invitation to Bologna, and shortly afterwards to Pisa; and Vesalius, thus professor in three universities, appears to have carried on his anatomical investigations and instructions alternately at Padua, Bologna, and Pisa, in the course of the same winter. It is on this account that Vesalius, though a Fleming by birth, and trained originally in the French school, belongs, as an anatomist, to the Italian, and may be viewed as the first of an illustrious line of teachers by whom the anatomical reputation of that country was in the course of the sixteenth century raised to the greatest eminence.

Vesalius is known as the first author of a comprehensive and systematic view of human anatomy. The knowledge with which his dissections had furnished him, proved how many errors were daily taught and learned under the broad mantle of Galenian authority; and he perceived the necessity of a new system of anatomical instruction, divested of the omissions of ignorance and the misrepresentations of prejudice and fancy. The early age at which he effected this object has been to his biographers the theme of boundless commendations; and we are told that he began at the age of 25 to arrange the materials he had collected, and accomplished his task ere he had completed his 28th year.

Soon after this period we find him invited as imperial physician to the court of Charles V., where he was occupied in the duties of practice, and answering the various charges which were unceasingly brought against him by the Galenian disciples. After the abdication of Charles, he continued at court in great favour with his son Philip II. To this he seems to have been led principally by the troublesome controversies in which his anatomical writings had involved him. It is painful to think, however, that even imperial patronage bestowed on eminent talents does not insure immunity from popular prejudice; and the fate of Vesalius will be a lasting example of the barbarism of the times, and of the precarious tenure of the safety even of a great physician. On the preliminary circumstances authors are not agreed; but the most general account states, that when Vesalius was inspecting, with the consent of his kinsmen, the body of a Spanish grandee, it was observed that the heart still gave some feeble palpitations when divided by the knife. The immediate effects of this outrage to human feeling were to denounce the anatomist to the inquisition; and Vesalius escaped the merciful dispensations of this tribunal only by the influence of the king, and by promising to perform a pilgrimage to the Holy Land. He forthwith proceeded to Venice, from which he sailed with the Venetian fleet, under James Malatesta, for Cyprus. When he reached Jerusalem, he received from the Venetian senate a message requesting him again to accept the Paduan professorship, which had become vacant by the death of his friend and
pupil Fallopius. His destiny, however, which pursued 1564.
him fast, suffered him not again to breathe the Italian air. After struggling for many days with adverse winds in the Ionian Sea, he was wrecked on the island of Zante, where he quickly breathed his last in such penury, that unless a liberal goldsmith had defrayed the funeral charges, his remains must have been devoured by beasts of prey. At the time of his death he was scarcely 50 years of age.

To form a correct estimate of the character and merits of Vesalius, we must not compare him, in the spirit of modern perfection, with the anatomical authors either of later times or of the present day. Whoever would frame a just idea of this anatomist, must imagine himself living in the days of Charles V., when learning did not uniformly liberalize,—when the rekindling light of ancient times shone on nothing but its own glories,—when education consisted in the knowledge of ancient opinions, and the authority of Grecian and Roman names usurped in the temple of science the legitimate worship of nature. He must imagine, not a bold innovator without academical learning,—not a genius coming from a foreign country, unused to the forms and habits of Catholic Europe,—nor a wild reformer, blaming indiscriminately every thing which accorded not with his opinions;—but a young student scarcely emancipated from the authority of instructors, and whose intellect was still influenced by the doctrines with which it had been originally imbued,—an individual strictly trained in the opinions of the time, living amidst men who venerated Galen as the oracle of anatomy and the divinity of medicine,—exercising his reason to estimate the soundness of the instructions then in use, and proceeding, in the way least likely to offend authority and wound prejudice, to rectify errors, and to establish on the solid basis of observation the true elements of anatomical science. Vesalius has been denominated the founder of human anatomy; and though we have seen that in this career he was preceded with honour by Mondino and Berenger, still the small proportion of correct observation which their reverence for Galen and Arabesque doctrines allowed them to communicate, will not in a material degree impair the original merits of Vesalius. The errors which he rectified, and the additions which he made, are so numerous, that it is impossible, in such a sketch as the present, to communicate a just idea of them.

Besides the first good description of the sphenoid bone, he showed that the sternum consists of three portions, and the sacrum of five or six; and described accurately the vestibule in the interior of the temporal bone. He not only verified the observation of Etienne on the valves of the hepatic veins, but he described well the *vena azygos*, and discovered the canal which passes in the fœtus between the umbilical vein and the *vena cava*, since named *ductus venosus*. He described the omentum, and its connections with the stomach, the spleen, and the colon; gave the first correct views of the structure of the pylorus; remarked the small size of the cæcal appendix in man; gave the first good account of the mediastinum and pleura, and the fullest description of the anatomy of the brain yet advanced. He appears, however, not to have understood well the inferior recesses; and his account of the nerves is confused by regarding the optic as the fifth pair, the third as the fifth, and the fifth as the seventh.

The labours of Vesalius were not limited to the immediate effect produced by his own writings. His instructions and example produced a multitude of anatomical inquirers of different characters and varied celebrity, but by whom the science was extended and rectified. Of these it belongs not to this place to speak in detail; but historical justice requires us to notice shortly those to whose exertions the science of anatomy has been most indebted.

1495 or 1500. The first that claims attention on this account is Bartholomeo Eustachi of San Severino, near Salerno, who though greatly less fortunate in reputation than Vesalius, divides with him the merit of creating the science of human anatomy. He extended the knowledge of the internal ear, by re-discovering and describing correctly the tube which bears his name; and if we admit that Ingrassias anticipated him in the knowledge of the third bone of the tympanal cavity, the *stapes*, he is still the first who described the internal and anterior muscles of the *malleus*, as also the *stapedius*, and the complicated figure of the *cochlea*. He is the first who studied accurately the anatomy of the teeth, and the phenomena of the first and second dentition. The work, however, which demonstrates at once the great merit and the unhappy fate of Eustachius, is his *Anatomical Engravings*, which, though completed in 1552, nine years after the impression of the work of Vesalius, the author was unable to publish. First communicated to the world in 1714 by Lancisi, afterwards in 1740 by Cajetan Petrioli, again in 1744 by Albinus, and more recently at Bonn, in 1790, they show that Eustachius had dissected with the greatest care and diligence, and taken the utmost pains to give just views of the shape, size, and relative position of the organs of the human body.

The first seven plates illustrate the history of the kidneys, and some of the facts relating to the structure of the ear. The eighth represents the heart, the ramifications of the *vena azygos*, and the valve of the *vena cava*, named from the author. In the seven subsequent plates is given a succession of different views of the viscera of the chest and abdomen. The seventeenth contains the brain and spinal chord; and the eighteenth more accurate views of the origin, course, and distribution of the nerves than were then given. Fourteen plates are devoted to the muscles.

Eustachius did not confine his researches to the study of relative anatomy. He investigated the intimate structure of organs with assiduity and success. What was too minute for unassisted vision he inspected by means of glasses. Structure, which could not be understood in the recent state, he unfolded by maceration in different fluids, or rendered more distinct by injection and exsiccation. The facts unfolded in these figures are so important, that it is justly remarked by Lauth, that if the author himself had been fortunate enough to publish them, anatomy would have attained the perfection of the 18th century two centuries earlier at least. Their seclusion for that period in the papal library has given celebrity to many names, which would have been known only in the verification of the discoveries of Eustachius.



Eustachius was the contemporary of Vesalius. Columbus and Fallopius were his pupils. The former, as his immediate successor in Padua, and afterwards as profes- 1523.
sor at Rome, distinguished himself by rectifying and improving the anatomy of the bones; by giving correct accounts of the shape and cavities of the heart, of the pulmonary artery and aorta, and their valves, and tracing the course of the blood from the right to the left side of the heart; by a good description of the brain and its vessels, and by correct understanding of the internal ear, and the first good account of the ventricles of the larynx.

The latter, who after being professor at Pisa in 1548, and at Padua in 1551, died at the age of 40, studied the general anatomy of the bones; described better than heretofore the internal ear, especially the tympanum and its osseous ring, the two *fenestræ*, and their communication with the vestibule and cochlea; and gave the first good account of the stylo-mastoid hole and canal, of the ethmoid bone and cells, and of the lacrymal passages. In myology he rectified several mistakes of Vesalius. He made some curious researches into the organs of generation in both sexes, and discovered the utero-peritoneal canal which still bears his name.

Osteology nearly at the same time found an assiduous 1510–46–
cultivator in John Philip Ingrassias, a learned Sicilian 80.
physician, who, in a skilful commentary on the osteology of Galen, corrected numerous mistakes. He gave the first distinct account of the true configuration of the sphenoid and ethmoid bones, and has the merit of first describing the third bone of the tympanum, called *stapes*, 1546.
though this is also claimed by Eustachius and Fallopius. He appears also to have known the *fenestræ*, the *chorda tympani*, the *cochlea*, the semi-circular canals, and the mastoid cells.

The anatomical descriptions of Vesalius underwent the 1530–89.
scrutiny of various inquirers, actuated, some by motives of hostility to the individual, others by the more honourable wish to ascertain if his representations accorded with nature. Of the latter, Fallopius was one; but the most distinguished by the importance and veracity of their researches, as well as the temperate tone of their observations, were Julius Cæsar Aranzi, anatomical professor for 32 years in the university of Bologna, and Constantio Varoli, physician to Pope Gregory XIII. To the former we are indebted for the first correct account of the anatomical peculiarities of the fœtus, and for being the first to show that the muscles of the eye do not, as was falsely imagined, arise from the *dura mater*, but from the margin of the optic hole. He also, after considering the anatomical relations of the cavities of the heart, the valves, and the great vessels, corroborates the views of Columbus regarding the course which the blood follows in passing from the right to the left side of the heart. I have already mentioned Alexander Achillini as the reputed and probable discoverer of the inferior recesses of the cerebral cavities; but whether he knew them or not, certain it is that neither his contemporaries nor successors gave any proof that they were acquainted with these regions of the brain. Aranzi is the first anatomist who describes them distinctly, who recognises the objects by which they are distinguished, and who gives them the name by which they are still known (*bombyx*, *hippocampus*); and his account is more minute and perspicuous than that of the authors of the subsequent century. He speaks at large of the choroid plexus, and gives a particular description of the fourth ventricle under the name of *cistern of the cerebellum*, as a discovery of his own.

Italy, though rich in anatomical talent, has produced 1545–75.
probably none greater than Constantio Varoli of Bologna.

History. Though limited in the measure of his existence to the short space of 32 years, he acquired reputation not inferior to that of the most eminent of his contemporaries. He is now known chiefly as the author of an Epistle, inscribed to Hieronymo Mercuriali, on the optic nerves, in which he describes a new method of dissecting the brain, and communicates many interesting particulars relating to the anatomy of the organ. Overlooking the fanciful comparison of the transverse eminence and the prolongations (*crura*) of the brain and cerebellum to a bridge over the water of an aqueduct, though he examines the lower surface of the organ with tedious minuteness, he gives evidence that he formed a more accurate and just idea of its configuration than any of the best modern anatomists. He observes the threefold division of the inferior surface or base, defines the limits of the anterior, middle, and posterior eminences, as marked by the compartments of the scull, and justly remarks that the cerebral cavities are capacious, communicate with each other, extending first backward and then forward, near the angle of the pyramidal portion of the temporal bone, and that they are folded on themselves, and finally lost above the middle and inferior eminence of the brain. He appears to have been aware that at this point they communicate with the exterior or convoluted surface. He recognised the impropriety of the term *corpus callosum*, seems to have known the communication, called afterwards *foramen Monroianum*, and describes the *hippocampus* more minutely than had been previously done.

1534. Among the anatomists of the Italian school, as a pupil of Fallopius, Eustachius, and Aldrovandus, is generally enumerated Volcher Coiter of Groningen. He distinguished himself by accurate researches on the cartilages, the bones, and the nerves, recognised the value of morbid anatomy, and made some experiments on living animals to ascertain the action of the heart and the influence of the brain.

The *Frutefull and Necessary Briefe Worke* of John Halle (1565), and *The Englisheman's Treasure*, by Master Thomas Vicary (1586), both English works published at this time, are tolerable compilations, partly from Berenger, partly from Vesalius, and much tinged by the Galenian and Arabian distinctions.

1537–66–1619. The celebrity of the anatomical school of Italy was worthily maintained by Hieronymo Fabricio of Aquapendente, who, in imitation of his master Fallopius, laboured to render anatomical knowledge more precise by repeated dissections, and to illustrate the obscure by researches on the structure of animals in general. In this manner he investigated the formation of the fœtus, the structure of the œsophagus, stomach, and bowels, and the peculiarities of the eye, the ear, and the larynx. The discovery, however, on which his surest claims to eminence rest, is that of the membranous folds, which he names *valves*, in the interior of veins. Several of these folds had been observed by Fernel, Sylvius, and Vesalius; and in 1547 Cannani observed those of the *vena azygos;* but no one appears to have offered any rational conjecture on their use, or to have traced them through the venous system at large, until Fabricius in 1574, upon this hypothesis, demonstrated the presence of these valvular folds in all the veins of the extremities.

Fabricius, though succeeded by his pupil Julius Casserius of Placenza, may be regarded as the last of that illustrious line of anatomical teachers by whom the science was so successfully studied and taught in the universities of Italy. The discoveries which each made, and the errors which their successive labours rectified, tended gradually to give anatomy the character of a useful as well as an accurate science, and to pave the way for a discovery which, though not anatomical, but physiological, is so intimately connected with correct knowledge of the shape and situation of parts, that it exercised the most powerful influence on the future progress of anatomical inquiry. This was the knowledge of the circular motion of the blood,—a fact which, though obscurely conjectured by Aristotle, Mondino, and Berenger, and partially taught by Servetus, Columbus, Cæsalpinus, and Fabricius, it was nevertheless reserved to William Harvey fully and satisfactorily to demonstrate.

I have already shown that Mondino believed that the blood proceeds from the heart to the lungs, through the *vena arterialis* or pulmonary artery, and that the aorta conveys the spirit into the blood, through all parts of the body. This doctrine was adopted with little modification by Berenger, who further demonstrated the existence and operation of the tricuspid valves in the right ventricle, and of the sigmoid valves at the beginning of the pulmonary artery and aorta, and that there were only two ventricles separated by a solid impervious septum. These were afterwards described in greater detail by Vesalius, who nevertheless appears not to have been aware of the important use which might be made of this knowledge. It was Michael Servet or Servetus,[1] a Spanish monk, who in his treatise *de Trinitatis Erroribus*, published at Basil in 1531, or, according to Sprengel, in 1552, first maintained the imperviousness of the septum, and the transition of the blood by what he terms an unknown route, namely, from the right ventricle by the *vena arteriosa* (pulmonary artery) to the lungs, and thence into the *arteria venosa* or pulmonary vein, and left auricle and ventricle, from which, he adds afterwards, it is conveyed by the aorta to all parts of the body.[2] Though the leading outlines, not only of the pulmonary

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[1] Born in 1509; burnt in 1553.

[2] The passage of Servetus is so interesting, that our readers may feel some curiosity in perusing it in the language of the author; and it is not unimportant to remark, that Servetus appears to have been led to think of the course of the blood, by the desire of explaining the manner in which the animal spirits were supposed to be generated. "Vitalis spiritus in sinistro cordis ventriculo suam originem habet, juvantibus maxime pulmonibus ad ipsius perfectionem. Est spiritus tenuis, caloris vi elaboratus, flavo colore, ignea potentia, ut sit quasi ex puriore sanguine lucens, vapor substantiam continens aquæ, aeris, et ignis. Generatur ex facta in pulmone commixtione inspirati aeris cum elaborato subtili sanguine, quem dexter ventriculus sinistro communicat. Fit autem communicatio hæc, non per parietem cordis medium, ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longo per pulmones ductu agitatur sanguis subtilis; a pulmonibus præparatur, flavus efficitur, et a vena arteriosa in arteriam venosam transfunditur. Deinde in ipsa arteria venosa, inspirato aeri miscetur, et exspiratione a fuligine expurgatur; atque ita tandem a sinistro cordis ventriculo totum mixtum per diastolen attrahitur, apta supellex, ut fiat spiritus vitalis. Quod ita per pulmones fiat communicatio et præparatio, docet conjunctio varia, et communicatio venæ arteriosæ cum arteria venosa in pulmonibus. Confirmat hoc magnitudo insignis venæ arteriosæ, quæ nec talis nec tanta esset facta, nec tantam a corde ipso vim purissimi sanguinis in pulmones emitteret, ob solum eorum nutrimentum; nec cor pulmonibus hac ratione serviret, cum præsertim antea in embryone solerent pulmones ipsi aliunde nutriri, ob membranulas illas seu valvulas cordis, usque ad horum nativitatem; ut docet Galenus, &c. Itaque ille spiritus a sinistro cordis ventriculo arterias totius corporis deinde transfunditur, ita ut qui tenuior est, superiora petit, ubi magis elaboratur, præcipue in plexu retiformi, sub basi cerebri sito, ubi ex vitali fieri incipit animalis, ad propriam rationalis animæ rationem accedens." (*De Trinitate*, lib. v.)

History. or small, but even of the great circulation, were sketched thus early by one who, though a philosopher, was attached to the church, it was only in his work *De Re Anatomica*, published at Venice in 1559, that Columbus formally and distinctly announced the circular course of the blood as a discovery of his own; and maintained, in addition to the imperviousness of the septum, the fact that the *arteria venalis* (pulmonary vein) contains not air, but blood mixed with air brought from the lungs to the left ventricle of the heart, to be distributed through the body at large.

1570–1593. Soon after, views still more complete of the small or pulmonary circulation were given by Andrew Cæsalpinus of Arezzo, who not only maintained the analogy between the structure of the arterious vein or pulmonary artery and the aorta, and that between the venous artery or pulmonary veins, and veins in general, but was the first to remark the swelling of veins below ligatures, and to infer from it a refluent motion of blood in these vessels. The discoveries of Aranzi and Eustachius in the vessels of the fœtus, tended at first to perplex, and afterwards to elucidate some of these notions. At length it happened, that between the years 1598 and 1600, a young Englishman, pursuing his anatomical studies at Padua under Fabricius of Aquapendente, learnt from that anatomist the existence of the valves in the veins of the extremities, and undertook to ascertain the use of these valves by experimental inquiry. It is uncertain whether he learnt from the writings of Cæsalpinus the fact observed by that author, of the tumescence of a vein below the ligature; but he could not fail to be aware, and indeed he shows that he was aware, of the small circulation as taught by Servetus and Columbus. Combining these facts already known, he, by a series of well-executed experiments, demonstrated clearly the existence, not only of the small, but of a general circulation from the left side of the heart by the aorta and its subdivisions, to the right side by the veins. This memorable truth was first announced in the year 1619.

It belongs not to this place, either to consider the arguments and facts by which Harvey defended his theory, or to notice the numerous assaults to which he was exposed, and the controversies in which his opponents wished to involve him. It is sufficient to say, that after the temporary ebullitions of spleen and envy had subsided, the doctrine of the circular motion of the blood was admitted by all enlightened and unprejudiced persons, and finally was universally adopted, as affording the most satisfactory explanation of many facts in anatomical structure which were either misunderstood or entirely overlooked. The inquiries to which the investigation of the doctrine gave rise produced numerous researches on the shape and structure of the heart and its divisions, of the lungs, and of the blood-vessels and their distribution. Of this description were the researches of Nicolas Steno on the structure of the heart, the classical work of Richard Lower, the dissertation of Pechlin, the treatise of Vieussens, the work of Malpighi on the structure of the lungs, several sketches in the writings of Mayow, and other treatises of less moment. Systematic treatises of anatomy began to assume a more instructive form, and to breathe a more philosophical spirit. The great work of Adrian Spigelius, which appeared in 1627, two years after the death of the author, contains indeed no proof that he was aware of the valuable generalization of Harvey; but in the institutions of Caspar Bartholin, as republished and improved by his son Thomas in 1651, the anatomical descriptions and explanations are given with reference to the new doctrine. A still more unequivocal proof of the progress of correct anatomical knowledge was given in the lectures delivered by Peter Dionis, at the Jardin Royal of Paris, in 1673 and the seven following years, in which that intelligent surgeon gave most accurate demonstrations of all the parts composing the human frame, and especially of the heart, its auricles, ventricles, and valves, and the large vessels connected with it and the lungs. These demonstrations, first published in 1690, were so much esteemed, that they underwent in the space of 30 years seven editions, were translated into English, and formed for a long time the best and only anatomical system in Europe. History.

The progress of anatomical discovery continued in the mean time to advance. In the course of the 16th century, Eustachius, in studying minutely the structure of the *vena azygos*, had recognised in the horse a white vessel full of watery fluid, connected with the internal jugular vein, on the left side of the vertebral column, corresponding accurately with the vessel since named *thoracic duct* Fallopius also described vessels belonging to the liver, distinct from arteries and veins; and similar vessels appear to have been noticed by Nicolaus Massa. The nature and properties of these vessels were, however, entirely unknown. On the 23d July 1622 Gaspar Asellius, professor of anatomy at Pavia, while engaged in demonstrating the recurrent nerves in a living dog, first observed numerous white delicate filaments crossing the mesentery in all directions; and though he took them at first for nerves, the opaque white fluid which they shed quickly convinced him that they were a new order of vessels. The repetition of the experiment the following day showed that these vessels were best seen in animals recently fed; and as he traced them from the villous membrane of the intestines, and observed the valves with which they were liberally supplied, he inferred that they were genuine chyliferous vessels. By confounding them with the lymphatics, he made them proceed to the pancreas and liver,—a mistake which appears to have been first rectified by Francis De le Boe. The discovery of Asellius was announced in 1627; and the following year, by means of the zealous efforts of Nicolas Peiresc, a liberal senator of Aix, the vessels were seen in the person of a felon who had eaten copiously before execution, and whose body was inspected an hour and a half after. In 1629 they were publicly demonstrated at Copenhagen by Simon Pauli, and the same year the thoracic duct was observed by Mentel for the first time since it was described by Eustachi. Five years after (1634), John Wesling, professor of anatomy and surgery at Venice, gave the first delineation of the lacteals from the human subject, and evinced more accurate knowledge than his predecessors, of the thoracic duct and the lymphatics. Highmore in 1637 demonstrated unequivocally the difference between the lacteals and the mesenteric veins; and though some perplexity was occasioned by the discovery of the pancreatic duct by Wirsung, yet this mistake was corrected by Thomas Bartholin; and the discovery by Pecquet in 1647, of the common trunk of the lacteals and lymphatics, and of the course which the chyle follows to reach the blood, may be regarded as the last of the series of isolated facts by the generalization of which the extent, distribution, and uses of the most important organs of the animal body were at length developed.

To complete the history of this part of anatomical science one step yet remained,—the distinction between the lacteals and lymphatics, and the discovery of the termination of the latter order of vessels. The honour of this discovery is divided between Jolyffe, an English anatomist, and Olaus Rudbeck, a young Swede. The former, according to the testimony of Glisson and Wharton, was aware of the distinct existence of the lymphatics in 1650, History. and demonstrated them as such in 1652. It is nevertheless doubtful whether he knew them much before the latter period; and it is certain that Rudbeck observed the lymphatics of the large intestines, and traced them to glands, on the 27th January 1651, after he had, in the course of 1650, made various erroneous conjectures regarding them, and, like others, attempted to trace them to the liver. The following year he demonstrated them in presence of Queen Christina, and traced them to the thoracic duct, and the latter to the subclavian vein. Their course and distribution were still more fully investigated by Thomas Bartholin, Wharton, Swammerdam, and Blaes, the two last of whom recognised the existence of valves; while Antony Nuck of Leyden, by rectifying various errors of his predecessors, and adding several new and valuable observations, rendered this part of anatomy much more precise than formerly.

After this period anatomists began to study more accurately organs and textures already known, and to obtain more precise knowledge of the intimate structure and organization of the human body. 1654. Francis Glisson distinguished himself by a minute description of the liver, and a clearer account of the stomach and intestines than had yet been given. 1656. Thomas Wharton investigated the structure of the glands with particular care; and though rather prone to indulge in fanciful generalization, he developed some interesting views of these organs; while Charleton, who appears to have been a person of great genius, though addicted to hypothesis, made some good remarks on the communication of the arteries with the veins, the fœtal circulation, and the course of the lymphatics. But the circumstance which chiefly distinguished the history of anatomy at the beginning of the seventeenth century, was the appearance of Thomas Willis, who rendered himself eminent not only by the first good researches on the brain and nerves, but by many judicious observations on the structure of the lungs, the intestines, the blood-vessels, and the glands. His anatomy of the brain and nerves is so minute and elaborate, and abounds so much in new information, that the reader is struck by the immense chasm between the vague and meagre notices of his predecessors, and the ample and correct descriptions of Willis. This excellent work, however, is not the result of his own personal and unaided exertions; and the character of Willis derives additional lustre from the candid avowal of his obligations to Wren and Millington, and, above all, to the diligent researches of his fellow-anatomist Richard Lower.

Willis was the first who correctly numbered the nerves, and described their origins in the order in which they have been generally named till the recent improvements of Soemmering. His observation of the connection of the eighth pair with the slender nerve which issues from the beginning of the spinal chord is known to all. He remarked the parallel lines of the mesolobe, afterwards minutely described by Vicq d'Azyr. He seems to have recognised the communication of the convoluted and figurate surfaces of the brain, and that between the lateral cavities beneath the *fornix*. He designates the objects of the central surface—the anterior as the lentiform eminences, with the striated appearance of their internal substance—the posterior as the optic chambers or *thalami;* the four orbicular eminences, with the bridge, which he first named *annular protuberance;* and the white pisiform bodies, since called mammillary eminences, behind the *infundibulum*. In the cerebellum he remarks the arborescent arrangement of the white and grey matter, and gives a good account of the internal carotids, and the communications which they make with the branches of the basilar artery. Wepfer had already demonstrated the peculiar curvature of the former vessels in the carotic canal, and refuted the fiction of the *rete mirabile*. History.

About the same time the researches of Malpighi tended greatly to improve the knowledge of minute structure. He gave the first distinct ideas on the organization of the lung, and the mode in which the bronchial tubes and vessels terminate in that organ. By the microscope he traced the transition of the arteries into the veins. He examined the omentum, and inquired into the manner in which fat and marrow are secreted. He endeavoured to unfold, by dissection and microscopic observation, the minute structure of the brain. He demonstrated the organization of the skin, and considered its constituents as the organ of touch. He studied the structure of bone, and rectified the errors of Gagliardi; he traced the formation and explained the structure of the teeth; and he finally carried his researches into the substance of the liver, the spleen, the kidneys, and the conglobate glands. In these difficult inquiries the observations of Malpighi are in general faithful, and his descriptions are accurate. He may be regarded as the founder of that part of anatomical science which treats of structure and organization; and, even in the present day, his writings are both interesting and instructive.

Nicolas Steno described with accuracy the lacrymal 1660.
gland and passages, and re-discovered the parotid duct. Bellini studied the structure of the kidneys, and described the tongue and tonsils with some care; and Drelincourt laboured to investigate the changes effected on the uterus by impregnation, and to elucidate the formation of the fœtus. The science might have derived still greater advantages from the genius of Regnier de Graaf, who investigated with accuracy the structure of the pancreas and of the organs of generation in both sexes, had he not been cut off at the early age of 32. Lastly, Wepfer, though more devoted to morbid anatomy, made, nevertheless, some just observations on the anatomical disposition of the cerebral vessels, the glandular structure of the liver, and the termination of the common duct in the duodenum.

The appearance of Frederic Ruysch, who was born in 1638, and became professor of anatomy at Amsterdam in 1665, gave a new impulse to anatomical research, and tended not only to give the science greater precision, but to extend its limits in every direction. The talents of Ruysch are said to have been developed by accident. To repel the audacious and calumnious aspersions with which De Bils attacked De le Boe and Van Horne, Ruysch published his tract on the valves of the lymphatics, which completely established his character as an anatomist of originality and research. This, however, is the smallest of his services to the science. The art of injecting, which had been originally attempted by Eustachi and Varoli, and was afterwards rudely practised by Glisson, Bellini, and Willis, was at length carried to greater perfection by De Graaf and Swammerdam, the former of whom injected the spermatic vessels with mercury and variously coloured liquors, while the latter, by employing melted wax with other ingredients, made the first approach to the refinements of modern anatomy. By improving this idea of using substances, which, though solid, may be rendered fluid at the period of injecting, Ruysch carried this art to the highest perfection.

By the application of this happy contrivance, he was enabled to obtain more correct views than his predecessors of the arrangement of minute vessels in the interior of organs, and to demonstrate peculiarities of organization which escaped the scrutiny of previous anatomists. Scarcely a part of the human body eluded the penetration of his syringe; and his discoveries were proportionally great. His account of the valves of the lymphatics, of the vessels of the lungs, and their minute structure; his researches on the vascular structure of the skin, of the bones, and their epiphyses, and their mode of growth and union; his observations on the spleen, the *glans penis*, the clitoris, and the womb impregnated and unimpregnated, were sufficient to give him the reputation of a skilful and accurate anatomist. These, however, were but a limited part of his anatomical labours. He studied the minute structure of the brain; he demonstrated the organization of the choroid plexus; he described the state of the hair when affected with Polish plait; he proved the vascular structure of the teeth; he injected the *dura mater*, the pleura, the pericardium, and peritoneum; he unfolded the minute structure of the conglomerate glands; he investigated that of the synovial apparatus placed in the interior of the joints; and he discovered several curious particulars relating to the lacteals, the lymphatics, and the lymphatic glands. So assiduously, indeed, did Ruysch study by injection the tissue of the organs of the animal body, that it is less easy to say what he did than what he neglected. To him we are indebted for many of the facts of which anatomy at the present day consists. The success of his injections, however, though it enabled him to trace the most delicate terminations of vessels in the substance of organs, perhaps exercised an unfavourable bias in making him look for vessels exclusively in the minute structure of all the tissues.

1670. Meanwhile, Meibomius re-discovered the palpebral
glands, which were known to Casserius; Swammerdam
studied the action of the lungs, described the structure
of the human *uterus*, and made numerous valuable obser-
vations on the *cæca* and pancreatoid organs of fishes; and
Kerckringius attempted to explain the process of ossifica-
tion, and determine its different stages. John Conrad Brun-
1687. ner, in the course of experiments on the pancreas, disco-
vered the muciparous glands of the duodenum,—a fact to
1677–81. which Conrad Peyer gave a more generalized character
by his description of the muciparous glands of the intes-
tinal canal at large. Leonard Tassin, distinguished for
original observation, rendered the anatomical history of
the brain more accurate than heretofore, and gave parti-
1678. cular accounts of the intestinal tube, the pancreatic duct,
and the hepatic ligaments. About the same time much light was thrown on the intimate constitution of several of the tissues, and on the minute communications of the arterial and venous tubes by the microscopical observations of Leeuwenhoeck.

That France might not be without participation in the glory of advancing the progress of anatomical knowledge, the names of Duverney and Vieussens are commemorated with distinction. The former, born in 1648, and first introduced into public life in 1676 in the Royal Academy of Sciences, decorated with the honorary title of professor of anatomy to the Dauphin, and appointed in 1679 professor at the Jardin Royal, distinguished himself by the first accurate account of the organ of hearing, and by his dissections of several animals at the academy, supplied valuable materials for the anatomical details of the natural history of animals published by that learned body. He appears to have been the first who demonstrated the fact, that the cerebral sinuses open into the jugular veins, and to have been aware that the former receive the veins of the brain, and are the venous receptacles of the organ. He understood the cerebral cavities, and their mode of communication; distinguishes the posterior pillars of the vault from the *pedes hippocampi*; recognises the two plates of the *septum lucidum*; and, what is still more remarkable, he first indicates distinctly the crossing or plaiting of the cerebral chords in the linear furrow between the right and left pyramidal bodies,—a fact afterwards verified by the researches of Mistichelli, Petit, and Santorini. He studied the ganglions attentively, and gives the first distinct account of the formation, connections, and distribution of the intercostal nerve. It is interesting to remark, that his statement that the veins or sinuses of the spinal chord terminate in the *vena azygos* has been verified by the recent researches of Dupuytren and Breschet, which show that the vertebral veins communicate by means of the intercostal and superior lumbar veins with the azygos and demi-azygos. His account of the structure of bones, and of the progress of ossification, is valuable. He recognised the vascular structure of the spleen; and he gives a correct account of the excretory ducts of the prostate gland, the *verumontanum*, and the anteprostates.

One of the circumstances which the history of this period of anatomical science shows tended considerably to its improvement, is the attention with which Comparative Anatomy was beginning to be cultivated. In ancient times, and at the revival of letters, the dissection of the lower animals was substituted for that of the human body; and the descriptions of the organs of the latter were too often derived from the former. The obloquy and contempt in which this abuse involved the study of animal anatomy made it be neglected, or pursued with indifference, for more than two centuries, during which anatomists confined their descriptions, at least very much, to the parts of the human body. At this period, however, the prejudice against Comparative Anatomy began to subside; and animal dissection, though not substituted for that of the human body, was employed, as it ought always to have been, to illustrate obscurities, to determine doubts, and to explain difficulties, and, in short, to enlarge and rectify the knowledge of the structure of animal bodies generally.

For this revolution in its favour, Comparative Anatomy was in a great measure indebted to the learned societies which were established about this time in the different countries of Europe. Among these the Royal Society of London, embodied by charter by Charles II. in 1660, and the Academy of Sciences of Paris, founded in 1665 by Colbert, are undoubtedly entitled to the first rank. Though later in establishment, the latter institution was distinguished by making the first great efforts in favour of Comparative Anatomy; and Perrault, Pecquet, Duverney, and Mery, by the dissections of rare animals obtained from the royal menagerie, speedily supplied valuable materials for the anatomical naturalist. In England, Nehemiah Grew, Edward Tyson, and Samuel Collins, cultivated the same department with diligence and success. The first has left an interesting account of the anatomical peculiarities of the intestinal canal in various animals; and the second, in the dissection of a porpoise, an opossum, and an ourang outang, adduces some valuable illustrations of the comparative differences between the structure of the human body and that of the lower animals. To the third belongs the merit of conceiving, and executing on an enlarged plan, a comprehensive system, embodying all the information then extant. With the aid of Tyson and his own researches, which were both extensive and accu-
rate, he composed a system of anatomical knowledge, in 1685.
which he not only delivers ample and accurate descriptions of the structure of the human body, and the various morbid changes to which the organs are liable, but illustrates the whole by accurate and interesting sketches of the peculiarities of the lower animals. The matter of this work

History. is so excellent, that it can only be ascribed to ignorance
that it has received so little attention. Though regarded
as a compilation, and though indeed much of the human
anatomy is derived from Vesalius, it has the advantage of
the works published on the Continent at that time, that it
embodies most of the valuable facts derived from Mal-
pighi, Willis, and Vieussens. The Comparative Anatomy
is almost all original, and acquired from personal research
and dissection; and the pathological observations, though
occasionally tinged with the spirit of the times, show the
author to have been endowed with the powers of observa-
tion and judicious reflection in no ordinary degree.

About this time also we recognise the first attempts to
study the minute atomic constitution of the tissues, by
the combination of the microscope and the effects of che-
mical agents. Bone furnished the first instance in which
this method was put in use; and though Gagliardi, who
undertook the inquiry, had fallen into some mistakes which
it required the observation of Malpighi to rectify, this
did not deter Clopton Havers and Nesbitt, in England,
and Courtial, Du Hamel, and Delasone, and afterwards
Herissant, in France, from resuming the same train of in-
vestigation. The mistakes into which these anatomists
fell belong to the imperfect method of inquiry. The facts
which they ascertained have been verified by recent ex-
periment, and constitute no unessential part of our know-
ledge of the structure of bone.

1695. Ten years after the publication of the work of Collins,
Henry Ridley, another English anatomist, distinguished
himself by a monograph on the brain, which, though not
free from errors, contains nevertheless some valuable ob-
servations. Ridley is the first who distinguishes by name
the restiform processes, or the posterior pyramidal emi-
nences. He recognised the figure of the four eminences in
the human subject; he remarked the mammillary bodies;
and he discovered the sinus which passes under his name.

Raymond Vieussens, by the publication of his great
work on neurography in 1684, threw new light on the
configuration and structure of the brain, the spinal chord,
and the nerves; and gave a description of the arrange-
ment and distribution of the latter more precise than
heretofore. Of the formation and connections of the
sympathetic nerve especially he gave views which have
been generally adopted by subsequent anatomists. His
new arrangement of the vessels, published in 1705, con-
tains several curious and some hypothetical opinions. His
observations on the structure of the heart, published in
1706, and enlarged in 1715, exhibit the first correct views
of the intimate structure of an organ, which afterwards
was most fully developed by the labours of Lancisi and
Senac. His treatise on the ear is not superior to that of
Duverney.

1685-97. To the same period belong the rival publications of
Godfrey Bidloo and William Cowper, the last of whom,
however, stained a reputation otherwise good, by publish-
ing as his own the engravings of the former. Cowper
further distinguished himself by a minute account of the
urethral glands, already known to Columbus and Mery; a
good description of the intestinal glands, discovered by
Brunner and Peyer; and by demonstrating the communi-
cation of the arteries and veins of the mesentery.

The anatomical genius of Italy, which had slumbered
since the death of Malpighi, was destined once more to
revive in Lancisi, Valsalva, and his illustrious pupils Santo-
rini and Morgagni. Valsalva especially distinguished him-
self by his description of the structure of the ear, which,
in possessing still greater precision and minuteness than
that of Duverney, is valuable in setting the example of
rendering anatomy altogether a science of description.
Santorini, who was professor at Venice, was no unworthy History.
friend of Valsalva and Morgagni. His anatomical observa-
tions, which relate to the muscles of the face, the brain, and 1724.
several of the nerves, the ducts of the lacrymal gland, the
nose and its cavities, the larynx, the viscera of the chest
and belly, and the organs of generation in the two sexes,
furnish beautiful models of essays distinguished for per-
spicuity, precision, and novelty, above any thing which
had then appeared. These observations, indeed, which
bear the impress of accurate observation and clear con-
ception, may be safely compared with any anatomical
writings which have appeared since. Those on the brain
are particularly interesting. Morgagni, though chiefly
known as a pathological anatomist, did not neglect the
healthy structure. His *Adversaria*, which appeared be- 1706.
tween 1706 and 1719, and his *Epistles*, published in 1728, 1717.
contain a series of observations to rectify the mistakes of 1719.
previous anatomists, and to determine the characters of 1728.
the healthy structure of many parts of the human body. 1740.
Many parts he describes anew, and indicates facts not
previously observed. All his remarks show how well he
knew what true anatomical description ought to be. In this
respect, indeed, the three anatomists now mentioned may
be said to have anticipated their contemporaries nearly a
century; for, while other authors were satisfied with giv-
ing loose and inaccurate or meagre notices of parts, with
much fanciful supposition, Valsalva, Santorini, and Mor-
gagni, laboured to determine with precision the anatomical
characters of the parts which they describe.

The same character is due to Winslow, a native of Den-
mark, but, as pupil and successor of Duverney, as well as
a convert to Catholicism, naturalized in France, and finally
professor of anatomy at the Royal Garden. His exposi- 1732.
tion of the structure of the human body is distinguished
for being not only the first treatise of descriptive anatomy,
divested of physiological details and hypothetical expla-
nations foreign to the subject, but for being a close de-
scription derived from actual objects, without reference
to the writings of previous anatomists. About the same
time Cheselden in London, the first Monro in Edinburgh, 1713-22.
and Albinus in Leyden, contributed by their several trea- 1726-32.
tises to render anatomy still more precise as a descriptive 1726-46.
science. The *Osteographia* of the former was of much 1733.
use in directing attention to the study of the skeleton,
and the morbid changes to which it is liable. This
work, however, magnificent as it was, was excelled by
that of Albinus, who, in 1747, published engravings de-
scriptive of the bones and muscles, which, perhaps, will
never be surpassed either in accuracy of outline or beauty
of execution. The several labours of this author, indeed,
constitute an important era in the history of the science.
He was the first who classified and exhibited the muscles
in a proper arrangement, and applied to them a nomencla-
ture which is still retained by the consent of the best
anatomists. He gives a luminous account of the arteries 1736.
and veins of the intestines, represents with singular fide- 1737.
lity and beauty the bones of the fœtus, inquires into the
structure of the skin, and the cause of its colour in differ-
ent races; represents the changes incident to the womb
in different periods of pregnancy, and describes the rela-
tions of the thoracic duct and the *vena azygos* with the 1757.
contiguous parts. Besides these large and magnificent
works, illustrated by the most beautiful engravings, six
books of Academical Annotations were the fruits of his 1754-64.
long and assiduous cultivation of anatomy. These con-
tain valuable remarks on the sound structure and morbid
deviations of numerous parts of the human body.

To render the knowledge of the skeleton more com- 1739-43.
plete, Duhamel and Delasone studied the minute structure

History. of bone, and the process of ossification; William Hunter
1751–52. and Herissant investigated the texture of the cartilages; and Weitbrecht gave a copious and minute account of the ligaments. M. Lieutaud also, who had already laboured to rectify many errors in anatomy, described with much accuracy the structure and relations of the heart
1753. and its cavities, and rendered the anatomy of the bladder very precise, by describing the triangular space and the mammillary eminence at its neck.

Albinus found a worthy successor in his pupil Albert Von Haller, who, with a mind imbued with every department of literature and science, directed his chief attention, nevertheless, to the cultivation of anatomical and physiological knowledge. Having undertaken at an early age (21) to illustrate, with commentaries, the physiological prelections of his preceptor Boerhaave, he devoted himself assiduously to the perusal of every work which could tend to facilitate his purpose; and as he found numerous erroneous or imperfect statements, and many deficiencies to supply, he undertook an extensive course of dissection of human and animal bodies, to obtain the requisite information. For 17 years, during which he was professor at Goettingen, he dissected 400 bodies,[1] and inspected their organs with the utmost care. The result of these assiduous labours appeared at intervals in the form of dissertations by himself, or under the name of some one of his pupils, finally published in a collected shape, between 1746 and 1751 (*Disputationes Anatomicæ Selectiores*); and in eight numbers of most accurate and beautiful engravings, representing the most important parts of the human body, *e. g.* the diaphragm, the uterus, ovaries and vagina, the arteries of the different regions and organs, with learned and critical explanatory observations. Some years after, when he had retired from his academical duties at Goettingen, he published, between 1757 and 1765, the large and elaborate work which, with singular modesty, he styled *Elements of Physiology*. This work, though professedly devoted to the latter science, rendered nevertheless the most essential services to the former. Haller, drawing an accurate line of distinction between the two, gave the most clear, precise, and complete descriptions of the situation, position, figure, component parts, and minute structure of the different organs and their appendages. The results of previous and coeval inquiry, obtained by extensive reading, he sedulously verified by personal observation; and though he never rejected facts stated on credible authorities, he in all cases laboured to ascertain their real value by experiment. The anatomical descriptions are on this account not only the most valuable part of his work, but the most valuable that had then or for a long time after appeared; and it is perhaps a sufficient proof of their intrinsic merit, that they are still resorted to by the anatomist as the most faithful guide to many of his researches. It is painful, nevertheless, to think, that the very form in which this work is composed, with copious and scrupulous reference to authorities, made it be regarded as a compilation only; and that the author was compelled to show, by a list of his personal researches, that the most learned work ever given to the physiologist, was also the most abundant in original information.[2]

With the researches of Haller, it is proper to notice those of his contemporary, John Frederick Meckel, and his pupil John Godfrey Zinn. The former, who was professor of anatomy at Berlin, described with unrivalled
1748–51. accuracy the Gasserian ganglion, the first pair of nerves and its distribution, and that of the facial nerves general- History.
ly, and discovered the spheno-palatine ganglion. He made some original and judicious observations on the
tissue of the skin and the mucous net; and above all, 1753–57.
he recognised the connection of the lymphatic vessels with the veins,—a doctrine which, though neglected, has been lately revived by Fohmann and Lippi. He also collected several valuable observations on the morbid states of the heart and brain. At the same time Zinn, who was professor of medicine at Goettingen, published on
the eye a classical treatise, which demonstrated at once 1755.
the defects of previous inquiries, and how much it was possible to elucidate, by accurate research and precise description, the structure of one of the most important organs of the human frame. As a general proof of the extraordinary merit of this work, it is sufficient to say, that in critical learning and descriptive accuracy it has not been equalled, and probably will never be surpassed. It
was re-published after his death by Wrisberg. 1780.

General anatomy, and the study of the atomic constitution of the tissues which had originally been commenced by Leeuwenhoeck, Malpighi, and Ruysch, began at this period to attract more general attention. De
Bergen had already demonstrated the general distribution 1732.
of cellular membrane, and shown that it not only incloses every part of the animal frame, but forms the basis of every organ,—a doctrine which was adopted, and still
more fully expanded, by his friend Haller, in opposition to 1757.
what was asserted by Albinus,[3] who maintains that each part has a proper tissue. William Hunter at the same time gave a clear and ingenious statement of the difference between cellular membrane and adipose tissue, in which he maintained the general distribution of the former, and represented it as forming the serous membranes, and
regulating their physiological and pathological properties,— 1757.
doctrines which were afterwards confirmed by his brother John Hunter. A few years after, the department of general anatomy first assumed a substantial form, in the systematic view of the membranes and their mutual connections traced by Andrew Bonn of Amsterdam. In his inaugural dissertation *De Continuationibus Membranarum*,
published at Leyden in 1763, this author, after some pre- 1763.
liminary observations on membranes in general and their structure, and an exposition of that of the skin, traces its transition into the mucous membranes and their several divisions. He then explains the distribution of the cellular membrane and the aponeurotic expansions, and the periosteum and perichondrium, by either of which, he shows, every bone of the skeleton is invested and connected. He finally gives a very distinct view of the arrangement of the internal membranes of cavities, those named serous and fibro-serous, and the manner of their distribution over the contained organs. This essay, which is a happy example of generalization, is remarkable for the interesting general views of the structure of the animal body which it exhibits; and to Bonn belongs the merit of sketching the first outlines of that system which it was reserved for the genius of Bichat to complete and
embellish. Lastly, Bordeu, in an elaborate essay on the 1767.
mucous tissue, or cellular organ, as he terms it, brought forward some interesting views of the constitution, nature, and extent of the cellular membrane.

Though anatomy was hitherto cultivated with much success as illustrating the natural history and morbid states of the human body, yet little had been done for the elucidation of local diseases, and the surgical means by

[1] "Pene quadringentis mea manu dissectis hominum cadaveribus." (Præfatio ad tom. vi. *Elementorum Physiologiæ*.)
[2] *Ibid.*
[3] *Annot. Acad.* lib. iii. p. 2.

History. which they may be successfully treated. The idea of applying anatomical knowledge directly to this purpose appears to have originated with Bernardin Genga, a Roman surgeon, who published in 1672, at Rome, a work entitled *Surgical Anatomy, or the Anatomical History of the Bones and Muscles of the Human Body, with the description of the Blood-vessels.* This work, which reached a second edition in 1687, is highly creditable to the author, who appears to have studied intimately the mutual relations of different parts. It is not improbable that the example
1718-26. of Genga led Palfyn, a surgeon at Ghent, to undertake a similar task about 30 years after. For this, however, he was by no means well qualified; and the work of Palfyn, though bearing the name of Surgical Anatomy, is a miserable compilation, meagre in details, inaccurate in description, and altogether unworthy of the honour of being republished, as it afterwards was, by Antony Petit.

While these two authors, however, were usefully employed in showing what was wanted for the surgeon, others were occupied in the collection of new and more accurate facts. Albinus, indeed, ever assiduous, had, in his account of the operations of Rau, given some good sketches of the relative anatomy of the bladder and urethra; and Cheselden had already, in his mode of cutting into the urinary bladder, shown the necessity of exact knowledge of the relations of contiguous parts. The first decided application, however, of this species of anatomical research it was reserved for a Dutch anatomist of the 18th century to make. Peter Camper, professor of Anatomy at
1760. 1762. Amsterdam, published in 1760 and 1762 his anatomico-pathological demonstrations of the parts of the human arm and pelvis, of the diseases incident to them, and the mode of relieving them by operation. These observations are of the utmost value. The situation of the blood-vessels, nerves, and important muscles, is explained with the greatest clearness; and though the engravings are rather bold and accurate than elegant, they constitute a work indispensable to the anatomical reader. His remarks on the lateral operation of lithotomy, which contain all that was then known on the subject, are exceedingly interesting and valuable to the surgeon. It appears further that he was the first who examined anatomically the mechanism of ruptures, his delineations of which were published in 1801 by Soemmering.

It had been originally observed by Riolan, Severinus, Rudbeck, Harvey, and De Graaf, that in the fœtus the testicles are situate in the abdomen; but this observation, so pregnant with important results, appears to have been overlooked, nay doubted, till verified by Haller, who showed that their removal from this region is connected with the formation of congenital hernia. The situation of the testicles previous to birth, their gradual descent into the scrotum, and the mode in which a portion of intestine may slip down with them, was still more fully investigated by William Hunter, by Camper, and finally by John Hunter; and the peculiarities of the inguinal canal, and the manner in which its persistence after birth, or its re-opening, may occasion hernial protrusions, have been well explained by Sandifort, Scarpa, Sir Astley Cooper, Allan Burns, and Lawrence, and more recently by Hesselbach and Langenbeck.

The attention of anatomists was now directed to the elucidation of the most obscure and least explored parts of the human frame—the lymphatic vessels and the nerves. Although, since the first discovery of the former by Asellius, Rudbeck, and Pecquet, much had been done, especially by Ruysch, Nuck, Meckel, and Haller, many points, notwithstanding, relating to their origin, and distribution in particular organs, and in the several classes of animals, were imperfectly ascertained or entirely unknown. William Hunter investigated their arrangement, History.
and proposed the doctrine that they are absorbents; and 1746-48-51.
John Hunter, who undertook to demonstrate the truth of this hypothesis by experiment, discovered, in 1758, lymphatics in birds in the neck. As this doctrine required the existence of this order of vessels, not only in quadrupeds and birds, but in reptiles and fishes, the inquiry attracted attention among the pupils of Hunter; and William Hewson at length communicated, in December 1768, to the Royal Society of London, an account of the lacteals and lymphatics in birds, fishes, and reptiles, as he had discovered and demonstrated them. The subject appears about the same time to have been investigated by the second Monro, who indeed claimed the merit of discovering these vessels in the classes of animals now mentioned But whatever researches this anatomist may have instituted, Hewson, by communicating his observations to the Royal Society, must be allowed to possess the strongest as well as the clearest claim to discovery. The same author, in 1774, gave the first complete account of the anatomical peculiarities of the lymphatic system in man and other animals, and thereby supplied an important gap in this department. Hewson is the first who distinguishes the lymphatics into two orders, the superficial and the deep, both in the extremities and in the internal organs. He also studied the structure of the intestinal *villi*, in which he verified the observations of Lieberkuhn; and in inquiring into the minute structure of the glands, he adopted the views of Ruysch. He finally applied his anatomical discoveries to explain many of the physiological and pathological phenomena of the animal body. Ten years after, John Sheldon, another pupil of Hunter, gave a second history and description of the lymphatics, which, though divested of the charm of novelty, contains many interesting anatomical facts. He also examined the structure of the *villi*.

Lastly, Cruikshank, in 1786, published a valuable history of the anatomy of the lymphatic system, in which he 1786.
maintains the accuracy of the Hunterian doctrine, that the lymphatics are the only absorbents; gave a more minute account than heretofore of these vessels, of their coats and valves; and supplied the defect left by Hewson, by explaining the structure of the lymphatic glands. He also injected the *villi*, and examined them microscopically, verifying most of the observations of Lieberkuhn. The origin of the lymphatics he maintains rather by inference than direct demonstration. To these three works, though in other respects very excellent, it is a considerable objection that the anatomical descriptions are much mixed with hypothetical speculation and reasonings on properties, and that the facts are by no means always distinguished from mere matters of opinion. At the same time Haase published an account of the lymphatics of the skin and intestines, and the plexiform nets of the pelvis.

To complete this sketch of the history of the anatomy of the lymphatic system, it may be added that Mascagni, who had been engaged from the year 1777 to 1781 in the same train of investigation, first demonstrated to his pupils several curious facts relating to the anatomy of the lymphatic system. When at Florence in 1782, he made several preparations, at the request of Peter Leopold, grand duke of Tuscany; and when the Royal Academy of Sciences at Paris announced the anatomy of this system for their prize essay appointed for March 1784, Mascagni resolved on communicating to the public the results of his researches—the first part of his commentary, with four engravings. Anxiety, however, to complete his preparations detained him at Florence till the close of 1785; and from these causes his work did

History. not appear till 1787. These delays, however, unfavourable as they were to his claims of priority to Sheldon and Cruikshank, were on the whole advantageous to the perfection of his work, which is not only the most magnificent, but also the most complete, that ever was published on the lymphatics. In his account of the vessels and their valves, he confirms some of Hewson's observations, and rectifies others. Their origins he proves by inference much in the same manner as Cruikshank; but he anticipates this author in the account of the glands, and he gives the most minute description of the superficial and deep lymphatics, both in the members and in the internal organs.

General accounts of the nerves had been given with various degrees of accuracy by Willis, Vieussens, Winslow, and the first Monro; and the subject had been much rectified and improved by the indefatigable Haller. The first example of minute descriptive neurography was given in 1748 by J. F. Meckel, whose account of the fifth pair, and their connection with the intercostal, and of the nerves of the face, will long remain a lasting proof of accuracy and research. The same subject was investigated in 1765 by Hirsch, and in 1777 by Wrisberg. In 1766 Metzger examined the origin, distribution, and termination of the first pair,—a point which was afterwards very minutely treated by Scarpa in his anatomical disquisitions published in 1780; and the internal nerves of the nostrils were examined in 1791 by Haase. The optic nerve, which had been studied originally by Varoli, and afterwards by Mery, Duverney, Henkel, Mœller, Hein, and Kaldschmid, was examined with extreme accuracy, with the other nerves of the organ of vision, by Zinn, in his elaborate treatise. The phrenic nerves, and the œsophageal branches of the eighth pair, were studied by Haase; the phrenic, the abdominal, and the pharyngeal nerves, by Wrisberg; those of the heart most minutely by Andersch; and the origins, formation, and distribution of the intercostal nerve, by Iwanoff, Ludwig, and Girardi. The labours of these anatomists, however, were eclipsed by the splendid
1783. works of Walter on the nerves of the chest and belly; and
1794. those of Scarpa on the distribution of the 8th pair, and splanchnic nerves in general. In minuteness of description, and in beauty of engraving, these works have not yet been equalled, and will never perhaps be surpassed. About the same time Scarpa, so distinguished in every branch of anatomical research, investigated the minute structure of the ganglions and plexuses.

1780. The brain was also studied with great attention by Malacarne, Vicq d'Azyr, and Soemmering; more recently Reil examined the minute structure of the organ and its component parts with unrivalled research and accuracy; and Rolando studied the structure of the *cerebellum*.

Lastly, the anatomy of the gravid uterus, which had been originally studied by Albinus, Roederer, and Smellie, was again illustrated most completely by William
1774. Hunter, whose engravings will remain a lasting memorial of scientific zeal and sculptorial talent.

The perfection which anatomical science has attained has been evinced during the last ten years of the eighteenth century, and the first half of the nineteenth century, in the improved character of the systems published by anatomists. The first who gave a good modern system was Sabatier; but his work was speedily eclipsed by the superior merits of the treatises of Soemmering, Bichat, and Portal. To the first belongs the character of being at once the most learned and critical, and at the same time the most precise, yet published. The General Anatomy of Bichat is a monument of his philosophical genius, which will last as long as the structure and functions of the human body are objects of interest. His Descriptive Anatomy is distinguished by clear and natural arrangement, precise and accurate description, and the general ingenuity with which the subject is treated. The physiological observations are in general correct, often novel, and always highly interesting. It is unfortunate, however, that the ingenious author was cut off prematurely during the preparation of the third volume. It must nevertheless be acknowledged, that if the two last ones betray the want of the genius of Bichat, they are pervaded with the general spirit by which the others are impressed, and are highly creditable to the learning, the judgment, and the diligence of MM. Roux and Buisson. The system of Portal is a valuable and correct digest of anatomical and pathological knowledge, which, in exact literary information, is worthy of the author of the History of Anatomy and Surgery, and, in accuracy of descriptive details, shows that M. Portal trusts not to the labours of his predecessors only. Since the appearance of these standard works, Meckel published a Manual, which combines the philosophical generalizations of Bichat with the precise description and pathological knowledge of Portal. Of this work a French translation was published at Paris in 1825. Lastly, Cloquet formed, on the model of the Descriptive Anatomy of Bichat, a system in which he avails himself of the literature and precision of Soemmering, and the details of Portal. The system of Gordon is imperfect, its completion being interrupted by the death of the author; but, so far as it goes, it gives a correct summary of General Anatomy, and some accurate descriptive details of the heart and brain. The work of Dr Monro is entitled to mention in this place, as an elementary treatise, containing with anatomical description a good deal of physiological and pathological matter. These, however, must be considered foreign to the subject.

Of treatises on particular departments, those of Blumenbach on the bones, Innes and Sandifort on the muscles, the several anatomical writings and engravings of Charles Bell on the arteries, the nerves, and the brain, Barclay on the arteries, Tiedemann on the nerves of the uterus, and the same author's engraved delineations of the arteries, and Harrison's excellent work on the arteries, deserve notice. The most complete work, however, on the anatomy of the arteries was published at London between the years 1840 and 1844, by Richard Quain, Professor of Anatomy in London University College. In this work, Mr Quain has given with great accuracy, views of the normal origin, course, and distribution of all the important arteries of the human body; and has bestowed great attention in distinguishing and fixing all those which are normal from those which are abnormal. This work consists of eighty-seven most faithful lithographed engravings of large size, and is accompanied by 543 octavo pages of descriptive letterpress. From the attention with which it has been prepared, it ought long to continue a standard work on the anatomy of the arterial system.

The minute structure of bone which had been examined by Scarpa, was again studied by that indefatigable inquirer, and in this country by Howship. In 1834, Deutsch published at Breslau a dissertation containing some good observations on the minute structure of Bone; and in 1836, Miescher, with the aid of John Müller, published at Berlin a history of the general anatomy of bone, with some important observations on the *canaliculi* of Clopton Havers, and the manner in which the earthy matter is deposited in the bony texture. These observations, which were made by the aid of the microscope, form the basis of much of the modern knowledge on the structure of these organs.

On the minute structure of the teeth, the results of careful investigation were published by Retzius in 1837; by Alexander Nasmyth in 1839 and 1849; and by John Tomes in 1848; and the mode in which these organs are developed was elucidated with much skill in 1839 by Mr John Goodsir.

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The structure of the lungs, which was investigated in 1808 by Reisseissen, in 1821 by Magendie, and in 1827 by Sir E. Home, was anew subjected to scrutiny in 1836 by Bourgery, in 1842 by Mr William Addison; in 1845 by Mr George Rainey; and in 1846 by M. Rossignol.

On the anatomy of the nervous system numerous treatises have appeared during the last forty years. Joseph and
1812. Charles Wenzel investigated in 1812 the minute structure of the brain in man and the lower animals; Tiedemann traced the development of the organ in the fœtus, and rectified many errors on its formation and minute structure; Sir Everard Home and M. Bauer investigated its atomic constitution by the microscope. But this was done in a manner still more elaborate, and with improved means of observation, by Ehrenberg in 1833, by Valentin in 1834, by Remak in 1838, and by Purkinje about the same time. In 1836 Samuel Solly published an instructive treatise containing the anatomical history of the brain and its parts, elucidated chiefly after the method of demonstration proposed by Gall and Reil, and improved by Foville. A second edition of this work, enlarged and improved by much additional information, appeared in 1847; and though much of the volume is devoted to physiological and pathological matter, it may be regarded as the most complete treatise on the subject in the English language. More strictly anatomical, and not less valuable, is the Descriptive and Physiological Anatomy of the Brain, Spinal Chord, and Ganglions, by Robert Bentley Tod, published in 1845; a treatise remarkable for accuracy and precision in information.

Lobstein investigated in 1823 the structure and distribution of the Great Sympathetic Nerve; Bellingeri published the same year an accurate description of the Spinal Chord and its Nerves; Charles Bell, in his great work on the Nervous System, develops and establishes the truth of the ancient theory of the separate nature of the nerves of motion and those of sensation.

Between 1830 and 1834, Joseph Swan published a series of twenty-five excellent drawings, representing the connections, course, and distribution of all the demonstrable nerves of the human body, upon a scale as large as life; a work, the result of several years of personal dissection. Robert Lee gave in 1842 elaborate views of the position of the ganglia, and distribution of the Nerves of the Uterus in the virgin, and in the impregnated state; and the same parts were made the subject of investigation by Mr Snow Beck.

Comparative Anatomy, which, during the eighteenth century, was diligently cultivated by Daubenton, Pallas, Haller, John Hunter, and the second Monro, became during the first thirty years of the nineteenth century a subject of increased interest, from its intimate connection with the sciences of zoology, physiology, and geology, and has consequently been studied with great assiduity and skill by Cuvier, Dumeril, Home, Tiedemann, Meckel, Spix and Martius, Robert Grant, Rymer Jones, Richard Owen, and by numerous inquirers in the several countries of Germany.

The improvement which has been effected in the construction of the compound microscope during the thirty years subsequent to 1822, has contributed, in no small degree, to enable anatomists to obtain more correct information on the intimate structure of different organs and tissues of the animal body. For the first twenty years of the nineteenth century, opticians and instrument-makers had at intervals endeavoured to render the compound microscope at once an instrument of greater power, and more free from sources of error and optical illusion than it had hitherto been possible to obtain it. Two defects, however, still adhered to the compound microscope. The instrument was not achromatic; and a considerable degree of spherical aberration uncorrected rendered the image indistinct.

Between 1812 and 1815, Professor Amici of Modena had attempted to construct an achromatic object-glass of one single lens; but found that this was impracticable. M. Selligues of Paris, in 1823, after various trials, found that this could be done by making the object-glass consist of four achromatic compound lenses, each of which was composed of two single lenses. This method was carried into practice, and improved by the two MM. Chevalier of Paris. About the same time, Dr Goring in London, with the aid of Mr Tulley and Mr Pritchard, constructed compound microscopes upon a similar principle.

On the 5th of April 1824, M. Selligues presented to the Academy of Sciences a microscope, constructed by M. Chevalier, on the principle of combined lenses; and in the course of the same year, and without the knowledge of what had been done in France, the late Mr Tulley, at the suggestion of Dr Goring, constructed a compound microscope, an achromatic object-glass, of nine-tenths of one inch focal length, composed of three lenses, and transmitting a pencil of eighteen degrees. This was the first achromatic microscope that had been made in England.

By the labours of these practical opticians, and the suggestions of various scientific persons, as Sir John Herschel, Mr Airy, Mr Barlow, one great defect of the compound microscope was obviated. There was still another under which the instrument laboured; the effects of spherical aberration. This was overcome, in a very simple manner, by the experiments of Mr Jackson Lister, who had early observed that the combined achromatic object-glasses, devised by Selligues, were fixed in their cells with the convex side foremost, and that this is the most improper position, as it renders the spherical error very great. This gentleman found, after various trials, that, by placing three or more achromatic glasses with their plane surfaces directed foremost, it was possible to correct completely all spherical aberration.[1]

This fact was made known in the beginning of the year 1830; and by its application, the compound microscope was brought to a high degree of perfection as an achromatic instrument in 1831 and 1832, and became the means of affording valuable assistance in anatomical inquiries. After this period, accordingly, we find a succession of valuable monographical essays appearing, from time to time, from the anatomists of this country and the continent, on the minute microscopical anatomy of various important organs of the animal body. The whole of these writings it is impossible to mention in this place, further than to say that the use of the microscope in anatomy, which had in the times of Malpighi, Leeuwenhoeck, William Cowper, Baker, Fontana, Hewson, and the second Monro, been much cultivated, but had afterwards, from the imperfection of the instrument, and the illusions to which it not unfrequently gave rise, been unduly neglected, became so general and so necessary, that it may be said that, since the year 1832, minute structural anatomy has been, if not created anew, at least most thoroughly revised. The amount of knowledge has been increased; that which was already possessed was rendered greatly more accurate and precise.

By the aid furnished by these improved instruments, John Muller was enabled in 1830 to publish his elaborate Commentary on the Minute Structure of the Glands, the first work in which the anatomy of these organs was examined and elucidated in a comprehensive and systematic manner. By the aid of the same instrument Ehrenberg was enabled

[1] On some Properties in Achromatic Object-Glasses applicable to the Improvement of the Microscope. By Joseph Jackson Lister, Esq. *Philosophical Transactions,* 1830. Read 21st January 1830.

to publish, in 1833, his observations on the Minute Structure of the Brain; to explain in a manner hitherto impracticable the structure of numerous infusoria, and to disclose the peculiarities of many other structures, animal, vegetable, and mineral, which had previously eluded the most skilful researches. By the same means Francis Kiernan, in 1833, published the first correct account of the Minute Anatomy of the Liver. By means of the same assistance, Dr Martin Barry has communicated a large amount of new and correct information upon the structure of the Germinal Vesicle and the changes which it undergoes; the structure of cells; the minute structure of muscular fibres, and several other subjects intricate and little understood. By the same means, Mr William Addison and Mr George Rainey in this country, and M. Rossignol in Belgium, have been enabled to investigate carefully the minute structure of the lungs, and the disposition and figure of the air-vesicles. By the same means Gulliver, Queckett, and Wharton Jones, have studied to explain the minute structure of the corpuscules or globules of the blood in different classes of animals, and have thrown much light upon the forms of these globules. Lastly, by means of the same instrument, Mr Bowman has been enabled to give the first clear and intelligible views of the sacculo-vascular structure of the *corpora globosa* or Malpighian bodies of the kidncy, and has shown in what manner the cirriform or curling capillaries of these bodies contribute to the secretion of the urine; while in the same department Huschkc, Reichert, Gerlach, and Bidder, have laboured with grcat perseverance in elucidating various obscure points.

For several years past, in short, anatomists in Great Britain, France, Switzerland, Germany, Belgium, and Holland, have been industriously occupied in studying various departments of minute anatomy, by means of the improved compound microscope, and in throwing light upon all those points that are most obscure and uncertain. It cannot be said, nevertheless, that all has been discovery and all acquisition. These investigations have given rise to a large proportion of discordance in the representations given by different observers; and though all must have beheld the same objects, yet all have not put upon them the same interpretation. The result is, that it is a work of no ordinary difficulty to reconcile these discordant points, and out of the whole stock of facts, to form a consistent and correct description. Perhaps a considerable time must elapse before all these difficulties can be fully explained, and all thc points of discordance can be satisfactorily reconciled.

Meanwhile, it is proper to mention that systematic treatises have shared in the general improvements and rectifications thus introduced into anatomical science. In the year 1833 Carl Frederick Theodore Krause published at Hanover the first division or section of the first volume, in the year 1836 the second part, and in 1838 the third division, completing the first volume of a Handbook or Manual on Anatomy, General and Special. The general anatomy is given in the first part of the first division; the rest of the first division is occupied with the anatomy of the skeleton, thc muscles, the ligaments, and the fasciae. The second division is employed in explaining the anatomy of the compound organs and apparatus, including the organs of the senses, those of respiration, digestion, the organs of secretion, and those of reproduction. In the third division the author treats of the heart, the bloodvessels and lymphatics, and the nervous system.

This treatise is one of great merit. It is remarkable for clearness and method, brevity, accuracy, and precision; and the author must be allowed to have presented a most instructive system of anatomical knowledge. Krause has given in it accurate average estimates of the weights and dimensions of the different organs. This work appeared in a second edition in 1841 and 1842.[1]

In the year 1837, Joseph Berres, professor of anatomy at Vienna, published in that city the *Microscopical Anatomy of the Human Body;* and in which he gave views of the anatomy of all the simple textures and the various organs, as disclosed by the microscope. The instrument which Professor Berres employed was one made by Ploesslich. This work is undoubtedly one of great labour and no ordinary value; but probably it is in its plan too comprehensive, and embraces too large a field to be in all points accurate. The descriptions are given in the German and Latin languages.[2]

Cruveilhier published in 1834 and 1835, a good general treatise on Descriptive Anatomy, which was translated into English, and published in 1841 as part of the Library of Medicine.[3] A new and improved edition of this treatise the author himself published at Paris in 1842 and 1844.

The excellent work by Samuel Thomas Soemmering,[4] originally published in the German language, between the years 1791 and 1796; then in the Latin language between the years 1794 and 1800; and in a second edition in the German language in 1800 and 1801, maintaining the high character which it first possessed for clear arrangement, accurate description, and general precision; was between the years 1841 and 1844 republished in eight volumes at Leipsic, by Bischoff, Henle, Huschke, Theile, Valentin, Vogel, and Wagner, with suitable additions, and a large amount of new and accurate information. In this edition Rudolph Wagner gives in the first division of the first volume, the Life, Correspondence, and Literary writings of Soemmering; and, in the second volume, the anatomy of the Bones and Ligaments. The third volume contains the anatomy of the Muscles and the Vascular system by Theile. Valentin devotes one volume, the fourth, to the minute anatomy of the Nervous system and its parts, as disclosed by careful examination by the microscope; and it must be allowed that the author has been at great pains to present just views of the true anatomy of the Brain, the Spinal Cord, the Nervous Branches, and the Ganglia. In the fifth volume, Huschke of Jena, gives the anatomical history of the Viscera, and the organs of the senses; a department which had been left in some degree incomplete in the original; but for one division of which the author had left useful materials in his large figures already mentioned. In the sixth volume, an entire and complete system of General Anatomy, deduced from personal observation, and that of other careful observers, the materials being in general new,

[1] Handbuch der Menschlichen Anatomie Durchaus nach Eigenen Untersuchungen und mit Besonderer Ruchsicht auf das Bedürfniss der Studirenden, der Practischen Aerzte und Wundärzte und der Gerichtsärzte Verfasst von Carl Friederich Theod. Krause, M.D., U.S.W. Erster Band in Drei Abtheilungen. Hannover 1833–1838.

[2] Anatomie der Mikroskopischen Gebilde des Menchlichen Körpers. Von Dr Joseph Berres K. K. Offentliche Professor der Anatomie an der Wiener Universitat, &c. Wien 1837, Folio.

Anatomia Microscopica Corporis Humani. Auctore Dr Josepho Berres Professore Publico Ordinario in Universitate Vindobonensi, &c. Viennae 1837, Folio, p. 272, with numerous plates.

[3] Descriptive Anatomy. By T. Cruveilhier, Professor of Anatomy to the Faculty of Medicine of Paris, Physician to the Hospital of Salpetriere, &c. Two volumes small 8vo, London, 1841–42, pp. 1214. Library of Medicine, volumes seventh and eighth.

[4] Samuel Thomas Von Soemmerring vom Baue des Menschlichen Körpers. Neue umgearbeitete und vervollstandigte Original Ausgabe Besorgt von W. Th. Bischoff, J. Henle, G. Huschke, F. W. Theile, G. Valentin, J. Vogel und Rud. Wagner. Leipzig 1841–44. Acht Bände.

History. and in all instances confirmed and rectified, is given by Henle, at that time at Zurich, but subsequently professor at Heidelberg. The seventh volume contains the history of the process of Development in Mammalia and Man, by Th. L. W. Bischoff. The eighth volume contains the Pathological Anatomy of the Human Body, by Julius Vogel, but only the first division thereof, relating to the generalities of the subject.

This, which is probably the most accurate, as it is the most elaborate system of anatomical knowledge up to the date of its publication in 1844, was translated into the French language by Jourdan, and published in 1846, under the name of *Encyclopedie Anatomique.* The eighth volume was translated into the English language in the year 1847.

In 1840, Francis Gerber published at Berne a Manual of General Anatomy in the Human Subject and the Domestic Mammalia. Of this work, which contains a large amount of new and accurate information, an English translation was published by Mr Gulliver in 1842.[1]

In 1846, Joseph Hyrtl published at Prague a system of Anatomy of the Human Body in reference to Physiology, which contains short but interesting views of the Physiological Anatomy of the different organs. In the course of the same year, and in 1847, the same writer published a Manual of Topographical and Surgical Anatomy; the latter chiefly for surgeons and accoucheurs, as the former work was intended for the benefit of physicians. The second volume contains the surgical anatomy of the Male and Female Pelvis, the Spine, and the extremities.[2]

Bourgery began in 1834 to publish a work on Elementary Anatomy; and in 1837 a large and complete system of anatomical knowledge, illustrated with large figures of all the divisions and organs of the human body. This work consist of two divisions, one on Medical and Physiological Anatomy; the other on Surgical Anatomy. It is only now completed.

In England the treatise by Jones Quain, which was highly esteemed, was republished in a fifth edition between the years 1843 and 1848, by Mr Richard Quain and Dr Sharpey, in two volumes. The work was in this form enlarged to about double its previous size; and it contains a large amount of accurate information in General Anatomy, and in several of the divisions of Descriptive Anatomy. The General Anatomy is written entirely anew by Dr Sharpey, who has taken great pains to present a just and accurate view of the state of knowledge in that department. This work is the most complete English system hitherto published. Of various English manuals, those by Ellis, by Wilson, and Harrison, are most entitled to recommendation.[3]

In the three years between 1846 and 1849, Dr Arthur Hill Hassall published the *Microscopic Anatomy of the Human Body in Health and Disease.*[4] Though in this work the author treats of the morbid state of the fluids and solids, as well as their normal or healthy condition; yet as he takes great pains to give correct views of the minute anatomy of the textures in the state of health, it would be unjust here to omit mentioning his services. The work is illustrated by sixty-nine coloured drawings, and may be recommended as one giving very just views of the minute anatomy of the tissues and organs, both from personal observations, and that of contemporary inquirers.

In the year 1850, Dr A. Kolliker, Professor of Anatomy at Wurzberg, published at Leipsic the first half of the second volume of a work devoted to the elucidation of the microscopical anatomy of the human body: and in 1852 the second half of the same volume. For manifold reasons the author states that he publishes the second volume, which is devoted to the history of the Special or Particular Tissues, before the first. In the first half of this volume, Kolliker treats of the microscopical anatomy of the Skin, the Muscles, the Bones, and the Nerves, and in the first division of the second half of the microscopical anatomy of the Organs of Respiration and Digestion.[5] From the specimens already published, this work gives the promise of being the most complete and accurate hitherto published on the subject of minute structural anatomy. The author has been at great pains in examining every texture with the greatest care, and comparing his own observations with those given by previous and contemporary anatomists; and while the information is ample on every disputed point, every reader must feel that he finds in this work more accurate knowledge on the intimate structure of organs than he had previously possessed. This work, when completed, will, in short, probably prove to be the standard treatise on general and microscopical anatomy. The descriptions are illustrated by numerous beautiful wood engravings (295), and four lithographed tables.

The account now given embraces the principal works upon anatomy, not by any means the whole, that have been published since the use of the improved compound microscope has become general. Many writings of very considerable merit upon individual subjects and questions in anatomy have during the same time appeared in different countries of Europe. Upon the brain and the nervous system they have been most numerous; some inquirers devoting their attention to the nerves, as Remak, Purkinje, Pappenheim, Bidder, and Volkmann, Budge, Schiff, Bowman; others, as Valentin, Longet, Solly, Todd, Lockhart, to the Brain and its Vertebral Prolongation. These, however, the limits assigned to the present outline prevent us from recording. It shall be our study, nevertheless, in the proper place to notice whatever facts may seem most important, as ascertained by each, as far as the nature and objects of this article will admit. Minute details it will not be possible to introduce. But it shall be our endeavour to present upon the structure of the tissues and the different organs, such accounts as may convey a just idea of the facts hitherto ascertained, and may enable readers to form correct notions on the state of anatomical knowledge in the middle of the nineteenth century.

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[1] Fr. Gerber Handbuch der Allgemeine Anatomie des Menschen und der Haussäugthiere mit Steindruck Tafeln. Folio. 2 Durchgesch: Ausgabe gr. 8vo. Bern, 1840.

Elements of General and Minute Anatomy by Fr. Gerber, translated by George Gulliver. London 1842, atlas 8vo.

[2] Joseph Hyrtl Lehrbuch Anatomie des Menschen mit Ruchsicht auf Physiologische Begründe und Practische Anwendung gr. 8vo. Prag. 1846.

Joseph Hyrtl Handbuch der Topographischen Anatomie und ihre Practische Med-Chirurg Anwendung mit Steindruck Tafeln N. Einer Band gr. 8vo. Wien 1846–47.

[3] Elements of Anatomy by Jones Quain, M.D. Fifth Edition. Edited by Richard Quain, F.R.S., and William Sharpey, M.D., F.R.S., Professors of Anatomy and Physiology in University College, London. In two volumes, Illustrated with numerous engravings in wood, 8vo. General Anatomy cccvii. pp. Descriptive Anatomy 1324 pp.

[4] The Microscopic Anatomy of the Human Body in Health and Disease. Illustrated with numerous Drawings in colour, by Arthur Hill Hassall, M.B., &c., Member of the Royal College of Surgeons, England. In two volumes. London 1846–9, 8vo, pp. 570. Sixty-nine coloured Drawings.

[5] Mikroscopische Anatomie; oder Gewebelehre des Menschen von Dr A. Kolliker, Professor der Anatomie und Physiologie in Wurzburg. Zweiter Band Specielle Gewebelehre; Erste Hälfte mit 168 Holzschnitten. Leipzig 1850, grösse 8vo, seite 554, Zweite Hälfte I. Abtheilung Mit. 127 Holzschnitten. Leipzig 1852, seite 346.

In the foregoing account we have been anxious to trace merely a general sketch of the progressive advancement of anatomical discovery, from the first cultivation of the art to the present time. To mention every circumstance is impracticable, and would have extended this outline much beyond its legitimate limits. Though no name of genuine importance, however, has been omitted, every one not directly connected with strict anatomy has been excluded. For more minute and detailed information, we refer in general to the elaborate History of Anatomy and Surgery by Portal, the BIBLIOTHECA ANATOMICA of Haller, and the critical and learned history of Lauth. The latter work is not completed. But by combining its perusal with that of the works already mentioned, and several of the chapters of Sprengel's History of Medicine, the anatomical inquirer will form very just ideas of the literary history of his science.[1]

Human Anatomy.

## HUMAN ANATOMY.

ALL animal bodies agree in the possession of certain general characters, by which they are distinguished equally from inorganic bodies and from vegetables.

Besides the round shape by which organic bodies are distinguished, most animals are, externally at least, symmetrical, or present on each side of the mesial plane, lateral halves mutually alike. The substances of which they consist are not entirely solid, but are soft, compressible, distensible, and elastic, and contain a proportion of liquid matter, which is generally in the ratio of majority to that of the solid. These substances are enveloped in a thready or filamentous matter, named areolar or cellular, from the interstitial spaces which result from the intersection of its filaments; and the whole is inclosed in a general covering, which in several classes is soft, membranous, and elastic, but in others is hard, crustaceous, and even horny. The body is perforated by an internal cavity for the reception of food; and this cavity is lined by a membranous covering, which is continuous with that by which the exterior is involved. In several classes of animals there are tubular canals, distributed in an arborescent form, for conveying, in definite directions, the nutritious matter to all parts of the frame. These are named blood-vessels, or organs of circulation. One modification of these, arranged in such manner that this matter is subjected to the influence of the atmospheric air, forms lungs, gills, or organs of *respiration;* and another, in which part of it is separated from the whole, constitutes secreting organs or glands. The genital or reproductive organs consist of a cavity, from which the germs or *ova* are detached. For the purpose of motion, animals further possess organs generally of a fibrous structure, and which have the remarkable property of undergoing contraction on the application of a stimulus or irritating agent. These organs are denominated muscles (*lacerti, tori*); and their contractile property is termed *irritability* or *contractility.* For receiving the impression of external objects, they are provided with one or more organs of sensation, of structure more or less complex. And in almost all animal bodies, except the very lowest, there are found soft, gray, or whitish cords, inelastic, but marked in their course by fusiform, spheroidal, or irregular-shaped swellings, and connected at their further extremity with the muscles, with the organs of sensation, or with the exterior or interior coverings. It is remarkable that the purpose of these cords, which are named nerves, is not exactly known. They neither communicate mobility to the muscles, nor sensibility to the organs of sensation; but they render the actions of the former steady, regular, and voluntary; and the impressions received by the latter they certainly serve to convey to the centre of the nervous system. The faculty ascribed to the nerves is named *nervous action, nervous energy, nervous power, nervous influence,* or simply *innervation.*

In chemical composition, animal bodies consist of gelatine, albumen, fibrin, fat or oleaginous matter, a modification of mucus, and various saline substances. Subjected to combustion, or spontaneous decomposition, while vegetable substances furnish water, carbonic acid, and carburetted hydrogen, animal matters furnish also ammonia,—a circumstance which shows that they contain azote. They furnish also sulphuretted hydrogen, apparently from the decomposition of albuminous matters.

The fluids of animal bodies (*liquores, latices, humores*) are contained in tubular canals or vessels. If these fluids move through the vessels, they are denominated generally blood, whatever be their colour. All the fluids consist either of this, or of some modification separated from it by means of glandular action; and of the fluids so separated, some are destined for purposes within the economy, and are therefore secretions proper; others are intended to be eliminated immediately, and may therefore be regarded as excretions. Though it is impossible to estimate accurately the proportion of the fluids, some idea of it may be formed by the fact, that an animal body may be reduced by desiccation to $\frac{1}{9}$ or $\frac{1}{10}$ even of its previous weight. The proportion may be stated, in general terms, to vary from 9 or 6 of fluid, to 1 of solid matter.

The various forms of animal bodies may be referred to general divisions or classes, according to certain peculiarities in configuration and structure. These divisions are, the VERTEBRATA, MOLLUSCA, ARTICULATA, and RADIATA.

In the first class the central portion of the nervous system, consisting of the brain and spinal chord, is inclosed in a case of hard matter, containing much calcareous earth, and denominated bone. While one portion of this forms, by the union of its pieces, a cavity named the scull or *cranium,* the other is composed of separate pieces, which by their union constitute at once a continuous canal and a sort of internal pillar or column for attaching and supporting the soft parts. These pieces are named *vertebræ* (σπονδυλοι); and their presence is so uniform, that they constitute the character of the class, which are therefore named VERTEBRATED ANIMALS; (ANIMALIA VERTEBRIS PRÆDITA, *sive* VERTEBRATA).

The presence of vertebræ is accompanied with other peculiarities of structure. Thus the vertebrated animals have red blood and a muscular heart; a system of tubes for conveying blood from this to the different organs,—the distributory, or arteries; another system for returning it,—the regredient, or veins; and a particular system of

[1] *Histoire de l'Anatomie et de la Chirurgie, &c.* par M. Portal, Lecteur au Roi, &c. Paris, 1770–1773, 6 vols. *Bibliotheca Anatomica, qua Scripta ad Anatomen et Physiologiam facientia a rerum initiis recensentur.* Auctore Alberto von Haller Domino a Goumoens, &c. Tiguri, 1774–1777, 2 vols. 4to. *Histoire de l'Anatomie,* par Thomas Lauth, D. M. &c. &c. Strasbourg, 1815. *Versuch einer pragmatischen Geschichte der Arzneikunde* von Kurt Sprengel. Halle, 1792–1803. 3e Auflage, 1821–28.

vessels for exposing the latter blood to the influence of the atmosphere. They have further a mouth with two horizontal jaws; distinct organs of vision, hearing, smell, and taste, lodged in the cavities of the face; never more than four members; separate sexual organs; and considerable similarity in the arrangement of the central masses and the ramified chords of the nervous system. In all the vertebrated animals the blood which serves for the secretion of bile is the venous, which has circulated in the intestines, and which is afterwards made to undergo a ramifying distribution in the portal vein. In all the vertebrated animals also a peculiar secretion is formed from the arterial blood by two large glands, denominated kidneys.

In the second general division, which are destitute of those firm pieces named bones, the central portion of the nervous system, instead of being inclosed in portions of the skeleton, is placed on the œsophagus, and, with the other internal organs, is inclosed in a general soft envelope, contractile, corresponding to the skin, to which the muscles are attached, and in which stony patches named shells are occasionally formed. Of the four proper organs of sensation, those only of taste and sight are observed; and the last are often wanting. One family only are provided with organs of hearing. There is always a complete system of circulation, and organs for respiration. Those of digestion and secretion are almost as complicated as in the vertebrated animals. The division of the animal world thus distinguished have been named Molluscous Animals; (Animalia Mollusca).

In the third general division, the nervous system consists of two chords extending longitudinally along the belly, and swelling at intervals into knots or ganglions. The first of these, placed on the œsophagus, and distinguished as the brain, is scarcely larger than the others. The covering of the trunk is divided by transverse folds into a number of rings, the integuments of which may be hard or soft, but to the interior of which muscles are in all cases attached. The sides of the trunk, though often provided with, are nevertheless often without, articulated members. The annular appearance of the trunk has given these animals the character of Articulated; (Animalia Articulata). They have been occasionally named Annulosa.

This class of animal bodies is remarkable for presenting the first transition from circulation in close tubes or vessels, to nutrition by imbibition, and the corresponding transition from respiration in circumscribed organs to that which takes place in air-tubes distributed through the whole body. The only distinct organs of sensation are those of taste and sight; and a single family have organs of hearing. The jaws, when present, are lateral.

In these three divisions of animals the organs of motion and sensation are arranged symmetrically on both sides of an axis or imaginary line. In a fourth class they are distributed circularly round a centre. In these, which in homogeneous structure approach the nature of plants, neither distinct nervous system nor proper organs of sensation are observed. Scarcely do we recognise traces of circulation. The organs for respiration are almost always at the surface of the body. Most of them have for intestine a sac without vent; and some present only a homogeneous pulp, movable and sensible. To this class, which comprehends those beings denominated since the time of Aristotle *zoophytes* (ζωοφυτα), or *animal plants*, the name of Radiated Animals has been recently applied; (Animalia Radiata).

The vertebrated animals, however similar in general characters, present certain peculiarities by which they are naturally distinguished into classes. The first, and perhaps the most striking difference, is in the mode of birth, one large division being separated from the body of the female parent in a state of complete life, and therefore denominated viviparous; the other being detached in the form of an *ovum* or egg, which, though possessed of the elements of life, is not yet endowed with it, and requires for the full developement of that principle the assiduous care of the parent. This difference, however obvious, is more apparent than real. In viviparous birth the fœtus or new animal remains attached to the inner surface of the womb by means of nutrient blood-vessels, and is enveloped in membranes, which correspond very accurately to the coverings of the *ova* of oviparous animals. The rupture of these membranes at the moment of birth or detachment from the body of the parent is the only circumstance which constitutes a material difference between viviparous and oviparous generation. The viviparous animals, nevertheless, are further distinguished by nursing their offspring by means of teats or *mammæ*, glands destined for separating from the mass of blood the oleo-albuminous fluid denominated *milk*.

A still more important source of distinction among the vertebrated animals is found in the disposition of the vascular organs destined for respiration. The blood, which proceeds from the heart by the distributing tubes or arteries to the different organs, thereby undergoes a certain change, in consequence of which it is no longer capable of answering the several purposes of nutrition, secretion, &c. which are necessary to the maintenance of the animal body in the healthy state. To fit it once more for these purposes, the blood, in whole or in part, is, by means of the veins, brought back to the heart, and thence conveyed by means of a system of arborescent tubes to the surface of an organ, where it is, through the interposition of a thin membrane, exposed more or less freely to the atmospheric air. When it is exposed directly to this fluid introduced into the body by means of a single tube divided into ramifying branches, the respiratory organ is denominated *lungs*. When the blood, on the other hand, is exposed to atmospheric air by means of water, which passes over a pectiniform organ, the latter is denominated *gills*. Respiration varies, therefore, according as the structure of the organ allows the whole or part of the blood to be exposed to air, and according as this exposure is direct or indirect.

Taken together, these circumstances may be viewed as the integrant or constituent elements of the quantity, extent, or degree of respiration, which conversely, indeed, depends on two circumstances,—the quantity of blood present in the respiratory organ at any given moment, and the relative quantity of oxygen in the respired fluid.

The organs of circulation may be double, so that the whole mass of blood which is brought by the veins from the remote parts must circulate in the respiratory organ before it is again distributed by the arteries;—or they may be single, so that one portion only of the regredient blood is made to pass through the respiratory organ, while the residue is distributed by the arteries without undergoing this circulation. Of this mode of respiration an example is given by the class of animals denominated *Reptiles;* (Reptilia; Animalia Repentia); in which the heart is so constructed that only part of the blood is conveyed to the lungs, and in which, consequently, the amount or degree of respiration, and the concomitant qualities, vary according to the proportion of this fluid which goes to the lungs at each pulsation.

In Fishes, on the other hand, though the circulation is two-fold, that is, distributory by means of arteries, and regredient by means of veins, the respiratory organ is formed for respiration through the medium of water, and the blood thus exposed to air receives the influence of that only which is mingled or held in solution by the water. Their extent of respiration is therefore supposed to be less than that of reptiles, by reason of the imperfect exposure to the operation of the air. Their respiration may be termed *hydro-aerial.*

In mammiferous animals, again, though the circulation is two-fold, or distributory and regredient, the respiration is single, or confined to the lungs only. Their extent of respiration is therefore superior to that of the reptiles, by reason of the shape of their circulatory organs, and to that of fishes by reason of the nature of the element in which they live. Their respiration is *aerial.*

In another class of vertebrated animals, however, respiration assumes a form still more perfect and extensive, since not only is the circulation two-fold, and the respiration aerial, as in the *mammalia*, but their structure is such that the air of the trachea communicates with other cavities, especially those of the bones, and surrounds the branches of the aorta as completely as it does those of the pulmonary artery. The effect of this arrangement with regard to the ambient atmosphere is at once to render these animals specifically lighter, and enable them to support themselves in the air, and to restore and change the regredient or venous blood so completely, that when again distributed it may impart to the various organs the highest degree of energy of which they are susceptible.

From these characters a division of vertebrated animals may be formed in the following manner. 1*st*, Quadrupeds, in which the extent of respiration is moderate, and which are distinguished for walking or running, or other muscular exertion with strength; 2*d*, Birds, in which the extent of respiration is the greatest possible, and is connected with the levity of substance and energy of muscle requisite for flight; 3*d*, Reptiles, in which the small extent of respiration is connected with languor of motion and occasional seasons of torpor; and, 4*th*, Fishes, in which the still more limited form of the respiratory organ requires a fluid of nearly equal specific weight to their own bodies to enable them to move with facility. These characters are necessarily general; but they are so essential, that between them and the other circumstances of organization proper to each class, and especially those relating to motion and sensation, a necessary relation exists.

To the quadrupeds, mammiferous animals, or viviparous vertebrated animals, which form the first of these great classes, this place belongs, not only by the mode of generation and respiration, but by the more perfect form of the animal functions, and the higher degree of intelligence which their habits and actions indicate. They are less under the influence of that blind animal propensity denominated instinct, which, like the properties of inorganic matter, seems to operate regularly and uniformly, independent either of sensation or volition.

This class of animals is distinguished by great uniformity and regularity of structure and organization. In all of them the upper jaw forms part of the cranium; and upon this the lower jaw, consisting of two pieces only, articulated by a prominent condyle to the temporal bone, is made to move. The neck consists of seven, and, in one species only, of nine vertebræ; to the sternum are attached certain of the ribs, therefore named *sterno-vertebral;* the thoracic extremity is supported by a flat bone named shoulderblade (*scapula*, *ωμοπλατη*), not articulated, but simply suspended in the muscles, and in some species supported on the sternum by an intermediate bone, named collar-bone or clavicle (*clavicula*, *κληις*); in all excepting the *cetacea* or whale-like animals, the first part of the pelvic extremity is fixed to the vertebral column, and forms a cincture or basin (*pelvis*), which in early life is divided into three pairs of bones, the *os ilium*, which is attached to the spine, the *os pubis*, which constitutes the anterior or abdominal part of the pelvis, and the *os ischium*, which constitutes the most remote lateral portions of the pelvis. At the point of junction of these three bones on each side is a spherical cavity, in which the articular head of the thigh-bone is lodged.

The scull, articulated by two prominent convex surfaces with the first vertebra, denominated *atlas*, may be represented as consisting of three annular portions, an anterior formed by the frontal and ethmoid bones, a middle by the parietal and sphenoid bones, and a posterior by the occipital bone; the temporal bones, which are common to the face and scull, being interposed between the sphenoid, the occipital, and the parietal bones.

The face is formed essentially by the superior and inferior maxillary bones. Between the former is the cavity of the nostrils above, separated by the azygos bone named *vomer;* before are the intermaxillary bones, and behind are the two palate bones. The entrance of the nasal cavity is bounded above by the proper nasal bones; and to a groove in this cavity are attached the inferior turbinated bones, so as to cover partially the entrance into the maxillary sinus.

The brain consists of two similar hemispherical halves, united by a white mass, fibrous, especially in the transverse direction, named mesolobe, middle-band, or smooth body (*σωμα τιλλοειδες*, *corpus callosum*). Each hemisphere contains an interior cavity, formed into definite-shaped masses, uniform and symmetrical. These cavities communicate with each other, and with a third situate on the mesial plane, and extending by a narrow canal to a fourth situate between the *cerebellum* and *medulla oblongata.* The proper matter of the cerebral and cerebellic hemispheres is united on the mesial plane in a mass named *annular protuberance* or *pons Varolii*, the lower surface of which is marked by transverse fibres, while the upper is moulded into four roundish eminences named *nates* and *testes*, or *corpora quadrigemina.*

In the eye, lodged in a cavity of the cranium named orbit, and provided with two eye-lids and the vestige of a third, the crystalline lens is fixed by the ciliary processes; and the sclerotic, though firm, is cellular. The ear consists of a cavity named *tympanum*, closed externally by a membrane, and containing four minute but articulated and movable bones; an oval cavity or vestibule, in the orifice of which, one of these bones, the *stapes*, is fixed, and which communicates with three semi-circular canals; and, lastly, a spiral and tapering cavity, termed *cochlea*, parted by a thin plate into two spiral canals, one of which communicates with the tympanum, the other with the vestibule. The tongue is fleshy, and is supported by a *parabola*-shaped bone, attached to the cranium by ligaments, and to the larynx by membranes.

The lungs, in number two, consisting of numerous tubular canals, proceeding from the windpipe, and terminating in an infinity of minute intersecting canals, named cells or vesicles, are inclosed without attachment, in a cavity formed by the ribs on each side, the diaphragm abdominally, and on the mesial plane by a membranous partition named mediastinum, and lined all over by a thin transparent membrane; (*pleura*). At the guttural extremity of the windpipe is placed a particular apparatus, formed of cartilages put in motion by muscles, and which serves at once to regulate the quantity of air admitted into the tube, and to form the voice. This is named the larynx. A membranous fleshy production, suspended from the palate bones like a veil or valve, also moved at the will of the animal, establishes a direct communication between the larynx and the posterior nostrils.

The intestinal canal is suspended to a duplicature of the peritoneum, named mesentery, between the folds of which the blood-vessels, nerves, lymphatics, and lymphatic glands pertaining to the canal, are lodged. The peritoneum, after passing over the intestines, forms a similar duplicature, which in the manner of a prolongation hangs freely before them.

The urine, after secretion by the kidneys, is retained for a time shorter or longer in a distensible musculo-membranous bladder, and is expelled at various periods by a canal which opens, with few exceptions, in common with that of the organs of generation.

The latter function is, in all the mammiferous animals, essentially viviparous. The ovum, consisting of the fœtus and the enveloping membranes, immediately after conception is conveyed by appropriate tubes into the womb, to the inner surface of which it is attached by one or more plexiform clusters of vessels named *placentæ*, and which furnish the blood requisite to the nourishment of the new body. In the earliest periods of uterine life, however, the mammiferous animals present a bladder or *vesicula* (vitellar membrane), analogous to that which contains the yolk of the oviparous animals, and receiving also mesenteric vessels.

The peculiar mode in which viviparous animals nurse their offspring has been already noticed as that which distinguishes them particularly from the other three divisions of vertebrated animals.

Another character peculiar to this class, are the hairs with which their integuments are provided, and which, though analogous to the feathers or quills of birds, are nevertheless so characteristic, that they cannot be properly omitted in this enumeration. They are found in all mammiferous animals except the cetacea, in which marine residence is supposed to render them less necessary. Lastly, the blood of the mammalia is said to differ from that of oviparous animals in the shape of the coloured particles. In the former they are represented as lenticular, or of the shape of flat or oblate spheroids; in the latter they are ovoidal, or like oblong spheroids.

The mammiferous animals may be subdivided into subordinate groups or orders, according to certain natural characters in organization, which imply again peculiarities of habit and mode of life. These characters are derived from the organs of touch or prehension, on which depends their degree of ability or address; and from the organs of mastication, which always bear a certain relation to the nature of the food on which the individual animal subsists.

The delicacy of the organ of touch depends on the number and mobility of the toes, and on the extent to which their tips are enveloped in nail or hoof. The latter, enveloping entirely the part of the foot which touches the ground, impairs sensation, and renders the foot or paw incapable of prehension. When, on the contrary, a single plate of nail covers one of the surfaces of the tip of the toe, it not only leaves the other all its natural nicety of touch, but gives each toe that free and unembarrassed motion which enables the animal to seize and hold by the claws.

The nature of the aliment used by animals bears a relation to the teeth, with the form of which, again, the articulation of the jaws corresponds. To divide flesh, incisive teeth, like a saw, and jaws mutually opposed, like the blades of scissors, which simply open and shut, are requisite. In order to break grains or roots, teeth with a flat crown, and jaws admitting of horizontal motion, are required. The crowns of these teeth must further be unequal or tuberculated, like the surface of a mill-stone, and their substance must be unequally firm, since certain parts are more exposed to attrition than others.

All hoofed animals are necessarily herbivorous, or have flat-crowned teeth, since their feet do not allow them to seize living prey. Unguiculated animals, again, are susceptible of greater variety in the shape of the teeth, and their aliment depends on the mobility and delicacy of their toes One character of this description, which exercises great influence on their address, and multiplies their means of industry, is the faculty of opposing the great toe to the others, or the thumb to the fingers,—a circumstance which essentially constitutes what is termed the hand, and which is carried to its highest perfection in the case of man, in whom the pectoral extremity is entirely free and susceptible of every mode of prehension.

The several combinations now mentioned furnish characters for distinguishing the mammalia into the following orders.

| | | |
|---|---|---|
| UNGUICULATA; animals with separate toes or claws. | BIMANA; hands on the thoracic extremity; supported vertically by the pelvic extremities. | |
| | QUADRUMANA; hands on the thoracic and pelvic extremities. | |
| | CARNIVORA; toes without free and opposable thumb. | *MARSUPIALIA.* |
| | RODENTIA; no canine teeth; gnawing incisors. | |
| | EDENTATA; no incisors; occasionally no canine; sometimes teeth wanting. | |
| UNGULATA; hoofed animals. | PACHYDERMATA; dense, compact, callous hide. | |
| | SOLIDIPEDA; six incisors and six molars in each jaw; single stomach and large cæcum; one undivided hoof. | |
| | FISSIPEDA *s.* RUMINANTIA; no incisors in the upper jaw; quadruple stomach; cloven foot. | |
| CETACEA; animals with very short pelvic extremities, living in the water. | C. HERBIVORA. | |
| | C. CAPITULATA. | |
| | C. CAPITONES. | |

Of these subdivisions, the first three orders are known by the common character of possessing all the three varieties of teeth, molar, canine, and incisive. They differ from each other in the possession of complete hands on the thoracic extremities, of imperfect hands on the four extremities, and in the want of thumb or opposable toe on the four extremities. The fourth order is peculiar in wanting canine teeth, and having incisors constructed for gnawing. In the fifth the toes are much constrained in motion, being sunk in large claws; and the incisors are wanting. Some genera want the canine teeth, and some are void of teeth entirely.

This distribution of unguiculated animals would be complete, and would form a regular series, were it not interrupted by a small lateral series from New Holland, the native soil of the Marsupial animals. Of these, it is the peculiar distinction, that while some of their genera correspond to the CARNIVORA, others to the RODENTIA, and a third set to the EDENTATA, in the form of teeth and nature of food, all of them agree in the common character of having a large sac or purse (*marsupium*) for retaining some time after birth their offspring, which are detached from the body of the parent in a state of imperfection, corresponding nearly to the fœtus of other mammiferous animals shortly after conception.

In the series of hoofed animals, which are less numerous, less irregularity is also observed. The order of RUMINANT animals is well distinguished by cloven feet, the absence of incisors in the upper jaw, and the quadruple stomach, or that with four compartments. The other hoofed quadrupeds may be united in one order, distinguished by the absence of the ruminating stomach, and a peculiar density of integuments, from which they are named PACHYDERMATA. The elephant alone constitutes a distinct family, and is allied, by the form and mechanism of the teeth, with the family of RODENTIA. A third family of hoofed quadrupeds is distinguished by one apparent toe and one hoof in each foot; though beneath the skin, on each side of the *metacarpus* and *metatarsus*, are prominences corresponding to lateral toes. This small family (SOLIDIPEDA) includes the horse, ass, zebra, and quagga.

Lastly, the CETACEOUS or whale-like animals form a family by themselves, so peculiar, that though viviparous and mammiferous, they might readily be regarded as belonging to the class of fishes. Their organization, however, immediately shows their proper place in the classification; and even the fact observed by the ancients, that, though pisciform, they have warm blood, demonstrates their title to the character of Mammalia.

Man, who, as the most perfect specimen of mammiferous animal with which we are acquainted, is placed at the head of this class, partakes of the general characters of structure and function belonging to the class, and possesses also certain peculiarities by which he is distinguished. The study of the facts of the former description belongs properly to Comparative or Animal Anatomy. That of the latter constitutes Human Anatomy proper. It is, however, expedient to waive this distinction, and trace the anatomical history of the human body, without supposing the reader already minutely acquainted with the structure of mammiferous animals in general. In the course of this description, however, it is requisite to recur frequently to the lower animals, and to derive from them information more or less direct, tending to illustrate the structure of the human subject.

The external appearance of the human frame it is superfluous to describe minutely. Naturalists distinguish man as a bimanous and biped animal, or as one possessing two complete hands, and supporting himself in the vertical position by the two pelvic extremities. These characters are neither arbitrary nor unessential. Both depend on invariable peculiarities of structure; and whatever attempts have been made by men, more distinguished for ingenious paradox than accurate observation, to show that man was naturally quadruped, are readily refuted by appealing to the anatomical configuration and disposition of the four members, and their relation to the trunk.

Another character of the human subject is the globular or rather spheroidal shape of the skull, and its large size in proportion to the rest of the frame, with the general tendency of the plane of the face to the vertical direction. In no other mammiferous animal does the head make so near an approach to the spheroidal shape; and in no other is the plane of the face so nearly vertical. In the other Mammalia, the skull is angular-oblong, and the face acquires a peculiar character, which is readily ascribed to the lower animals by the extreme projection of the mouth, or, in other words, by the length to which the two jaws are prolonged. Even in the monkey tribe, the similitude of which to the human face was remarked by the poet Ennius, this remarkable character is by no means lost; and the upper and lower jaws make a much more conspicuous projection than in the human skull.

The great characteristic of the human race, however, is articulate or oral speech, which, combined with the perfect developement of which the mental faculties are susceptible, constitutes a very wide distinction between man and the lower animals. The latter possess what may be termed laryngeal voice, or that which is formed in the larynx. To man is superadded the faculty of articulate speech by means of the lips, tongue, and teeth.

All the known individuals of the human species, though agreeing in the possession of the general characters now enumerated, and therefore to be regarded as unigenous, or of one general family, differ nevertheless by certain peculiarities in external characters, which have been supposed sufficient to justify the separation into individual races or breeds. Of these, three appear to be very distinct, the WHITE or CAUCASIAN, the TAWNY or MONGOLIAN, and the NEGRO or ETHIOPIAN; and to one or other of these all the various forms which the human body assumes in different climates and countries may be referred.

The CAUCASIAN race is distinguished by the oval shape of the head, the softened aspect, and symmetrical harmony of the general person, and the high degree of cultivation of which the intellectual faculties admit. The colour of the skin and of the hair varies. In warm climates the former is dark or olive-coloured, and the latter is black and glossy. In colder regions the skin is fair and light-coloured, or ruddy, and the hair becomes chesnut, fair, or even red.

The MONGOLIAN or ALTAIC race is distinguished by prominent cheek-bones, flat countenance, oblique eyes, parted by a small interval, straight black hair, slender beard, and olive, tawny, or copper-coloured complexion. This race has formed great empires in China and Japan, and has sometimes extended its conquests beyond the Great Desert; but its civilisation has remained stationary.

The NEGRO or ETHIOPIAN race is confined to the south of the Atlas. Black complexion, crisp woolly hair, compressed skull, and flat nose, prominent mouth, and large thick or everted lips, form its distinguishing external characters. The tribes of which it consists have ever remained barbarous.

The first of these races, from which Europe, Asia, and the north and east of Africa have been peopled, is denominated CAUCASIAN, because tradition and the natural affinity of nations seem to justify the opinion that this race had originally inhabited the mountainous range between the Caspian and Black Seas, from which it has spread by radiation. In confirmation of this, it may be observed that the tribes of the Caucasus, the Circassians, the Georgians, and the Armenians, afford at the present hour the most perfect and beautiful specimens of the human form. This race may be distinguished, by the analogy of languages spoken by them, into three principal branches.

1. The Aramæan or Syrian branch, proceeding to the south, gave birth to the Assyrians, the Chaldeans, the Arabs ever unsubdued, and who, after Mahomet, aspired at the sovereignty of the world; the Phœnicians, the Jews, the Abessins, colonies of the Arabs, and probably the Egyptian or Koptic race. From this first branch, ever prone to mysticism, the most extended forms of religious belief have issued. Science and literature, occasionally flourishing among them, have, nevertheless, been always disguised or corrupted by fanciful ceremonials and a style highly figurative.

2. The Indian, German, and Pelasgic branch was much earlier divided into tribes, and much more extensively diffused. The most numerous affinities may nevertheless be traced between its four principal languages,—the Sanscrit, at present the sacred language of the Hindoos, and the parent of all the dialects of Hindostan; the ancient language of the Pelasgi, the common parent of the Greek, the Latin, of many extinct languages, and of all the present dialects of southern Europe; the Gothic or Tudesc, from which are derived the languages of the north and north-west, for instance the German, Dutch, Anglo-Saxon, and English, the Danish, Swedish, and their dialects; lastly, the Sclavonian, from which are sprung the languages of the north-east, the Russ, the Polish, the Bohemian, and the Vend.

By this branch of the Caucasian race, philosophy, the sciences, and the arts, have been carried to the highest degree of perfection; and of these they may be regarded as the chief depositaries. In Europe this race is believed to have been preceded by the *Celtæ* or *Titano-Celtæ*, whose tribes, proceeding by the north, and formerly very extensive, were nevertheless confined to the most western points; and by the Cantabrians, who passed from Africa to Spain, and who are now almost lost among the numerous nations, the posterity of which is mingled in the European peninsula. The ancient Persians are derived from the same source as the Indians; and their descendants still bear the most conspicuous marks of connection with the European nations.

3. The Scythian and Tartar branch, bending first to the north and north-east, always erratic in the immense plains of these countries, have returned only to ravage the happier establishments of their brethren. From this branch issued the Scythians, who anciently distinguished themselves by inroads into Upper Asia; the Parthians, who destroyed the Greek and Roman dominions; the Turks, who subverted that of the Arabs, and subdued in Europe the last remnant of the Hellenic nation. The Fins and Hungarians are tribes of the same family disseminated among the Sclavonian and Judaic nations. The north and east of the Caspian, their native soil, still maintains tribes which have the same origin and speak similar languages; but they are intermingled with numerous other small septs of different origin and speech. The Tartar tribes remained more unchanged in that tract from which they long threatened Russia, which has at length subdued them, from the mouths of the Danube to beyond the Irtish. Their blood, nevertheless, has been mixed with that of the Mongols, many traces of which may be seen in the younger Tartars.

On the east of this Tartar branch of the Caucasian race begins the MONGOLIAN, which thence extends to the shores of the Eastern Ocean. Its branches, still nomadic, the Calmucks and the Kalkas, roam the Great Desert. Three times have their ancestors, under Attila, Gengis, and Timour, spread the terror of their name among the settled inhabitants of Europe and Asia. The Chinese constitute the branch most early civilized, not only of this race, but of known nations. The Mantchoux, a third branch, who recently conquered, still retain, China. To the same race in great part belong the Japanese and the Coreans, and almost all the hordes which stretch to the north of Siberia, under the sway of the Russians. Excepting some learned Chinese, the whole Mongolian race are attached to the sects addicted to the worship of Fo.

The origin of this great race appears to be in the mountains of the Altaic range, as that of the Asio-European is in the elevation of Caucasus. It is impossible, however, to trace the filiation of its branches with the same accuracy. The history of these nomadic nations is as transitory as their establishments; and that of the Chinese, confined to the bosom of their empire, furnishes only short and unconnected views of the contiguous nations. The affinities of their modes of speech are further too little known to guide us in this labyrinth.

The languages spoken in the north of the Ultra-Gangetic peninsula, as well as that of Thibet, present some relations, at least in monosyllabic character, with the Chinese; and the nations by whom they are spoken are not void of features of physical resemblance to the other Mongolian tribes. The south of this peninsula, however, is inhabited by the Malays, a much handsomer race, whose breed and language have spread to the coasts of all the islands of the Indian Archipelago, and have occupied the greater number of those of the South Sea. In the largest of the former, especially in the wildest places, dwell other tribes, with crisp hair, black complexion, and negro features, all extremely barbarous. The best known are denominated Papous, which may be applied to the whole.

Neither the Malays nor the Papous can be readily referred to any one of the three great races. The former it is difficult to distinguish from the neighbouring races on each side the Caucasian Indians and the Mongolian Chinese. The Papous may be negroes anciently cast away in the Indian Seas; but to determine this point we require both accurate figures and descriptions.

The inhabitants of the north of the two continents, the Samoieds, the Laplanders, and the Esquimaux, spring, according to some, from the Mongolian breed; according to others, they are degenerate slips of the Scythian and Tartar branch of the Caucasian breed.

The Americans have not yet been clearly traced either to one or other of the races of the ancient continent; yet they are void of character sufficiently precise and constant to constitute a peculiar race: their copper-coloured skin is inadequate: by the dark hair and slender beard they approach to the Mongols; but from these again they are distinguished by the well-marked features and the prominent nose. The modes of speech are as numerous as their tribes; and neither between themselves nor with those of the ancient world has any satisfactory analogy been traced.

Of the various breeds now enumerated, the Caucasian or Asio-European is supposed to furnish the most perfect model of the human frame; and from this, therefore, anatomists derive their descriptions both of the body at large and of individual parts and organs.

The structure of the human body may be studied in two modes, either as an assemblage of organic substances endowed with characteristic physical and vital properties, or as an assemblage of organs destined to effect particular and definite purposes.

The human body, like that of every other mammiferous animal, consists of several kinds of animal organic substances endowed with appropriate characters and properties. The substances thus distinguished have been named *elementary textures*, since into them, as into so many elements or integrant principles, the human body is supposed capable of being resolved. To enumerate these elementary textures, to ascertain their minute structure or organization, to investigate their distinctive properties, and to determine the extent to which they enter into the composition of particular organs, is the province of GENERAL ANATOMY. In this department the anatomist, abstracting from the shape, position, and mechanical configuration of parts, studies only their intimate and distinctive characters as organic substances.

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The human body may further be regarded as an assemblage of organs, and sets of organs, destined to effect certain purposes. These purposes may be referred to two general heads; those which are common to plants and animals, and those which are proper to the latter. The first comprehends nutrition and generation, and have been named vital, organic, or automatic functions; the second embraces muscular action, sensation, and nervous influence or innervation, and are distinguished as animal functions. Since these purposes are effected by certain processes going on successively and simultaneously by the action of one or more organs, they are distinguished by the general name of FUNCTIONS, or orders of functions. Each function consists of several integrant and individual processes; every process consists of one or more actions; each action depends on certain properties; and properties in living bodies, though mechanical, chemical, or vital, are always connected either with the intimate structure of parts or with the configuration of organs. Thus nutrition is at once termed a function, and is said to consist of the several functions of digestion, absorption, circulation, respiration, and secretion. Generation, on the other hand, is said to be a function consisting of several processes—the formation of germs or *ova*, the secretion of semen, impregnation, gestation, and exclusion. Of the functions proper to animals, muscular action, modified in various modes, produces locomotion, gesture, voice, and several motions necessary to the performance of nutrition and generation. Sensation may be said in all cases to depend on nervous action and the mechanism peculiar to each species of sensation. Nervous energy, again, may be said to consist of three properties, those of receiving, transmitting, and recognising impressions. Lastly, a form of faculties connected with the immaterial or thinking part of the system peculiar to man constitutes what are named the intellectual functions.

This division of the phenomena of living bodies into certain assemblages or functions, has given rise to a similar division of these bodies into organs. An organ may be defined to be a part of a living body, of a definite shape, consisting of certain parts, composed of various elementary textures, the seat of one or more actions, and placed in a certain position and region. It rarely happens that one organ only is sufficient for the performance of a function. Several are commonly required to concur to the same general purpose; and hence the organs are arranged in classes, sets, or assemblages, according to the functions to which they are subservient. Thus the organs subservient to the function of digestion consist of the teeth, tongue, and mouth, as organs of mastication; the pharynx and œsophagus as the tube of deglutition; the stomach as the organ of chymification; the duodenum and small intestines as that of chylification; and the large intestines as the temporary receptacle of the excrementitial residue of food and drink. Such assemblages of organs have received, for want of better, the denomination of apparatuses; and the anatomist, when he designates a class of organs devoted to the performance of a specific function, is compelled to distinguish them as the apparatus of digestion, the apparatus of absorption, of circulation, of respiration, of secretion, and so forth. To this method of distinction it may indeed be objected, that scarcely in one instance are all the organs of any apparatus exclusively directed to the performance of the function of that apparatus; and an organ concerned in the function of digestion may also contribute to that of circulation or respiration. Thus the larynx, though more particularly the organ of voice, is also an organ of respiration; the tongue and teeth, though belonging in one sense to the organs of digestion, are not less important as those of speech; the diaphragm and abdominal muscles, though organs of respiration, are also accessary agents of digestion. These, however, are only to be regarded as examples of the ingenuity with which one organ in the animal body is made to answer several purposes; and since all arrangements are artificial, or bear relation, not to the purpose of construction, but to the mind of the observer, the best course is to choose that which is least so, and which makes the nearest approach to the apparent objects of nature.

To acquire a just knowledge of the organs of the human body, with the views now stated, it is requisite to study their external shape and configuration, their position and contiguous relations, their ordinary size and dimensions, the mechanical divisions of which they consist, their external characters and physical properties, their intimate structure and the elementary textures of which they are composed, their chemical constitution, their vital properties and consequent actions, and the uses to which they are obviously applied. The history of the organs, arranged upon these principles, constitutes the business of DESCRIPTIVE, PARTICULAR, or SPECIAL ANATOMY. The term *Topographical Anatomy*, which has also been proposed, is inadequate, since it indicates one class only of facts,—those belonging to local relations. That of *Morphology* is equally objectionable. The term *Organology*, though preferable by reason of greater generality, is not sufficiently appropriate to justify its adoption, to the exclusion of the one already in general use.

## GENERAL ANATOMY.

THE human body consists of solid and fluid substances, the former of which are organized, and determine the shape of the body and its parts. These organized solids are not in a strict physical sense solid and impenetrable. Most of them are soft, compressible, and elastic, by reason of the fluid matter contained in their interstices; and when deprived of this by desiccation, they shrink in various degrees, and lose both bulk and weight. The general ratio of the fluid to the solid parts has been already stated to vary from 7 to 1, to 9 to 1. An adult carcass weighing perhaps from 9 to 10 stones, has been reduced by desiccation to $7\frac{1}{2}$ lbs. In short, a human body may be reduced to nearly the weight of its skeleton, which varies from 150 ounces $= 9\frac{3}{8}$ lbs. to 200 ounces $= 12\frac{1}{2}$ lbs.

These organized solids agree in the possession of certain general characters. Their internal structure appears to consist of a union of solid and liquid matter, which is observed to exude in drops more or less abundant from the surface of sections. The solid parts are generally arranged in the form of collateral lines, sometimes oblique, sometimes perfectly parallel, sometimes mutually intersecting. Such lines are denominated *fibres*, and occasionally *filaments*. In other instances the solids are observed to consist of minute globular or spheroidal particles, connected generally by delicate filaments. Most of these solids anatomists and microscopical observers have attempted to resolve into what they conceive to be an ultimate fibre or last element; but this inquiry leads beyond the bounds of strict observation.

Most of the solids may be demonstrated to be pene-

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trated by minute ramifying tubes or bloodvessels, which traverse their substance in every direction, and in which is contained the greater part, perhaps the whole, of the fluid matter found in the solids. In a few in which ramifying vessels cannot be positively demonstrated, their existence is inferred by analogy from those in which they can. The filamentous, fibrous, or globular arrangement, with the distribution of arborescent vessels, constitutes organisation. The substances so constructed are named *organised tissues* (*telæ*, *textus*), or *textures*, or simply *tissues*.

The organised solids also resemble each other in chemical constitution. They may be resolved into proximate principles, either the same or very closely allied. The proximate principles most generally found are albumen, fibrin, and gelatine, one or other of which, sometimes more, form the basis of every tissue of the human body. Next to these are mucus, and oily or adipose matter. Osmazome or extractive matter is found in certain tissues. And lastly, several saline substances, as phosphate of lime, carbonate of lime, soda, hydrochlorate of soda, are found in variable proportions in most of them. Of these principles albumen and fibrin, which are closely allied and pass into each other, are the most common and abundant. Osmazome, which is probably a modification of fibrin, is less frequent. These also are contained in the blood, and probably derived from that fluid. Gelatine, though not found in the blood, is nevertheless a principle of extensive distribution, being found in skin, filamentous tissue, tendon, cartilage, and bone. These proximate principles are resolved, in ultimate analysis, into carbon, oxygen, hydrogen, azote, phosphorus, chlorine, and sulphur. From the saline substances, calcium, potassium, sodium, chlorine, iron, manganese, and, according to some, titanium and arsenic may be obtained.

The organised solids, which enter into the composition of the human body, though agreeing in the characters now mentioned, differ, nevertheless, in other respects. The most remarkable differences of this kind consist in peculiarities in the arrangement of their constituent fibres, peculiarities in the nature of these fibres, and different proportions or modifications of their proximate chemical principles. From one or other of these circumstances the organised solids may be referred to the following 17 elementary tissues:—Filamentous or cellular tissue, including ordinary cellular membrane, and adipose membrane; artery, vein, with their minute communications, termed capillary vessels, and the erectile vessels; lymphatic vessel, and gland; nerve, plexus, and ganglion; brain, or cerebral matter; muscle; white fibrous system, including ligament, periosteum, and fascia; yellow fibrous system, including the yellow ligaments, &c.; bone and tooth; gristle or cartilage; fibro-cartilage; skin; mucous membrane; serous membrane; synovial membrane; and lastly, glandular structure, or the peculiar matter which forms the liver, the pancreas, the kidneys, the female breast, the testicle, and other organs termed glands.

These tissues may be distinguished into orders, according to the mode of their distribution in the animal frame. Several,—for instance filamentous tissue, artery and vein, lymphatic vessel, and nerve,—are most extensively distributed, and enter into the composition of all the other simple tissues. To these, therefore, which are named by Bichat general or generating systems, the character of *textures of distribution* may be applied. A second order, consisting of substances confined to particular regions and organs, and placed in determinate situations, viz., brain, muscle, white fibrous system, yellow fibrous system, bone, cartilage, fibrocartilage, and gland, may be denominated *particular tissues*. To a third order, consisting of substances which assume the form of a thin membrane, expanded over many different tissues and organs, may be referred skin, mucous membrane, serous membrane, and synovial membrane, under the denomination of *enveloping tissues*. It may indeed be objected that the circumstance of mechanical disposition is insufficient to communicate a distinctive or appropriate character, and several of the tissues referred to the second head, *e.g. fascia*, must, on this principle, be referred to the third. The objection is not unreasonable. But it may be answered that it is almost vain to expect an arrangement entirely faultless; and the present is convenient in being, on the whole, more natural, and therefore more easily remembered, than any other. A distinct idea of it may be formed from the following tabular view.

| | | |
|---|---|---|
| General or Common Tissues. | Filamentous tissue. | |
| | Artery. | Capillary vessel. |
| | Vein. | |
| | Lymphatic vessel. | |
| | Nerve. | |
| Particular Tissues. | Brain. | |
| | Muscle. | |
| | White fibre. | Ligament. Periosteum. Fascia. |
| | Yellow fibre. | Yellow ligaments. Ligamentum nuchæ. |
| | Bone. | Tooth. |
| | Cartilage. | |
| | Fibro-cartilage. | |
| | Gland. | |
| Enveloping Tissues. | Skin. | |
| | Mucous membrane. | |
| | Serous membrane. | |
| | Synovial membrane. | |

### The Fluids or Liquids.

The fluids of the animal body are various, but may be distinguished into three sorts; the circulating nutritious fluid named the blood; the fluids which are incessantly mixed with the blood for its renewal; and those which are separated from it by secretion.

I. The blood is well known to be a viscid liquid, of red colour, peculiar odour, and saline, something nauseous taste. Its temperature in the living body is about 97°; its specific gravity is about 105 to water as 100. Its quantity is in the adult considerable, varying from seventeen and nineteen pounds (Lehmann) to thirty pounds.

The colour of the blood varies in different parts of the system. In the left auricle, ventricle, and arterial trunks generally, its colour is bright scarlet, a tint which it loses in the capillary vessels. In the veins, venous trunks, right auricle, right ventricle, and pulmonary artery, its colour is a dark or purple-red, or Modena. As it moves from the trunk and branches through the minute divisions of the pulmonary artery, it gradually parts with this tint; and in the branches of the pulmonary veins it is found to have acquired the bright scarlet colour which it has in the left auricle, ventricle, and aorta. Hence the Modena or dark-coloured blood is distinguished as venous, or proper to the veins; and the bright red or scarlet-coloured as proper to the arteries.

Globules or blood corpuscula.

According to the results of microscopic observation, blood consists of red particles suspended in a serous fluid. On the shape of these red particles various opinions have been entertained. Generally represented as globular, Hewson describes them as flattened spheroids, or lenticular bodies, a view which is partly confirmed by the observations of Prevost and Dumas, of Beclard, of Hodgkin and Lister, of Gulliver and Wharton Jones. The opinion of Home and Young, that the flattening of these globules is a process posterior to the discharge of the fluid, is not improbable. These particles have, indeed, since the time of Hewson, been almost universally represented as consisting of a cen-

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Globules or blood corpuscula.

tral transparent whitish globule, inclosed in a red translucent vesicle, which gives them the shape of an oblate spheroid. The diameter of these particles is estimated, by the subdivided scale of Kater, the micrometer of Wollaston, and the eriometer of Young, at $\frac{1}{5000}$th, and by the common micrometer, at $\frac{1}{1700}$th of an inch. (*Phil. Trans.*) Mr Gulliver estimates the average diameter of the human blood-corpuscle at $\frac{1}{3200}$th part of an English inch, and the average thickness at $\frac{1}{12400}$th part. This description applies to the blood circulating in the vessels.

In man, and the MAMMALIA in general, the blood-globules have, like a biconcave disk, a depression on each side of the broad surface. In the camel tribe they have an oval or elliptical outline, but agreeing in size and structure with the corpuscles in the Mammalia in general. In Birds, Reptiles, and most Fishes, they are oval disks, with an apparent central elevation. But the oval shape is liable to vary, and is in some osseous fishes shortened to nearly a circle. The blood-disks of the lamprey, and other cyclostomatous fishes are circular and biconcave. In the Aspondylous classes, or those void of vertebræ, the blood-corpuscles are colourless and flattened disks; but as to figure, in some they are orbicular, in others oblong oval.

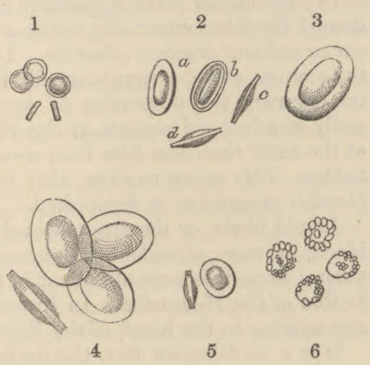


Fig. 1. Red particles of human blood (Wagner).
... 2. Red particles of the blood of the common fowl. *a*, Ordinary appearance when the flat surface is turned towards the eye. *b*, Appearance sometimes presented by the particle in the same portion. *c*, *d*, Different appearances of the particle viewed edgeways.
... 3. Red particles of the frog.
... 4. Red particles of the *Squalus squatina* (Wagner).
... 5. Red particles of the *Lophius piscatorius*, or angler fish.
... 6. *Corpuscula* from the blood of the scorpion.

As to size of the globules in relation to the different kinds of animals, the general rule is, that in the Mammalia they are smaller than in Birds, Fishes, and Reptiles; and in the small Mammalia they are as large as in the large Mammalia. In the harvest mouse the corpuscles are as large as those of the horse; and in the common mouse they are larger than in the ox and horse. The blood-corpuscles of the elephant are larger, [$\frac{1}{2745}$th of an inch,] than those of any other mammiferous animal; they are next in size in the sloth; next in the whale, in which they are larger than in man; next in the capybara and the porpoise. They appear to be smallest in the goat and deer family. In the Napu musk-deer the corpuscles are the smallest yet observed, $\frac{1}{12325}$th of an inch; those of the Stanley musk-deer are about the same size ($\frac{1}{10825}$th); in the ibex (*Capra Caucasia*) they are larger; and in the goat a little larger, being about double the size of those of the Napu musk-deer.

In Birds in which the corpuscles are oval, there is considerable variation in size. But, in general, the long diameter is greater than the diameter of the corpuscles in the Mammalia; while the short diameter varies from the $\frac{1}{4000}$th part of one inch to the $\frac{1}{10000}$th part of one inch. In the majority, the short diameter is about the same as the diameter of the circular corpuscles in man.

In Reptiles in general, in which the corpuscles are oval, they are much larger than in the Mammalia; the average long diameter being about $\frac{1}{1260}$th of one inch, and the average short diameter about $\frac{1}{2286}$th.

The corpuscles are largest in size in what are called the AMPHIBIA, including the frog, toad, triton, and siren. In the frog, the long diameter is $\frac{1}{1108}$th part of one inch, the short diameter $\frac{1}{1821}$th. In the siren, the long diameter is $\frac{1}{420}$th part of one inch, and the short diameter $\frac{1}{760}$th part of one inch.

In the large Ruminants and Rodents the corpuscula are larger than in the small species. The FERÆ, if arranged according to the size of the corpuscula, would assume the following order: the seal, dog, bear, weasel, cat, viverra. Among genera of doubtful affinity, if regard be given to the size of the blood-corpuscula, the hyæna would be arranged with the CANIDÆ, *Basaris* with the Ursine family, and *Cercoleptes* with the VIVERRIDÆ. In the fox the corpuscles are smaller than in the dog.

In the Frog, salamander, and other lower vertebrated animals, the large Corpuscula consist of a thin, transparent vesicular covering, enclosing another body in general oval, which appears to be solid, and surrounded by a quantity of soft red coloured matter. This inclosed body has been named a *nucleus.* When weak acetic acid is dropped upon these corpuscula, the colouring matter is removed, the nucleus becomes distinct, and the envelope is rendered faint. Strong acetic acid dissolves the envelope, and the nucleus escapes.

Some observers have attempted to demonstrate an analogy between the *nucleus* of the lower VERTEBRATA and the central spot of the human corpuscula. But according to the testimony of the most careful observers, it is not possible to recognise in the corpuscula of the Mammalia any body similar to the *nucleus* of the lower vertebrated animals.

When blood is drawn from the vessels and immediately afterwards examined by the microscope, the red corpuscula are observed dispersed in a confused manner in the *liquor sanguinis*, as is represented in Fig. 2. In the course of half a minute or a little longer, the red corpuscula are seen to overlap each other, and assuming the appearance of standing on their edges, to be applied to each other by their broad surfaces, like a pile or rouleau of coins. In a small quantity of blood several piles or rolls of blood-disks are in this manner formed; the direction of these is not exactly straight, but often slightly curved; and the rolls intersect each other so as to form interstitial spaces. In the case of healthy blood, these intervening spaces are small. In the case of blood that is drawn during the state of inflammation, they are larger.

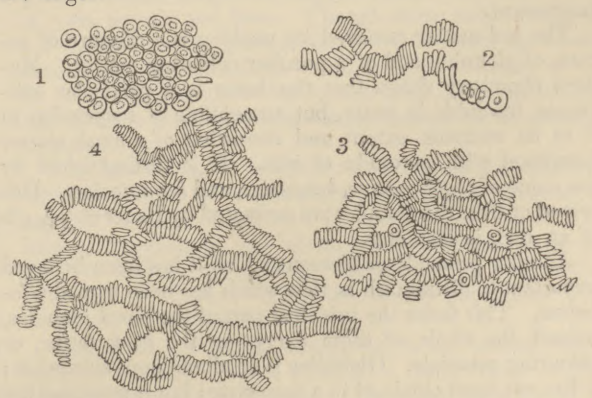


Fig. 1. Red *corpuscula* of healthy blood dispersed confusedly in *liquor sanguinis* (W. Jones).
... 2. Arrangement of the red *corpuscula* like coins in rolls, when beginning and when fully formed.
... 3. The irregular net-like arrangement of the rolls of red *corpuscula* in healthy blood. Meshes small.
... 4. The net-like arrangement of the same rolls presented by buffy blood. The meshes are large.

**Globules or blood-corpuscula.**

Henle admits two sorts of blood *corpuscula;* the one coloured, those namely belonging to the vertebrated animals, and especially to Mammalia, Birds, and Fishes; another sort, colourless, found mostly in the lower vertebrated animals, as the frog and triton, and in the Aspondylous animals. These are the same as those called lymph-globules. They are smaller in size than the coloured globules; those in the frog being 0·005 in diameter, according to Wagner. The proportion of these colourless globules to the coloured particles, varies according to rate of feeding and other circumstances. After the blood of a healthy frog has stood two hours, there are, in one drop of the upper stratum, among 55 coloured globules, 76 colourless particles.

**Mechanical separation; its results.**

Discharged from the vessels, the blood exhales, during the process of cooling, a thin watery vapour, consisting of water suspending animal matter capable of impressing the sense of smell, and undergoing decomposition. During the same space it is observed to be converted into a firm mass, which, though still soft and elastic, is entirely void of fluidity. As this process advances, a thin watery fluid, straw-coloured, not perfectly transparent, is observed to exude from every part of the solid mass, which also diminishes in size, till at length it is found floating like a tolerably thick cake in the thin watery fluid. The thick solid mass is named the clot or *coagulum;* the watery fluid is denominated *serum;* and the process of the separation, which is spontaneous, is termed *coagulation.* The blood at the same time is said to discharge carbonic acid.

The clot, if divided and washed in water often changed, or in alcohol or *aqua potassæ,* may be deprived of its red colour, and made to assume a gray or bluish-white tint. This gray mass, which is tough, coherent, opaque, and more or less dense, homogeneous, but void of traces of organic structure, consists chiefly of albumen or fibrin, or a substance partaking of several of the characters of both. To this substance the blood owes its viscidity and its property of spontaneous coagulation; and from the circumstance of its resemblance to the lymph or albuminous fluid which is effused from wounds and inflamed surfaces, and to the fibrin of muscle, and the albumen of many of the tissues, it may be regarded as the most vital and nutritious part of that fluid. It is a mistake nevertheless to assert, as is done by Beclard and others, that this substance presents to the microscope the aspect and structure of muscular fibre. Its aspect is by no means so regular as this, nor can its particles be said to present traces of organic structure or arrangement.

The red matter removed by washing is a mixture of serum, of globules, and of a peculiar colouring matter. Modern chemistry shows that the latter is a particular substance, insoluble in water, but susceptible of suspension in it to an extreme extent, and consisting of animal matter combined with peroxide of iron. It is distinguished by the name of *zoohæmatine, hæmatine,* and *hæmatosine.* Deprived of this, the globules are estimated by Bauer at $\frac{1}{2000}$th of an inch in diameter.

Another principle or element which it has been believed important to distinguish is, that which has been named *Globuline.* This forms the principal part of the blood globules, indeed, the whole of them excepting the *hæmatosine,* or colouring principle. Globuline is an albuminous substance; it has not been obtained in a pure state; but it possesses the composition and characters of albumen. By stirring blood so as to separate the fibrin, and mixing it with six volumes of a saturated solution of sulphate of soda, and then boiling the mass with alcohol acidulated with sulphuric acid, sulphate of hæmatosine is dissolved, and sulphate of globuline remains. This is gray or white, and is said to contain four atoms of sulphuric acid and one of proteine.

General Anatomy.

**Mechanical separation; its results.**

The serum, with the taste and odour of the blood, rather alkaline, coagulates at 162° F. or on the addition of acids, nitrate of silver, or corrosive sublimate, and then resembles boiled white of egg. The coagulated matter is albumen; and a little water containing soda and salts of soda may be separated. It is a remarkable difference between this albumen, which is suspended in the serum, and that which constitutes the clot, that while the former requires heat as a re-agent, the latter assumes the solid form spontaneously.

The specific gravity of arterial serum is 1022; of venous serum 1026.

The proportion of serum to clot varies in different animals, in different individuals, and in different states of the system.

In the human body a quantity of five ounces of blood usually furnishes about one ounce and two drachms, or one ounce and four drachms of serum. In inflammatory diseases the amount of the serum is usually increased. In fever, on the contrary, the proportion of serum is diminished, especially at advanced periods of the disease. But the clot is at the same time less firm than usual, and is soft, loose, and flabby. This seems to show, that the force with which the blood is coagulated is diminished.

Liquid fibrin, or the spontaneously coagulable part of the blood, is most abundant in warm-blooded animals; and among these it is more abundant in the blood of Birds than in that of the Mammalia. In Fishes it is scanty; and it is also sparing in the blood of the Reptiles and Amphibia.

It is a well-known fact, that in frogs the blood does not coagulate on exposure of the vessels to air, as it does in the Mammalia. This must be owing, either to the blood of these animals containing a much smaller proportion of fibrin than that of the Mammalia, or the fibrin having much less coagulating power.

This property of spontaneous coagulating power has been supposed by Saissy and others to bear some relation to the state of respiration, or what may be denominated the intensity and energy of that function in the different classes of animals; and the idea seems accordant with the facts. In Birds the function of respiration is most fully developed. In Reptiles and Fishes it is very imperfectly developed.

***Liquor Sanguinis* or Plasma.**

When blood, drawn from the veins of a person labouring under acute rheumatism and other inflammatory diseases, is undergoing coagulation in a glass vessel, a colourless fluid may be perceived round the edge of the surface; and, after an interval of four or five minutes, a bluish appearance is observed from the formation of an upper layer of the blood, in consequence of the subsidence of the red particles to a certain distance below the surface, and the clear liquor being left between the place of the red particles and the edge of the vessel. This liquid may be collected by a spoon and placed in another vessel, where it is first clear, though opalescent, viscid, homogeneous. After some time, however, it undergoes separation into two parts, one coagulated, the other fluid. The coagulated part is the fibrin of the blood, or that which is spontaneously coagulable; the fluid part the serum. The opalescent liquor has been named *Liquor Sanguinis* (Babington).[1]

To this the name of *Plasma* has been given by Müller, Henle, and other German writers. The former by filtering the blood of the frog, which coagulates very slowly, causing the larger corpuscula to be retained by the filter, and the *liquor sanguinis* to come though clear and colourless, obtained it in a separate form.

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[1] Some Considerations with respect to the Blood, &c. *Medico-Chirurgical Transactions,* vol. xvi., p. 293.

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Chemical constitution.

Oil or fat.

From the facts now stated, it seems reasonable to infer, that the element of the blood which is called *Liquor sanguinis* and *Plasma*, is the coagulable part, or the albuminous or fibrinous, freed from the colouring matter and the serum.

In 1830, Dr Babington found a yellow concrete oil in blood in the state of health;[1] Boudet, in 1833, found in the serum a peculiar oily or fat matter, to which he gives the name of seroline, and which melts at 97° F.;[2] and Gmelin, Chevreul, and Lecanu, obtained from the blood stearine and elaine. In certain morbid states these adipose principles are liable to become greatly increased in amount, and their presence then renders the serum opaque and milky-like. The globules are often at the same time deficient (Lecanu).

The chemical constitution of the blood and its elements has been examined by many chemists with different degrees of accuracy and completeness. It may be sufficient here to advert to the results of those given by Denis and Lecanu, the former of which was given in 1830, and the last was published in 1837.

In the first place, it is to be observed, that one thousand parts of blood consist of 869 parts of serum, and about 131 parts of what has been named coagulum, that is, globules and colouring matter.

In the second place, it is admitted, that the serum contains all the immediate principles of the blood, excepting fibrine and colouring matter; that the fibrine and colouring matter make part of the globules; and that the serum represents exactly the fluid, in the midst of which, during life, the globules float; while the clot or coagulated portion represents the globules themselves, though in a state more or less deformed and altered.

For these reasons, chemists in ascertaining the chemical constitution of the blood have subjected the serum only to accurate analysis.

The two following tables exhibit the quantitative analyses of the serum, as given by Denis and Lecanu.

According to Denis.

| | |
|---|---|
| Water .................. | 900·0 |
| Albumen ............... | 80·0 |
| Soda ..................... | 0·5 |
| Lime.................. } Magnesia traces ... } | 0·2 |
| Sulphate of potash ... | 0·8 |
| Sulphate of soda ...... | 0·8 |
| Phosphate of soda .... | 0·4 |
| Chloride of sodium ... | 4·0 |
| Oleic acid and margarate of soda ... } Volatile sebacic acid with soda ......... } | 3·0 |
| Phosphate of lime ... | 0·3 |
| Yellow biliary colouring matter... } Blue colouring in traces ............ } | 3·0 |
| | 1000·0[3] |

According to Lecanu.

| | | |
|---|---|---|
| Water ............... | 906·00 | 901·00 |
| Albumen ......... | 78· | 81·2 |
| Extractive matters | 3·79 | 4·60 |
| Fat matter ......... | 2·20 | 3·40 |
| Hydrochlorates of soda and potash......... | 6· | 5·52 |
| Alkaline. Subcarbonate... } Phosphate ...... } Sulphate......... } | 2·10 | 2· |
| Subcarbonate of lime and magnesia, phosphate of lime and magnesia | 0·91 | 0·87 |
| Loss.................... | 1· | 1·41 |
| | 1000·00 | 1000·00[4] |

These tables show the substances contained in the blood taken as a whole, and the proportions, as nearly as may be, in which each substance is contained. But it is of consequence to ascertain, as nearly as may be practicable, the proportion in which these articles are present in the serum and the globules respectively. This Lecanu attempts to exhibit in the following table, which he gives as representing in man the medium composition of the venous blood in the normal state.

| | | | |
|---|---|---|---|
| Free oxygen, | | | |
| ... azote, | | | |
| ... carbonic acid, | | | |
| Extractive matters, | | | |
| Fat phosphorated matter, | | | |
| Cholesterine, | | | |
| Seroline, | | | |
| Free oleic acid, | | | |
| Free margaric acid, | | | |
| Hydrochlorate of soda, | | | |
| ... of potash, | | | |
| ... of ammonia, | 10·9800 | | |
| Sulphate of potash, | | Serum | 869·1547 |
| Carbonate of soda, | | | |
| ... lime, | | | |
| ... magnesia, | | | |
| Phosphate of soda, | | | |
| ... lime, | | | |
| ... magnesia, | | | |
| Lactate of soda, | | | |
| Salt with fat fixed acids, | | | |
| ... volatile and yellow colouring matter, | | | |
| Albumen, | 67·8040 | | |
| Water, | 790·3707 | | |
| Fibrin, | 2·9480 | | |
| Hematosine, | 2·2700 | Globules, | 130·8453 |
| Albumen, | 125·6273 | | |
| | 1000·0000 | | 1000·0000 |

Further, if we suppose that one thousand parts of blood give

869·1547 of serum,
130·8453 of globules,

these numbers may then be represented in distribution in the following manner.

| | | | |
|---|---|---|---|
| 869·1547 | | Serum. | |
| 130·8453 | 2·9480 | Fibrin. | Globules. |
| | 2·2700 | Globules. | |
| | 125·6273 | Albumen of globules | |
| 1000·0000 | | | |

The main point which it is important to know, is that blood consists of albumen and fibrin to the extent of between 78 and 81 parts in the thousand, suspended in about 902 parts of water, with some adipose matter, and salts, chiefly of soda, potash, and lime. Though these saline substances are neutral, yet in general the blood presents an alkaline reaction, which is ascribed to a slight predominance of soda. In persons and animals that subsist much on vegetable food, this alkaline reaction ought also to depend on the presence of potash.

The blood may be believed to contain all the substances which are found to be present in the different textures and organs. It either does so, or it contains their material elements, excepting in one instance. It contains, so far as is hitherto known, no gelatine. According to Marchand, it contains a little urea. But in the healthy state, this is in exceedingly small quantity.

The blood, that is, the serum, has in the normal state an alkaline reaction, which is ascribed to the presence of phosphate of soda, not carbonate. The saline matter is of use in maintaining the fluidity of the blood; in contributing to

[1] Account of a Concrete Oil existing as a constituent principle in healthy Blood, by Benjamin G. Babington, M.D. *Medico-Chirurgical Transactions*, vol. xvi. p. 46. 1830.

[2] Nouveaux Recherches, &c., par Felix Boudet. *Journal de Pharmacie*, No. vi. June 1838; and *Edinburgh Medical and Surgical Journal*, vol. xl., p. 489. Edinburgh, 1834.

[3] Recherches Experimentales sur le Sang Humain. Par P. S. Denis. Paris, 1830.

[4] Etudes Chimiques sur le Sang Humain. These, &c. Novembre le 23, 1837. Par Louis René Lecanu, D.M. Paris, 1837, 4to, p. 57.

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its red colour (Stevens); and probably it may be useful in contributing to certain galvanic or electro-magnetic actions in different organs.

Chemical constitution.

From the blood and its elements the animal tissues derive the materials of their nutrition, and the different secreted fluids are formed.

Arterial blood differs from venous according to Lecanu, besides the difference in colour already mentioned, chiefly in the following circumstances.

It contains a larger amount of globules, a greater proportion of fibrin, an amount of albumen, extractive matters, saline and fatty matters, to all appearance equal, more oxygen in proportion to its carbonic acid, less combined carbon and oxygen. In consequence chiefly of the larger proportion of globules, it shows a greater tendency to coagulation, and the clot is more bulky, more firm, and gives a small proportion of serum. Its density is to that of venous blood as 1050 to 1053 (J. Davy).

The proportion of serum is smaller, and the proportion of globules greater in man than in the female; in the blood of sanguine persons than in the blood of lymphatic individuals of the same sex; in the blood of adults than in the blood of children and of the aged; and in the blood of persons well fed than in those imperfectly nourished.

The blood of the portal vein contains a smaller proportion of globules and a larger proportion of water, serum, and fat, than the blood of the venous system in general.

The blood of the placenta is greatly more rich in globules, and contains less water than the blood of the veins.

In the fœtus, the blood contains little coagulable matter; and this principle is entirely wanting in the blood of the menstrual discharge.

Chyle and Lymph.

II. The fluids received by the blood are chyle and lymph. Chyle is derived from chyme, a gray pulpy substance, formed from the alimentary mass in the stomach and duodenum. Detached from this substance, and received by the chyliferous tubes, it is whitish and scarcely coagulable. In the mesenteric glands, it becomes more coagulable, and assumes a rose colour. Lastly, in the thoracic duct, and before joining the mass of blood, it is distinctly rose-coloured, coagulable and globular in its particles. In the branches of the pulmonary artery it appears to become perfect blood. Lymph is a colourless, viscid, albuminous fluid, imperfectly known.

The globules or *corpuscula* of the chyle, of the thymus fluid, and of the lymph, appear delicately granulated on the surface. They are generally globular or lenticular, never following the differences in shape and size of the blood-disks in different classes of animals, nor in birds affecting the long oval figure of the nucleus of the red corpuscle.

The globules of chyle, thymus fluid, and of lymph, are smaller than the colourless globules of the blood. They also differ in structure. In the last, two, three, or four nuclei are seen when the envelope is made more or less transparent by acetic, sulphuric, citric, or tartaric acid. But the globules of chyle, of lymph, and of the thymus fluid, like the nuclei of the red corpuscula of the blood, are only rendered more distinct and smaller by any of these acids, so that the central part presents no regular nuclei, or divided nucleus, such as are contained in the colourless globules of the blood. In short, according to Mr Gulliver, who has examined these bodies with great care, the colourless globules of the blood have the character of elementary cells, while the globules of chyle resemble, and probably are, nuclei or immature cells.

The microscopical and chemical characters of the globules of the chyme, of the thymus, and of the lymphatic glands, are nearly the same. When quite recent, they swell on being mingled with pure water, as does the nucleus of the blood corpuscle. When well mixed with a strong solution of alkali, or of a neutral salt, the globules undergo partial solution, become misshapen or faint, forming a ropy tenacious compound with the fluid (Gulliver).

Secreted fluids.

III. Of the fluids separated from the blood, all cannot be said to belong to the animal body. Several,—for instance, the perspired fluid of the skin and lungs, the fluid of the cutaneous and mucous follicles, and the urine,—become, after secretion, foreign to the body, and require to be removed. Those belonging to the body are such as are prepared for some purpose within it, and after this are either re-absorbed, or, being decomposed, are expelled. Of the former kind, fat, serum of serous membranes, and synovia, afford examples. To the latter description belong tears, saliva, gastric juice, pancreatic fluid, bile, the seminal fluid of the male, and the milk of the female, all of which are the result of a distinct glandular secretion for a specific purpose, after which they are expelled from the economy.

Of the fluids secreted upon the surface, or on different points of the alimentary canal, some are alkaline, some acid; but all agree in possessing some albuminous or albuminoid principle, which is believed to act by what is called catalysis, or being placed in contact with foreign bodies introduced, to act on them, either by inducing chemical changes, or by causing actions of assimilation.

1. Thus saliva contains salivine, a species of diastase, besides sulphocyanic acid, chlorides, lactates, and phosphates. It is alkaline when food is taken, and during mastication.

2. Gastric juice contains pepsine and chlorine or hydrochloric acid, and, according to some, lactic acid.

3. Bile contains choleic acid or biline, taurine, free soda, and the salts of the blood; while taurine, which is an albuminoid principle, contains sulphur. Thenard and Gmelin found in it picromel. Bernard states that the liver forms sugar.

4. Pancreatic juice contains, besides an albuminous principle, which may be named Pancreatinine, according to the observations of Bernard, free soda, which gives it an alkaline reaction.

5. The intestinal fluid (*Succus intestinalis*) has a reaction, sometimes acid, sometimes alkaline.

Urine may be regarded as urea suspended or dissolved in water. Urea is the peculiar and characteristic element of the secretion. It contains also a little uric acid, which is probably produced from the urea, as this acid can scarcely be said to be a constituent of healthy urine. The other ingredients are saline matters common to the blood and the urine or complementary between them.

The density of healthy urine varies from 1015 to 1033, water being as 1000; and the average, as determined from the examination of the urine in fifty instances of persons in good health, is at the highest 1026 and at the lowest 1017. The general average, therefore, amounts to 1022. This is understood while the quantity discharged daily is from 45 to 53 ounces, which is about the general average in healthy individuals who consume liquids at the ordinary rate.

This density above that of water, urine owes to the presence of urea and saline matters. If the urea and saline matters be increased, the density of the urine is increased; if they be diminished, the density of the urine is also diminished.

It may here be observed, that urea is the form which the elements of the fibro-albuminous parts of the blood assume, after these fibro-albuminous principles have been employed in repairing the waste of the tissues. If the proximate chemical principles of albumen be compared with those of urea, it is seen that the latter are the complement of the former. Thus,—

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Secreted fluids.

| | Hydrogen. | Carbon. | Oxygen. | Nitrogen. |
|---|---|---|---|---|
| Albumen consists of...... | 7·77 | 50·00 | 26·66 | 15·55 |
| Urea consists of.......... | 6·66 | 20.00 | 26·66 | 46·66 |

Thus while albumen and urea contain the same proportion of oxygen, the former contains one-seventh more hydrogen, three-fifths more carbon, and two-thirds less nitrogen. It is known that the former proportions of these principles are employed in repairing the waste of the albuminous tissues, especially the muscular system; and while carbon and oxygen are discharged by the lungs, and carbon, oxygen, and hydrogen by the liver, the large superfluous portion of nitrogen not required, namely 31 per cent., uniting with hydrogen, oxygen, and carbon in the form of urea, is left to pass through the blood, and by means of the kidneys to be expelled from the system.

In the healthy state urine is always slightly acid when discharged. This acidity is liable to become excessive on the one hand; and on the other to diminish so far as to render the urine alkaline. This change is much favoured, if not wholly occasioned by the presence of mucus, purulent matter, or other azotised substances.

## BOOK. I.

### CHAP. I.—FORMATION, DEVELOPMENT, AND ULTIMATE ANALYSIS OF THE TISSUES.

Cell-formation.

It has, at different times, in the history of Anatomy and Physiology, been an object with various ingenious observers to trace to some one simple element all the different forms which the animal textures assume. In general, however, these attempts have not been successful, and have led to generalisations too great to be just, and more fanciful than to be founded in careful observation.

In the year 1773 William Hewson communicated to the Royal Society his account of the Red Particles of the Blood, making known among other points the fact of the existence in them of an opaque central spot, and of an opaque body in the globules of the oviparous vertebrated animals. The application of this fact it was not easy at that time, perhaps not possible, to discover. After the lapse of sixty years, in 1833, Robert Brown, well known as a skilful botanist, in Observations on the family of the *Orchideæ*, in the *Transactions of the Linnæan Society*, made known the existence of a vesicular or celluliform body containing a solid, to which he gave the name of *Areola* or *Nucleus* of the cell. The signification, however, of this structure was little or not understood. At length in 1838, J. M. Schleiden, professor of Botany in the university of Jena, made known the fact, that when a slice from the succulent part of certain plants is examined under the microscope, part of it appears to consist of an infinite number of minute vesicles, rounded or polygonal, generally flattened, cohering by the margins, and containing in their interior matters coloured or colourless. This appearance is most perceptible in various monocotyledonous orders, as *Orchideæ*, *Commelineæ*, and *Asphodeleæ*, and many dicotyledonous orders, as the *Cacteæ*, *Balanophoreæ*, &c. But it is also found in different degrees of distinctness in the greater part of the vegetable world. This close vesicle generally contains a fluid, sometimes jelly-like; but it also contains a body more or less rounded, to which Schleiden applied the name of Cell-Kernel and *Cytoblastus*. It is attached on one side to the inner surface of the vesicle, but on the other is free. When perfectly formed it is a flat, lenticular, sharply defined, transparent, pale-yellow body, in which it is possible to distinguish one or two, seldom three, hollow corpuscula. These are called *nucleoli*.[1]

General Anatomy.

Cell-formation.

The Cytoblast is represented by Schleiden to be a nitrogenous body or proteine compound, perhaps in its simplest state pure proteine. Its minuteness is almost inconceivable, being from 0·00009 to 0·0022 of one inch in circumference.[1]

The Cytoblast has been more generally known under the name of *Nucleus;* and the vesicle containing it has been called Nucleated Cell; (*Cellulæ Nucleatæ*); *Elementary Cells; Primary Cells.*

In 1839, the year following that in which Schleiden published his doctrines on Phytogenesis, or the formation of plants, Schwann made known the fact, that in the animal tissues the same structure exists which Schleiden had shown is found in those of the vegetable world.[2] The fact has been stated in general terms by Henle in the following manner. In most vegetable and animal tissues, there exist during the whole period of life, or a certain time of the development of these tissues, microscopical *corpuscula* of peculiar and very characteristic shape. These are minute bladders or *vesiculæ*, consisting of a fine enclosing membrane and a fluid, occasionally something granular, content. In the wall of these *vesiculæ* lies a smaller darker body, namely, the Kernel or *Nucleus* of the cell,—Cytoblast of Schleiden; and this is generally distinguished by one or two, rarely more, darker and almost regularly round specks (*Nucleoli*).

It is here to be observed, that nucleated cells as thus described are not perceptible in the tissues at all times of their existence. It is chiefly in the early period, or that of formation and development that they are observed. The process of cell-formation is in truth progressive; and this circumstance has led Schwann, Henle, and others, to speak of the life of the cell and of its youth or early period of existence, though Henle himself makes an apology for the use of the term youth in this manner.

The cells lie in a shapeless or amorphous matter, the *Cytoblastema*, in which they float when this is fluid, and are imbedded when it is semi-solid or solid. The solid Cytoblastema, in which the cells are more or less compressed, appears like inter-cellular substance, and is also the connecting medium of the cells.[3]

What is now stated embraces almost all the points in which observers are agreed. Upon all others minute but real differences of opinion exist;—upon the nature and composition of the cell, upon the mode in which cells are developed and multiplied, and upon the transformations which they undergo.

The covering or wall of the cell is allowed by most to be an albuminoid or proteine substance. It is rendered transparent and indistinct, but not dissolved by acetic acid. The contents of cells are semifluid, often granular, that is, consisting of small grains or bodies differently coloured, of fat particles, and of a fine molecular substance, that is minute atoms, the nature of which is unknown.

On the nature and general characters of the body called

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1 On Phytogenesis, by J. M. Schleiden. Scientific Memoirs, translated by Richard Taylor, F.S.A., &c., volume second, London, 1841. From Muller's Archiv, 1838. Also, Principles of Scientific Botany, or Botany as an Inductive Science, by Dr J. M. Schleiden. Translated by Edwin Lankester, M.D. Book second, Chapter I. London, 1849, 8vo.

2 Th. Schwann Mikroskopische Untersuchungen uber die Uebereinstimmung in der struktur und dem Wachsthum der Thiere und Pflanzen, Berlin, 1839, 8vo.

Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants; translated from the German of Dr Th. Schwann, by Henry Smith. London, 1847. Printed for the Lydenham Society, 8vo, p. 268.

3 Henle Allgemeine Anatomie, Leipzig, 1841. Seite 151.

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the *Nucleus*, opinions are discordant. In some instances the nucleus has the appearance of a granular body, more or less solid, while in other instances it has that of a pale vesicle, with a distinct cell-wall and fluid content. The pale vesicular form is the most general, and, according to Kölliker, it is the constant form of the early stages of the life of the cell. That the composition of the nucleus is different from that of the cell, is shown by the fact, that many agents which act upon the one, have no effect upon the other. Kölliker is of opinion, that the membrane of the *nucleus* is composed of pyin, the clear content of albumen, and the *nucleolus* of fat.

In the animal tissue cell, as in the vegetable cell, the nucleus is commonly situate on the wall of the cell, apparently imbedded in its substance, but according to Schwann most frequently attached to its inner surface. Occasionally the nucleus is situate towards the centre of the cell, as is the case in the cells of cylinder epithelium.

The phenomena now mentioned are most easily seen in cartilage in its early or growing stage.

On the mode in which Elementary or Primary Cells are themselves formed, different representations have been given by different observers. In general a nucleus is first formed; and even upon this process different views are given. According to Schleiden and Schwann, in the Blastema or plastic fluid *nucleoli* first appear; and as new matter continues to collect, round one or more of these, the *nucleus* is formed. Afterwards, matter deposited on the nucleus forms the cell-wall or vesicular membrane. Henle, on the other hand, thinks, from various facts, that a *Nucleus* may be formed independent of any *Nucleolus*. He supposes in the *blastema* the existence of elementary particles or granules, which, he says, are found wherever new formations are taking place; for instance, in the yolk of the egg, in milk, in chyle, and in lymph, in the delicate commencements of glands, and the epithelium, when rapid regeneration takes place, and in pathological fluids.[1]

These elementary granules are for the most part, as far as can be ascertained, composed of fat, and a membrane inclosing the fat-drops; and he adduces, in proof of the correctness of this view, the fact made known by Ascherson, that when oil and albumen are allowed to unite in small drops, there are formed minute *corpuscula*, consisting of fat, inclosed in an albuminoid membrane.

It appears, in the *second* place, that, in certain circumstances, cells are formed without the previous existence of a nucleus. Thus, in addition to the fact, that in cryptogamic, and many higher plants, a minute spherule first appears, soon becomes a vesicle, and is eventually formed into a cell; in the *chorda dorsalis* of fishes and reptiles, cells are formed without the previous formation of any *nucleus*. It is to be remarked, however, that even in this instance, nuclei appear after the cells have been formed.

In the *third* place, it is observed that cells and nuclei are in certain circumstances formed simultaneously. Thus, in the embryonic cartilage of the toad, the formation of both bodies is so simultaneous, that Vogt never could detect nuclei without a cell-wall, or cells which did not enclose a nucleus.

On the mode in which cells are reproduced and multiplied, several conjectures have been formed, but nothing can be said to be ascertained. It is the opinion of Schwann, for the subject cannot be said hitherto to admit of proof, that the continued increase of cells is in most cases effected, though he does not show how, in the plastic fluid or blastema. In other instances new cells are formed within cells which had previously existed; and by these they are surrounded, until they have attained, by growth, a certain size, when they escape, apparently by rupturing the original or parent cell. This is supposed to be illustrated by the process of what is called cleavage in the ovum, and by what takes place in the cells of cartilage. But, excepting in these instances, this process of cell-multiplication, which has been termed *endogenous*, though common in vegetable productions, is rare in the textures of the animal world.

Influence of cells and nuclei in formation of tissues.

It was believed, with considerable confidence, when the discovery of the existence of elementary cells was made known that an easy and intelligible method was found of explaining the formation of all the textures which enter into the composition of the animal body. It is quite possible that this belief is well-founded; and in a few instances probably it may be said to be in a slight degree realised. But it must not be concealed, that the whole theory is in a state of imperfection and transition; and that it is far from presenting those clear, certain, and consistent phenomena, which might be applied with any confidence in explaining the growth and visible structure of the several tissues of which the animal body is composed. It is manifest, that in order that the cell and its nucleus should be the means of forming these tissues, they should undergo certain transformations. Now, upon these transformations, and upon the mode in which they are effected, observers are by no means agreed. In some instances it appears that the cell is the agent of transformation and creation, and in others it is the nucleus that is believed to be the agent. Schwann supposed, that to form certain tissues, as the Cellular, that is the Filamentous, the Tendinous, and the fibrous or Ligamentous, the cells become elongated and were thus converted into fibres. But though such elongation seems to take place in certain circumstances, the doctrine has not been generally admitted.

The tissues in which the agency of cells and their nuclei are believed with least certainty to be seen, are cartilage in its early state, bone in a certain degree, tooth, nerve-substance, arterial tissue, muscle, adipose membrane, and the secreting glands, as the liver, the kidney, the pancreas, the salivary glands, the female mamma.

The appearances observed during the growth of Nerve-Fibres in the embryo, particularly by Schaffner and Kölliker, are thought to afford good examples of the influence, if such it may be called, of the nucleated cell. In the earliest period of its formation, nerve substance consists almost entirely of round, mostly nucleated, cells, filled with a fine granular material, and, with the exception of being somewhat smaller, exactly similar to the nerve *corpuscula*, found in the nervous centres of the adult animal. As development advances, many of these cells send forth fine tubular processes of a structure apparently homogeneous, which unite with similar processes from other cells, and thus eventually gave rise to continuous Nerve Tubules. Kölliker finds that in young batrachoid reptiles, a complete net-work of nerve tubules is formed by this junction and coalescence of the processes from branching cells. A similar observation was made by Schwann. In this particular instance, therefore, it appears, that Nucleated Cells, by sending out some shoots, and uniting with similar offsets from other cells, eventually form tubulated structures. According to Schaffner, as the nerve tubules coalesce and increase in size, the walls of the cells from which they proceed are gradually drawn out, and merge into the walls of the tubules, while the granular content becomes continued and identified with the content of the tubules.

Henle gives schemes or plans of the mode in which the

[1] Allgemeine Anatomie, Seite 162, 163, Erste theil.

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nuclei are transformed into the higher tissues;[1] and Kölliker subsequently gave his representations of the process. It was supposed by Schwann, that the nucleus disappears shortly after the cell is completely formed. But according to Retzius, Henle, and Kölliker, the nucleus is a main agent of development in many tissues. The only parts in which, according to Henle, the nucleus disappears, are the blood-globules, the cells of the epidermis and the nails, most of the fat-cells, the tubules of the crystalline lens and of tooth-enamel, and many of the cartilage *corpuscula*. But in all fibres or fibriform tissues, supposed to be formed from coalescing cells, excepting those of the lens and of enamel, the *nuclei* not only remain persistent, but they undergo, or are the agents of, certain transformations.

First, they assume an oval shape, then gradually elongating and becoming narrow, they are converted into fine dark streaks, which lie straight, angular, or curvilinear, or for some space serpentine upon their proper cells. The Nucleus corpuscula then disappear. By reason of their sharp outlines, these streaks look like fibrous tissues, and are frequently taken for elongated cells, in which case the intermediate substance is overlooked or considered as cellular substance. At this stage, sometimes the absorption of the *Nucleus* commences by being divided into a row of minute dots, which constantly become paler and smaller. Similar rows of minute dots are found in all fibrous tissues, and most numerously in the cornea and in the organic muscles.

In opposite cases the elongated *Nuclei* gradually form a mutual connection by means of threads which each send out, and which, at first delicate and pale, gradually acquire the strength and firmness of the dark *corpuscula* from whence they proceed.

In consequence of the representations now given, Henle distinguishes two kinds of fibres;—namely, Cell-fibres and *Nuclei*-fibres; the former being those in which cells are split or divided into fibres, and the latter into fibrils; the latter those in which the nuclei are elongated, and by mutual union form fibres. The latter, again, he distinguishes into two different types, according to the original position of the nucleus on the surface, or on the edge of the flat nucleus-fibre; and the position of the nucleus is regulated by the form of the Cell-Fibre. Perfectly flat nuclei-fibres have the nucleus on the surface; cell-fibres, which approach the cylindrical form have the nucleus on the edges. To the latter order, he states, belong the fibres or filaments of the cellular tissue (*tela conjunctiva*), the fibres of the cornea, and those of tooth-bone.

The *nuclei* and *nuclei*-fibres are represented by the same anatomist to be of much use in forming the texture of the bloodvessels. In the development of these tissues, layers of cytoblastema are deposited in the form of stuctureless membrane; in these nuclei are formed, and undergo various changes. In the innermost layer, cells grow round the nuclei, and form the epithelial coat of the vessel. In the next layer, which forms what has been usually called the inner coat of the vessel, the nuclei remain unchanged. In the formation of the fibrous or elastic contractile coat, the nuclei are elongated, and arrange themselves in rows or lines, in the manner already mentioned.

The second type of Nucleus-Fibres, which are arranged on the surface of the flat Cell-Fibres, are distinguished by the tendency which they manifest to shoot lateral branches, and in this manner to form junctions with other lateral branches and make a network which covers the layer of cell-fibres; so that in the normal development they are situate between two layers of cell-fibres. This mode of development may be seen in the tissues of the bloodvessels, both arteries and veins, and in the muscular coat of the viscera.

The whole of this doctrine, however, is yet in a state of uncertainty and contradiction; and it would be unprofitable in this place to spend more time upon it. Whenever under particular heads it is possible to state any well-authenticated facts, this shall be done, so far as the limits and nature of this article admit.

Relation between nucleated cells and corpuscula.

The only subject which it is required further at present to notice, is the relation between the nucleated cells and the *corpuscula* of the blood. This subject is still, notwithstanding the observations of several skilful inquirers, Martin Barry, Henle, Vogt, Kölliker, Wharton Jones, Gulliver, beset with contradictions and involved in a considerable degree of uncertainty. Nor have these difficulties been diminished by connecting with the relation between the nucleated cells and the *corpuscula*, the question regarding the formation of the latter.

One of the great sources of difficulty in the inquiry is this, that the *corpuscula* of Man and the Mammalia, though similar in several circumstances to those of the lower vertebrated and the Aspondylous animals, do not present complete resemblance to them.

According to the observations of Mr Wharton Jones, the blood of Fishes, that is, of the lower vertebrated animals, presents three kinds of cells, 1*st*, the granule blood-cell, containing a nucleus not at first visible, but discovered to be so by addition of acetic acid, which dissolves the granules and renders the nucleus evident; and, 2*d*, The nucleated blood-cell, which is the red oval *corpusculum*, but with the nucleus cellæ-form; and 3*d*, The pale or colourless granule cell. It appears further, that between the granule blood-cell and the nucleated blood-cell there subsists this relation, that they form two different phases of development of the same body; the granule cell being the early stage, and the nucleated cell the second or more advanced. It seems also probable, from the observations of the same inquirer, that the pale or colourless granule cells mentioned as the third kind, form advanced stages of the dark looking granule cell.

In the blood of the frog, which is taken as the representative of the reptile family, there are recognised two forms of *corpuscula:* 1. Granule cells in coarse and fine granular stages; and, 2. Nucleated cells in colourless and coloured stages. The nucleated blood cell in its coloured stage is the red oval corpuscle of the blood of the frog, that is, the blood globule of the frog in its most complete form.

Regarding the blood *corpusculum* of the Mammalia and Man, it appears to be certain that the central spot does not correspond to the nucleus, though this has been imagined by some observers.

In all the vertebrated animals hitherto examined, Oviparous and Mammiferous, there are, first, blood *corpuscula* in the first stage of development, or presenting the phase of Granule Cell, either coarsely grained or finely granular. Secondly, in all the animals examined there are blood *corpuscula*, in the second stage of development, that is in the phase of Nucleated Cell, which may be *a* in the colourless stage, or *b* in the coloured stage.

Regarding the nucleated blood-cell in the coloured stage, this occurs in its highest degree of development, and in great numbers, only in the Oviparous Vertebrata, in which it constitutes the red *corpusculum*, and in the early mammiferous embryon. In the fully formed blood of the Mammalia it occurs in a comparatively low degree of development, and in very small number.

[1] Allgemeine Anatomie, Seite 193, 194, 198.

In the Mammalia alone is the blood *corpusculum* found in what Mr W. Jones calls the third stage of development, or the phase of free cellæ-form nucleus. This is found in both uncoloured and coloured stages. In the former stage it is rare; in the latter it is the red corpuscle of the fully formed blood of man and the mammalia. In short, it is the opinion of Mr Jones, that the red *corpusculum* or globule of the fully formed blood of man and the mammalia is the cellæ-form Nucleus of the nucleated cell set free by the bursting of this cell itself, and become filled and red by the secretion of globuline and colouring matter into its interior.

For the facts and arguments establishing this inference, we refer to the memoirs of Mr Wharton Jones.[1]

## CHAP. II.—THE COMMON TISSUES.

*Filamentous or Cellular Tissue.* (*Tela Cellulosa,—Tissu Cellulaire,—Tissu Muqueux* of Bordeu,—*Corpus Cribrosum* Hippocratis,—*Corps Cribleux* of Fouquet,—Reticular Membrane of William Hunter.) Das Bindegewebe of Müller and Henle.

Under the name of Connecting Tissue, Henle describes a tissue consisting in its final elements of long, very fine, soft, transparent filaments, or cylinders or fibrils of uniform strength, and of a diameter varying from 0·0003–0·0008 of one line. This tissue he distinguishes into two general forms; one the shapeless or unformed Connecting Web; the other the formed Connecting Web. The first of these corresponds to what has been described by various authors under the names of Cellular Tissue, Mucous Tissue, and Filamentous Tissue. Under the second, which he divides into two orders, the Non-contractile and the Contractile Joining Web, he arranges a great number of textures in the following manner:—I. Non-contractile formed Web, including, 1. Tendon; 2. Ligament; 3. Fibrous Sheaths; 4. Fibrous Membranes, as the fibrous covering of the *Corpora Cavernosa* the *Dura Mater*, the *Membrana Tympani*, the Valves of the veins, the Neurilema, the Fasciæ, the Periosteum, and the Perichondrium; 5. The *Tunica Nervea* of the intestinal canal; 6. The External Coat of the Bloodvessels; 7. The Serous Membranes; 8. The *Pia Mater* and the Choroid Membrane;—II. Formed Contractile Joining Web, including the Skin; the *Dartos;* the Investing membrane of the *Corpora Cavernosa;* and the Contractile Web of the longitudinal and annular coat of the veins and lymphatic vessels.

Without pretending to offer any opinion upon the propriety of arranging all these different tissues under the head of Connecting Web, it may be remarked, that it is not very easy in this manner to communicate correct ideas of the true anatomical and physical characters of these tissues; and as the method already adopted in this article possesses the advantage of being at once simple, free from hypothesis, and serviceable to readers, it seems more prudent to adhere to it, after the explanations now given.

The general distribution of the filamentous or cellular tissue was first maintained by Haller and Charles Augustus de Bergen, and afterwards made the subject of elaborate discussion by William Hunter and Bordeu. It may be described as a substance consisting of very minute thready lines, which follow no uniform or invariable direction, but which, when gently raised by the forceps, present the appearance of a confused and irregular network. As these minute lines cross each other, they form between them spaces of a figure not easily determined, and perhaps not uniform. By some authors these spaces or intervals have been named cells; but, accurately speaking, the term is not fortunately applied. The component lines, which do not exceed the size of the silkworm threads, are so slender, that they do not form those distinct partitions which the term *cell* implies; and though by forcible distension, such as takes place in insufflation, or separation by forceps, cavities appear to be formed, these, it will be found, are artificial, and result from the separation of an infinity of the slender filaments of which the part is composed. These interlinear spaces necessarily communicate on every side with each other; and indeed the most distinct way of forming a true idea of the structure of the cellular tissue, is to suppose a certain space of the animal body which is divided and intersected into an infinite multitude of minute spaces (*areolæ*) by slender thready lines crossing each other. This description, derived from personal observation, renders the name of *filamentous* more appropriate to this tissue than that of *cellular* by which it is generally known.

The interstitial spaces resulting from the interlacement of these filaments do not exist as distinct cavities in the healthy state, so that they cannot be said to contain any substance solid or fluid. But when an incision is made into this tissue in the living body, it is found, that if we except those fluids which issue from divided vessels, nothing is observed to escape but a thin exhalation or vapour, which is evidently of an aqueous nature. This is what some authors have termed, from its resemblance to the serous part of the blood, the *cellular* serosity (Bichat), and the quantity of which has been greatly exaggerated. In the living body it appears not to exist as a distinct fluid, but merely as a thin vapour, which communicates to the tissue the moist appearance which it possesses.

This fluid is understood to be derived from the minute colourless capillaries named *exhalants;* and it is supposed to be no sooner poured forth in an insensible manner, than it is removed by the absorbing power of lymphatics, minute veins, or both. It is further believed, that whatever serous fluid is secreted into the interstitial spaces or cells of the filamentous tissue, is in the healthy state speedily removed; so that exhalation implies absorption; and the filamentous tissue is therefore represented as the seat of incessant exhalation and absorption.

The serous fluid of the filamentous tissue varies in quantity in different regions. In the cellular tissue of those parts which are free from fat, as in the eyelids, the prepuce, the *nymphæ* and *labia*, and the scrotum, it is said to be more abundant than in others. The peculiar structure of those parts, which is cellular, may render any excess of serous fluid more conspicuous; for it is matter of observation, that in many persons otherwise healthy these parts are not unfrequently distended with serous fluid. On the other hand, it must be remarked that the submucous cellular tissue, and that which surrounds arteries, veins, and excreting ducts, which is delicate in substance and compact in structure, contains but a small proportion of serous fluid, and does not readily admit its presence.

This fluid has been generally said to be of an albuminous nature; and if it be identical with the serum of the blood, from which it is believed to be secreted, this character is not unjustly given it. Bichat, who maintained this opinion, injected alcohol into the filamentous tissue of an animal previously rendered emphysematous, and found in various parts whitish *flocculi*, which he regarded as coagulated albumen. He also obtained the same result by immersing a portion of the scrotum in weak nitric acid; and when a considerable quantity of this tissue was boiled, it furnished much whitish foam, which Bichat regarded as albuminous.[2] These ex-

[1] *Philosophical Transactions of the Royal Society of London* for the year 1846, Part II., and *Edinburgh Medical and Surgical Journal*, vol. sixty-third, 1847, p. 529, and vol. seventy-third, 1850, p. 395.

[2] *Anatomie Générale*, tom. i. p. 50.

periments, however, are liable to this objection, that the effects in question may have arisen from coagulation of part of the filamentous tissue itself, which contains a considerable proportion of albuminous matter. The best mode of determining the point is to obtain the fluid apart, and to try the effects of the usual tests on it when isolated from the tissue in which it is lodged.

The description here given applies to the proper filamentous tissue. This substance was shown by Ruysch, and afterwards by William Hunter and Mascagni, to be penetrated by arteries and veins. Exhalants, absorbents, and nerves, it is also said to receive. The arteries certainly belong in the healthy state to the order of colourless capillaries, which are nearly the same with exhalants. It does not appear that the nervous twigs observed to pass through this tissue are lost in it; for in general they have been traced to some contiguous part.

Such are the general properties of this tissue, considered as an elementary organic substance extensively diffused through the body. In particular regions it undergoes some modifications, which may be referred to the following heads:—1. Beneath the skin, or rather under the adipose membrane,—the subcutaneous and intermuscular cellular tissue; 2. Beneath the villous or mucous membranes,—the submucous cellular tissue; 3. Beneath the serous membranes,—the subserous cellular tissue; 4. Round bloodvessels, excreting ducts, and other organs,—the inclosing tissue, vascular sheaths, &c.; 5. In the substance of organs,—the penetrating cellular tissue.

The situation of the subcutaneous filamentous tissue deserves particular notice. Though generally represented as below the skin, it is not immediately under this membranous covering. The skin rests on the adipose membrane, beneath which again is placed the filamentous tissue, extending like a web over the muscles and bloodvessels, penetrating between the fibres and bundles of the former, surrounding the tendons and ligaments, and connected by these productions with a deep-seated layer, on which the muscles move, where they do not adhere to the periosteum and to bones.

The extensive distribution of the subcutaneous filamentous tissue, the mutual connection of its parts, and its ready communication with the filamentous tissue of the mucous and serous membranes, were demonstrated by Haller, William Hunter, and Bordeu, and have been clearly explained by Portal and Bichat. The principal points worthy of attention may be stated in the following manner.

The filamentous tissues of the head and face communicate freely with each other, and with that of the brain by the cranial openings, and with the submucous tissue of the eyelids, nostrils, lips, and the inner surface of the mouth and cheeks. It communicates also with the subcutaneous tissue of the neck all round; and at the angle of the jaw, in the vicinity of the parotid gland, is the common point of reunion. To this anatomical fact is referred the frequency of swellings and purulent collections in the region of the parotid in the course of the various diseases of the head, face, and neck.

The filamentous tissue of the neck may be viewed as the connecting medium between that of the head and trunk. From the former region it may be traced downwards along the back, loins, breast, sides, flanks, and belly. At the cervical region, and between the shoulders, it is dense and abundant; and, surrounding the dorsal part of the vertebral column, it is connected with the mediastinal tissue, the submucous tissue of the lungs, and the subserous tissue of the costal pleura. At the fore part of the neck it is in like manner connected with the abundant tissue of the pectoral region, and by means of that surrounding the larynx and trachea, 1*st*, with the submucous tissue of the bronchi; and, 2*d*, with the anterior mediastinum. Passing downwards, the same communication may be traced with the intermuscular tissue of the loins and belly, the tissue surrounding the lumbar and sacral portion of the vertebral column, that connecting the mesentery and large vessels to the vertebræ, and extending all round under the muscular peritoneum, and into the pelvis, where, by means of the tissue at the posterior surface of the abdominal muscles, at the anterior surface of the *iliacus internus*, and through the obturator hole and ischiadic notch, it communicates with the filamentous tissue of the lower extremities. From the rectum and branches of the ischium it is continued along the perineum by the urethra, and into the scrotum.

In the whole of this course, it is abundant in the space before the vertebræ, round the *psoæ* and *iliacus internus* muscules, and round the bladder, rectum, prostate gland, and womb. The tissue surrounding the vertebral column communicates with that in the interior of the column by the intervertebral holes.

The armpit may be considered as the point of union between the filamentous tissue of the trunk and that of the upper extremities, while the groin is the corresponding spot for the lower extremities. These facts should be kept in mind in observing the phenomena of diseases of this tissue.

Notwithstanding this general connection, however, certain parts of the tissue are so dense and close as to diminish greatly the facility of communication. Thus, along the median line it is so firm, that air injected invariably stops, unless impelled by a force adequate to tear open its filaments; and water is rarely found effused in this situation. In the neighbourhood of some parts of the skeleton also, as at the crest of the ilium, over the great trochanter, and on the shin, the filamentous tissue is very dense and coherent.

In chemical composition it consists principally of gelatine, but contains some albuminous matter.

*Adipose Tissue.* (*Tela Adiposa,—Tissu Adipeux.—Tissu Graisseux.*) *Fett-Gewebe* (Henle).

The separate existence of an adipose membrane was suspected by Malpighi, maintained by De Bergen and Morgagni, and demonstrated by William Hunter. It was however, confounded with the filamentous tissue, under the general name of cellular membrane, adipose membrane, and cellular fat, by Winslow, Portal, Bichat, and most of the continental anatomists, till distinguished and described by M. Beclard.

According to the dissections of De Bergen and Morgagni, the demonstrations of Hunter, and the observations of Beclard, its structure consists of rounded packets or parcels separated from each other by furrows of various depth, of a figure irregularly oval, or rather spheroidal, varying in diameter from a line to half an inch, according to the degree of corpulence and the part submitted to examination. Each packet is composed of small spheroidal particles, which may be easily separated by dissection, and which are said to consist of a cluster of vesicles still more minute, and agglomerated together by delicate cellular tissue. The appearance of these ultimate vesicles is minutely described by Wolff in the subcutaneous fat, and by Clopton Havers and Monro, in the marrow of bones, in which the last two authors compared them to strings of minute pearls. If the fat with which these vesicles are distended should disappear, as happens in dropsy, the vesicles collapse, their cavity is obliterated, and they are confounded with the contiguous cellular tissue, without leaving any trace of their existence.

Hunter, however, asserts, that in such circumstances the cellular tissue differs from the tissue of adipose vesicles, in containing no similar cavities; and justly remarks that the latter is much more fleshy and ligamentous than the filamentous tissue, and contends, that though the adipose receptacles are empty and collapsed, they still exist. When the skin is dissected from the adipose membrane it is always possible to distinguish the latter from the filamentous tissue, even if it contain no fat by the toughness of its fibres, and the coarseness of the web which they make.

The distinguishing characters between the cellular or filamentous and the adipose tissue may be stated in the following manner.—1*st*, The vesicles of the adipose membrane are closed all round, and, unlike cellular tissue, they cannot be generally penetrated by fluids which are made to enter them. If the temperature of a portion of adipose membrane be raised by means of warm water to the liquefying point of the contents, they will remain unmoved so long as the structure of the visicles is not injured by the heat. If, again, an adipose packet be exposed to a heat of + 40 centigr. = 104 F. though the fat be completely liquefied, not a drop escapes until the vesicles are divided or otherwise opened, when it appears in abundance. The adipose matter, therefore, though fluid or semifluid in the living body, does not, like dropsical infiltration, obey the impulse of gravity. 2*d*, The adipose visicles do not form, like cellular tissue, a continuous whole, but are simply in mutual contiguity. This arrangement is demonstrated by actual inspection, but becomes more conspicuous in the case of dropsical effusions, when the filamentous tissue interposed between the adipose molecules is completely infiltrated, while the latter are entirely unaffected. 3*d*, The anatomical situation of the adipose tissue is different from that of the filamentous tissue. The former is found, 1*st*, in a considerable layer immediately beneath the skin; 2*d*, between the peritoneal folds which form the omentum and mesentery; 3*d*, between the serous and muscular tissues of the heart; and, 4*th*, round each kidney.

In each of these situations it varies in quantity and in physical properties. In the least corpulent persons a portion of fat is deposited in the adipose membrane of the cheeks, orbits, palms of the hand, soles of the feet, pulp of the fingers and toes, flexures of the joints, round the kidney, beneath the cardiac serous membrane, and between the layers of the mesentery and omentum. In the more corpulent, and chiefly in females, it is found not merely in these situations, but extended in a layer of some thickness almost uniformly over the whole person; and is very abundant in the neck, breasts, belly, *mons veneris*, and flexures of the joints.

Besides the delicate cellular tissue by which the packets and vesicles are united, the adipose tissue receives arterial and venous branches, the arrangement of which has been described by various authors, from Malpighi, who gave the first accurate account, to Mascagni, to whom we are indebted for the most recent. According to the latter, who delineates these vessels, the furrow or space between each packet contains an artery and vein, which, being sub-divided, penetrate between the minute grains or particles of which the packet is composed, and furnish each with a small artery and vein. The effect of this arrangement is, that each individual grain or adipose particle is supported by its artery and vein as by a foot-stalk or peduncle, and that those of the same packet are kept together, not only by contact, but by the community of ramifications from the same vessel. These grains are so closely attached, that Mascagni, who examined them with a good lens, compares them to a cluster of fish-spawn. Grutzmacher found much the same arrangement in the grains and vesicles of the marrow of bones.

It has been supposed that the adipose tissue receives nervous filaments; and Mascagni conceives he has demonstrated its lymphatics. Both points, however, are so problematical, that of neither of these tissues is the distribution known.

The substance contained in these vesicles is entirely inorganic. Always solid in the dead body, it has been represented as fluid during life by Winslow, Haller, Portal, Bichat, and most authors on anatomy. The last writer indeed states, that under the skin it is more consistent, and that in various living animals he never found it so fluid as is represented. The truth is, that in the human body, and in most mammiferous animals during life, the fat is neither fluid nor semifluid. It is simply soft, yielding, and compressible, with a slight degree of transparency or rather translucence. This is easily established by observing it during incisions through the adipose membrane, either in the human body or in the lower animals.

The properties and composition of fat form a subject for chemical rather than anatomical inquiry; and in this respect its nature has been particularly investigated by M. Chevreul. According to the researches of this chemist, fat consists essentially of two proximate principles, *stearine* (*στεαρ*, *sebum*, *sapo*), and *elaine* (*ελαιον*, *oleum*). The former is a solid substance, colourless, tasteless, and almost inodorous, soluble in alcohol and ether, and preserving its solidity at a temperature of 138° F., but fusible between 140° and 145° F. Elaine, on the contrary, though colourless, or at most of a yellow tint, and lighter than water, is fluid at a temperature of from 17° to 18° centigrade, = 63° to 64° F., and is greatly more soluble in alcohol.

Of this substance marrow appears to be merely a modification; and the membranous cavities or medullary membrane in which it is contained may be viewed as an intraosseous adipose tissue.

Little doubt can be entertained that animal fat is the result of a process of secretion; but it is no easy matter to determine the mode in which this is effected. Malpighi, departing, however, from strict observation, imagined a set of ducts issuing from glands, in which he conceived the fat to be elaborated and prepared. To this he appears to have been led by his study of the lymphatic glands, and inability to comprehend how the process of secretion could be performed by arteries only. This doctrine, however, was overthrown by the strong arguments which Ruysch derived from his injections; and Malpighi himself afterwards acknowledged its weakness and renounced it. In short, neither the glands nor the ducts of the adipose membrane have ever been seen.

Winslow, though willing to adopt the notion of Malpighi, admits, however, that the particular organ by which the fat is separated from the blood is unknown. Haller, on the contrary, aware of the permeability of the arteries, and their direct communication with the cells of the adipose tissue, and trusting to the testimony of Malpighi, Ruysch, Glisson, and Morgagni, that it existed in the arterial blood, saw no difficulty in the notion of secretion, or rather of a process of separation; and upon much the same grounds the opinion is adopted by Portal and others. Bichat, again, contends that no fat can be recognised in the arterial blood, and adduces the fact, that none can be distinguished in blood drawn from the temporal artery.

All this, however, is more or less erroneous. It has been ascertained by Babington, Gmelin, Denis, Boudet, and Lecanu, that fat or oil exists in blood in the normal state; and there is no difficulty in understanding that from this fluid it must be secreted and deposited in the adipose tissue. The truth is, that fatty matter is found in the chyle, and is conveyed into the blood by the chyliferous vessels; and that it is found in the blood after meals of certain kinds of food, has been shown by the researches of Dr R. D. Thomson and others. From these facts, it may be inferred, that adipose matter or its elements are conveyed in minute quantities into the blood, and that the fat itself is deposited from the vessels in various parts of the adipose tissue, and in the medullary membrane of the bones, in which it is afterwards found. From the phenomena of various diseases, and from those manifested by hybernating animals, which retire in the beginning of winter fat and heavy, and come out in spring meagre and extenuated, there is reason to believe that fat is absorbed by the veins and lymphatics.

There is little difficulty in understanding the sources from which fat is derived in animal bodies. All amylaceous and saccharine articles of food furnish the elements of fat; and it is impossible to doubt that from these chiefly, together with the oils found in the seeds and other parts of vegetables, fat may be formed. In animals which live almost entirely on grass and the seeds of grassy vegetables, as the ox, sheep, horse, deer, and camel, the amylaceous and saccharine matters of their food are manifestly converted into fat and marrow.

Insects abound in fat; and in the bee this substance is prepared from sugar.

*Artery, Arterial Tissue.* (*Arteria,—Tissu Arteriel.*)

Most anatomical writers, previous to the time of Henle, distinguished in the arterial tissue three tunics; 1*st*, an internal; 2*d*, a middle or fibrous coat, consisting of annular fibres; and 3*d*, an external or common covering of condensed filamentous tissue.

Henle enumerates six different tunics; 1*st*, the first or inner coat, consisting of pavement epithelium; 2*d*, the striped or trellised coat; 3*d*, the longitudinal fibrous coat; 4*th*, the annular fibrous coat; 5*th*, an elastic tissue found only in arteries of large calibre; and 6*th*, the external, filamentous, or adventitious coat.

Of these six tissues, the first three correspond to the inner coat; the fourth is the ordinary fibrous or elastic coat of arteries; the fifth is not present in all vessels; and the sixth is the ordinary external coat of filamentous tissue.

The Epithelial coat is seen in the smallest vessels as a simple granular membrane in which the cell-nuclei only are deposited in a certain order. Frequently it has quite the same structure as the Epithelium of the Serous Membranes; in other instances the nuclei are oval, the cells extremely pale, and so flat, that those standing on the edge appear as thin filaments, something swollen in the centre, the region of the nucleus. Henle allows that this arterial epidermis may be wanting or transformed into the next tissue.

The second layer, the Striped or Trellised coat, is a very fine, transparent, moderately stiff, brittle membrane, the filaments of which divaricate and decussate each other.

The third layer, the best specimens of which are seen in the valves of the veins, belongs only doubtfully to the arterial tissue.

The two first-mentioned tissues correspond to the inner coat described below.

Every arterial tube greater than one line in diameter is visibly composed of one adventitious and two essential substances: the first, the sheath, reputed to consist of condensed filamentous tissue; the last two, the proper arterial and internal tissues. (*Tunica propria et membrana intima.*)

1. The inner surface of the arterial tube is formed by a very thin semitransparent polished membrane, which is said to extend not only in the one direction over the inner surface of the left ventricle, auricle, and pulmonary veins, but in the other to form the minute vascular terminations which are distributed through the substance of the different organs. This membrane is particularly described by Bichat under the name of *common membrane of the system of red blood*, because he believed it to exist wherever red blood was moving,—in the pulmonary veins, in the left side of the heart, and over the entire arterial system.

The inner membrane may be demonstrated by cutting open or inverting any artery of moderate size, when it may be peeled off in the form of thin slips by the forceps. Or, if the tube be fitted on a glass rod, by removing the layers of the proper membrane in successive portions, the inner one at length comes into view in the form of a thin translucent pellicle, of uniform, homogeneous aspect, without fibres or other obvious traces of organization. Under the microscope, however, if we can trust the descriptions of Henle, this coat appears to be composed of the filaments above mentioned. These filaments cannot be said, strictly speaking, either to be transverse or longitudinal in relation to the axis of the artery. Most of them are rather oblique; and they ramify at acute angles, and form anastomotic unions with each other. The stripes formed by these filaments are extremely pale and difficult to be seen. Henle further mentions as scattered between the fibres, holes variable in size, mostly round in shape, but here and there regularly broad, as if the effect of laceration.

This membrane is supposed to be prolonged to form those minute vessels in which the proper coat connot be traced. It is very brittle, and is distinguished during life by a remarkable activity in forming the morbid states to which arteries are liable. In other respects it is deemed by Bichat peculiar, and, though similar to the proper membrane, is to be considered as unlike any other tissue. Its chemical composition is not known.

2. Exterior to this *common* or *inner* membrane is placed a dense strong tissue of considerable thickness, of a dun yellowish colour, which is found to consist of fibres disposed in concentric circles placed contiguous to each other round the axis of the artery. If this substance be examined either from without or in the opposite direction, it will be found that, by proper use of forceps, its fibres can be separated to an indefinite degree of minuteness, even to that of a hair, and that they uniformly separate in the same direction. Longitudinal fibres are visible neither in this nor any other tissue of the arterial tube. This is the proper arterial tissue; (*tunica propria.*) Its uniform dun yellow colour is perceived through the semitransparent inner membrane, and is most conspicuous either when this is removed, or when the outer cellular envelope is detached and the component threads separated from each other; and if it be less distinct in the smaller branches, it is because the tissue on which the colour depends is here considerably thinner. In this respect it varies in different regions. Though in general less dense and abundant as the arteries recede from the heart, it is thicker, *cæteris paribus*, in those of the lower than in those of the upper extremities. In the vertebral and internal carotid arteries, and in those distributed in the substance of the liver, spleen, &c., it is thinner than in vessels of the same size in the muscular interstices.

This is the tunic which Henle calls the Annular Coat. His description includes both this proper or middle coat of the Arteries and the proper coat of the Veins, and has thereby been made less appropriate than it might otherwise have been. He describes the arterial annular coat as presenting fine dark streaks, or rows of dark-coloured *punctula*, running across the axis of the artery; and he thinks it certain that these streaks proceed from the original transverse oval Nuclei, and that therefore they give distinct evidence of the mode in which the annular coat is developed.

In acetic acid the annular arterial coat is resolved into fine vessels, so that the transversely oval nuclei float about free in the mass. The peculiar fibres of the middle arterial coat become by acetic acid pale, transparent, yet not dissolved. The dark stripes and *punctula* remain unchanged.

In rare instances the proper fibres of the middle arterial coat are curled as fasciculi of fibro-filamentous tissue.

Henle maintains that no proper filamentous tissue is found in the annular coat, not even to connect the separate layers of the coat, though this is frequently asserted. He has occasionally met with shreds of the trellised coat itself in the external layer of the annular coat. Răuschel saw on all fine sections of the aorta, the layers of the proper fibres separated by means of transparent fine partitions, which consequently must perforate the proper fibres in all directions. If the middle coat be stripped from an artery, after it has been treated with wood vinegar, and again softened in water, it is easily divided into layers which are not separated by fibres, but by a white, fibreless transparent substance. Portions of this are sometimes attached to the transverse fibres. Henle thinks, in short, that the trellised coat forms not only the internal layer of the annular coat, but also separates the component layers of that coat. Răuschel counted in the aorta forty-four layers, in the carotid artery twenty-eight, in the axillary artery fifteen layers, separated by similar partitions. In the other arteries, these must be wanting.

The nature of this tissue has been the subject of much controversy. It was long believed to be muscular, and to possess the properties of muscular fibre. Bichat showed that the arguments by which this opinion was supported are inconclusive, and that the arterial tissue has very few qualities in common with the muscular. The circumstances from which he derived his proofs were its physical and physiological properties.

The arguments derived from the physical properties of this tissue are chiefly the following:—The arterial tissue is close, elastic, fragile, and easily divided by ligature; muscular fibre is more loose in structure, by no means elastic; and, instead of being divided or cut by ligature as artery is, undergoes a sort of strangulation. The action of alcohol, diluted acids, and caloric, by means of hot fluids which are not corrosive, affords a proof of the chemical difference of these animal substances. All of them produce in the arterial tunic a species of shrivelling or crispation, which seems to depend on more complete coagulation of one of the chemical principles; but no similar effect takes place in muscular fibres. According to Berzelius, the proper arterial tunic contains no fibrin.[1] Beclard, however, asserts that he has ascertained that it contains a portion of this principle; but nevertheless hesitates to consider it as a muscular or fibrinous tissue, and expresses his opinion that it would be with greater propriety referred to that order of substances which he has named yellow or tawny fibrous system.

The consideration of the physiological or organic properties leads to similar results. Neither mechanical nor chemical agents applied as stimulants produce any change or motion in the living arterial membrane. 1. The arteries of an amputated limb, exposed the moment after amputation, while the muscles are in active motion, do not contract or move when punctured by the scalpel. 2. The experiments of Bikker and Van-den-Bos with the electric spark, and those of Vassalli-Eandi, Giulio, and Rossi with the galvanic pile, may be considered as disproved by the experiments of Nysten,[2] who found no contraction in the human aorta after violent death, while the heart and other muscles could still be excited. In performing the same experiment with the artery of the living dog, this physiologist was equally disappointed. 3. The circular contraction of the calibre of an artery either partially or wholly divided, depends not on irritability, but either on its elasticity, or on that property which it possesses of contracting strongly the instant the distending agent is removed. This power is different from muscular contraction or irritability, and must not be confounded with them; but it depends on the living state of the body and the individual arterial tube. 4. The contraction said to take place in living arteries after the application of alcohol, acids, or alkalies, is to be ascribed to the chemical *crispation*, and not to stimulant power. It does not relax. 5. These inferences are not inconsistent with the experiments of Thomson, Philips, Hastings, Wedemeyer, and Kaltenbrunner, on minute arterial tubes, which may be admitted to possess something like irritability, or rather susceptibility of contraction, without the necessity of supposing the same property in the large branches and trunks. 6. This is so much more probable, as in these minute arteries the proper arterial tunic is either wanting, or is so much thinner and so modified, that it is impossible to conceive its presence capable of affecting the result of experiments made to determine the degree or kind of arterial contraction.

On the other hand, Henle maintains that the outer layers of the annular coat are muscular, and belong to the same category to which are referred the muscular fibres of the intestinal canal and those of excretory ducts.[3]

3. The outer surface of the proper arterial tissue is enveloped, as above noticed, in a layer of dense filamentous or cellular membrane, which is very firmly attached to it, and which was formerly considered as part of the arterial tissue. It is adventitious; a modification of filamentous or cellular texture, which establishes a communication between the artery and the contiguous parts, and is necessary to the nutrition and healthy state of the vessel. It incloses and transmits the minute vessels anciently denominated *vasa vasorum* (*arteriolæ arteriarum*, Haller); and if detached even through a trifling extent, the arterial portion thus divided is sure to become dead, to be affected with inflammatory and sloughing action, and ultimately to give way and discharge the contents of the vessel. M. Beclard considers it a fibro-cellular membrane, which may in the larger arteries be divided into two layers; one exterior, similar to the general filamentous tissue; the other inside, between the outer layer and the proper tissue, yellowish and firm, but still sufficiently distinct from the proper tunic. In the cerebral arteries it is wanting, and in most parts of the chest and belly its absence is supplied by a portion of pericardium, pleura, or peritoneum. Yet even there a thin layer of fine cellular tissue appears to connect these membranes to the proper tunic. In the extremities the cellular sheath is removed in dissecting arterial preparations.

The internal filamentous tissue above-mentioned is what Henle calls the fifth arterial coat. It occurs only in arteries of large size. It is a coat of true elastic tissue; a white membrane, which can be rent into fibres neither transversely nor longitudinally, but always follows the tug of the forceps in small shreds. This membrane possesses the firmness of the elastic tissue, while the annular coat is slender and brittle. When treated with acetic acid, this membrane retains completely its white colour, while the annular coat becomes transparent; though thinner, it has a much greater degree of elasticity than the annular coat; and it possesses the microscopical character of the elastic tissue in a remarkable degree.

At different periods several anatomists, as Willis, Douglas and Delasone, have maintained the existence of longitudinal fibres in arterial tissue; and even at the present day this no-

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1 *A View of the Progress of Animal Chemistry*, by J. J. Berzelius, M.D. &c. &c., p. 24, 25. London, 1813.
2 *Nouvelles Expériences Galvaniques*, &c., par P. H. Nysten, &c., l'an 11, p. 235–6. Paris. *Recherches de Physiologie*, 1811, p. 307. Paris.
3 *Adversaria Anatomica*, tom. ii. p. 78.

tion is not entirely abandoned. Morgagni was the first who, trusting to mere observation, doubted the existence of these fibres, and stated that he was unable to perceive them.[1] Upon the same ground Haller would not admit of their existence;[2] and Bichat and Meckel positively denied them. The longitudinal filaments mentioned by Henle are found principally in the veins.

Though arterial tissue does not appear to be very vascular, it is furnished with arteries and veins (*vasa vasorum, arteriolæ arteriarum*), which do not come from the artery or vein itself, but from the neighbouring vessels.[3] Thus the aorta at its origin is supplied with minute arteries from the right and left coronary, and in some instances with a proper vessel adjoining to the orifice of the right coronary artery, which Haller regards as a third coronary. The rest of the thoracic aorta derives its vessels from the upper bronchials, from twigs of the internal mammary arteries, from the bronchials, from the œsophageals, and from the phrenics. The abdominal portion is supplied from the spermatics, the lumbar, and in some instances the mesocolic artery. The same arrangement nearly is observed with regard to the veins.

Few textures are more liberally supplied with nerves than arteries are. Almost every considerable trunk or vessel is surrounded by numerous plexiform filaments of nerves, many of which may be traced into the tissue of the artery. The anterior part of the arch of the aorta is abundantly supplied with branches from the superficial cardiac nerves, which Haller was unable to trace beyond the artery. The cœliac, the mesenteric, and the mesocolic arteries are invested with numerous plexiform nervous filaments derived from the large semilunar ganglion of the splanchnic nerve. The renal arteries in like manner are surrounded by numerous twigs of the renal plexus; and each of the intercostal arteries at its origin receives nervous threads from the intercostal nerves. This arrangement, which is observed chiefly in the blood-vessels going to the internal organs, led Bichat to announce it as a general fact, that the arteries derive their nerves almost exclusively from the ganglions and the gangliar nerves.[4] The inference does not rest upon strict observation, and evidently owes its birth to the hypothetical opinions of this ingenious physiologist. All the arteries going to the extremities, the axillary, and iliac, and their branches, receive nerves from the neighbouring nervous trunks, which are formed chiefly from cerebral or spinal nerves, and have no immediate connection with the system of the ganglions. In the internal carotid and the vertebral arteries, and their branches, nerves cannot be distinctly traced.[5]

Organized in the manner now described, it is requisite to take a short view of the anatomical connections of the arterial system, or to consider it in its origin, its course, and its termination.

The arterial system of the animal body may be viewed as one large trunk divided into several branches, which again are subdivided and ramified to a degree of minuteness which exceeds all calculation. It is requisite, therefore, to consider the origin, 1*st*, of the aorta, the large trunk; 2*dly*, of the branches which arise from it; and, 3*dly*, of the small vessels into which these are divided.

Every one knows that the aorta is connected at its origin with the upper and anterior part of the left ventricle. The manner of this connection has been well examined by Lancisi, by Ludwig, and particularly by Bichat. It may be demonstrated by dissection, but is much more distinctly shown by boiling the heart with the blood-vessels attached. In a heart so treated, the thin internal membrane may be traced passing from the interior of the ventricle along the margin of its orifice to the inside of the arterial tube. Exactly at the point of union it is doubled into three semicircular folds, forming semilunar valves, and thence is continued along the whole course of the artery. This membrane is entirely distinct from the proper or fibrous coat. Of the latter, the cardiac extremity or beginning is notched into three semicircular sections, each of which corresponds to the base or attached margin of a semilunar valve. These sections are attached to the aortic orifice of the ventricle by delicate filamentous tissue, but are not connected with the fleshy fibres of the heart; and at the angle or point of attachment the thin inner membrane is folded in so as to fill up a space or interval which is left between the margin of the orifice and the circumference of the proper arterial tissue, where it is notched or trisected.

The aorta is soon divided into branches, which again are subdivided into small vessels. With the mathematical physiologists it was a favourite problem to ascertain the number of branches into which any vessel might be subdivided. Keill made them from forty to fifty. Haller states that, counting the minutest ramifications, he has found scarcely twenty. The inquiry is vain, and cannot be subjected to accurate calculation. In no two subjects is the same artery found to be subdivided the same number of times; and in no two subjects are the same branches found to arise from the same trunk.

A branch issuing from a trunk generally forms with it a particular angle. Most generally, perhaps, these angles are acute; but in particular situations they approach nearly to a right angle. Thus the *innominata*, left carotid, and left subclavian, issue from the arch of the aorta nearly at a right angle, at least to the tangent of the arch. The intercostals form a right angle with the thoracic aorta; the renal and lumbar arteries form a large acute angle, approaching to right, with the abdominal; and the cœliac comes off nearly in the same manner from the anterior part of the vessel. The internal and external carotids, again, the external and internal iliacs, the branches of the humeral, and those of the femoral, form angles more or less acute with each other. The angle which the spermatics make is, generally speaking, the most acute in the arterial system.

I have already alluded to the structure of the arterial tissue at the divarications. These changes relate both to the inner and to the proper membrane. In the inside of the vessel the inner membrane is folded somewhat so as to form a prominent or elevated point, the disposition of which varies according to the angle of divarication. 1*st*, When this is rectangular, the prominence of the inner membrane is circular, and is equally distinct all round. 2*d*, When the angle is obtuse, as in the mesenteric artery, the prominence is distinct, and resembles a semicircular ridge between the continuation of the trunk and the branch given off, but indistinct on the opposite side where the angle is obtuse. 3*d*, If the angle is acute, and that

[1] Allgemeine Anatomie, seite 575.

[2] "Verum anatome et microscopium omnino fibras longitudinem sequentes nunquam demonstravit, aut mihi, aut aliis ante me scriptoribus, quorum auctoritate meam tueor." (*Elementa Physiologiæ*, lib. ii. sect. 1, § 7.)

[3] Hunter, sect. iv. p. 131.

[4] "Le grand arbre à sang rouge ou l'artériel est presque exclusivement embrassé par la première classe des nerves." (*Anatomie Générale*, tom. i. p. 302.)

[5] H. A. Wrisberg, *De Nervis Arterias Venasque comitantibus*, apud Haller, *Disput. Anatom. Select.* tom. iii.

formed by the branch with the continuation of the trunk is obtuse, the beginning of the artery presents an oblique circle, the elevated half of which is near the heart, the other more remote.

The arrangement of the fibres of the proper tissue is described by Ludwig from the divarication of the iliac arteries, and may be seen in any part of the arterial system where the vessels are large. The circular fibres separating form on each side a half-ring, from which is produced a complete ring, which incloses the smaller rings formed by the circular fibres of the vessel given off. These circular fibres proceed to the prominence of the internal membrane already described, and are arranged round it much in the same manner in which those of the large vessel surround its inner membrane. In this, however, no continuity between the rings of the large vessel and those of the small one can be recognised. The latter are inserted as it were into the former, and they are connected by the continuity of the inner membrane only.

In observing the course or transit of arterial tubes, the principal point deserving notice is the sheltered situation which they generally occupy, their tortuous course, and their mutual communications. In the extremities they are always found towards the interior or least exposed part of the limb, generally deep between muscles, and sometimes lying along bones. When they are minutely subdivided, they enter into the interior of organs, without, however, sinking at once into their intimate substance. In the muscles they are lodged between the fibres; in the brain, in the convolutions; in glands, between their component lobes. In such situations they are generally observed to be more or less tortuous in the course which they follow. On the reasons of this much difference of opinion still prevails. (Bichat and Magendie.)

In the course of the arteries, no circumstance is of greater moment than their mutual communications or inosculations (*anastomoses*). Of this there may be two forms, the first when two equal trunks unite, the second when a large vessel unites with a smaller one. Of the first, three varieties have been mentioned. 1*st*, Two equal trunks may unite at an acute angle to form one vessel. Thus, in the fœtus, the *ductus arteriosus* and the aorta are conjoined; and the two vertebral arteries unite to form the basilar trunk. 2*d*, Two trunks may communicate by a transverse branch, as the two anterior cerebral arteries do in forming the anterior segment of the circle of Willis. 3*d*, Two trunks may, by mutual union, form an arch, from the convexity of which the minute vessels arise, as is seen in the branches of the mesenteric arteries. (Plate XXIX. fig. 4.)

The second mode of inosculation is frequent in the extremities, especially round the joints. The multiplied communications of the arterial system in these regions, though well known to anatomists, and enumerated by Haller, were first clearly and systematically explained by Scarpa, and afterwards by Cooper and Hodgson. The importance of this arrangement, in facilitating the motions of the circulation,—in obviating the effects of local impediment in any vessel or set of vessels,—and in enabling the surgeon to tie an arterial trunk when wounded, affected with aneurism or any other disease,—has been clearly established by these authors. Their researches have shown, that there is not a single vessel which may not be tied with full confidence in the powers of the collateral circulation. Even the aorta has in seventeen instances been found narrowed or obstructed in the human subject, and a ligature has been put on its abdominal portion. (Cooper.)

To ascertain the several modes in which arteries terminate has been a problem of much interest to the physiologist, and of no small difficulty to the anatomist. The alleged terminations, as believed to be established, are minutely and elaborately enumerated by Haller, who, however, multiplied them too much according to the modern acceptation of the term.

1. The first undoubted termination of arteries is immediately in veins. It is unnecessary to adduce in support of this fact the long list of observers enumerated by Haller. It is sufficient to say that it was clearly established by the microscopical observations of Leeuwenhoeck, Cowper, and Baker, by Haller himself, and by Spallanzani in his beautiful experiments on the circulation of the blood.

2. The second termination which may be mentioned here is that into the colourless artery, (*arteria non rubra*). This is sufficiently well established by the phenomena of injections.

3. A third termination which is supposed to exist, but of which no sensible proofs can be given, is that into colourless vessels supposed to open by minute orifices on various membranous surfaces, and therefore termed exhalants. The nature of these vessels shall be considered afterwards.

Haller admits a termination in, or communication with, lymphatic vessels, but allows that it is highly problematical. Partial communications have been traced between arteries and lymphatics by several anatomists; but the point requires to be again submitted to accurate researches.

Another mode of termination, that namely into excreting ducts, admitted by Haller, scarcely requires particular mention. So far as an artery can be said to terminate in such a manner, it would come under the head of that into exhalant vessels. Many of the proofs mentioned by Haller, however, may be shown to be examples of a morbid state of the mucous membranes of these ducts, in which their capillary vessels are disorganized.

In considering the several terminations of arteries, it is not unimportant to advert to the distribution of these vessels. Injections show that they penetrate into every texture and organ of the animal body, excepting one or two substances in which they have never yet been traced. But in different textures they are found in different degrees; and they may vary in extent even in the same texture in two different conditions. The parts which receive the largest and most numerous vascular ramifications are the brain and spinal chord, the glandular organs, the muscles voluntary and involuntary, the mucous membranes, and the skin. In bones, on the contrary, in the fibrous membranes, and their modifications, tendons, and ligaments, and in the serous membranes, few arteries are seen to penetrate; and these are generally minute, sometimes only colourless capillaries. In some textures arteries cannot be traced, though their properties indicate that they must receive vessels of some kind. Such are cartilage and the arachnoid membrane. (Ruysch and Haller.) Lastly, arteries are not found in the scarf-skin, in nails, the enamel of the teeth, the hair, nor in the membranes of the umbilical chord. In early life bones are much more vascular than in adult age; and in the bones of young subjects arteries may be traced going out through the epiphyses into the cartilages, in which they cannot at a later period of life be demonstrated. (*Phil. Trans.* No. 470.)

*Vein, Venous Tissue.* (Φλεψ,—*Vena*,—*Tissu Veneux.*)

Veins.

The structure of the tubular canals, termed veins, has been much less examined by anatomists than that of the arteries. Some incidental observations in the writings of Willis, Glass, and Clifton Wintringham, comprise all that was published regarding them previous to the short ac-

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count of Haller. Since that time they have been described with various degrees of minuteness and accuracy by John Hunter, Bichat, Magendie, Gordon, Marx,[1] and Meckel. In the following account, the facts collected by these observers have been compared with the appearance and visible organization presented by veins in different parts of the human body.

Veins.

The veins are membranous tubes extending between the right side or pulmonary division of the heart and the different organs in which their minute branches are ramified.

Every venous tube greater than one line in diameter consists of three kinds of distinct substance. The outermost is a modification of the filamentous tissue (*membrana cellulosa*), and though less compact and less thick than the arterial filamentous envelope, is in every other respect quite similar, and is in general intimately connected with it. The innermost (*membrana intima*) is a smooth very thin membrane. Between these is found a tunic somewhat thicker, which is termed the *proper venous tissue* (*tunica propria venæ*). The structure and aspect of this proper membrane shall be first considered.

1*st*, When the loose filamentous tissue in which the blood-vessels are inclosed, and the more delicate and firm layer immediately contiguous to the veins, are removed, the observer recognises a red or brown-coloured membrane, not thick or strong, but somewhat tough, which is the outer surface of the proper venous tunic. If dissected clean it is tolerably smooth; but however much so it can be made, a glass of moderate powers, or even a good eye, will perceive numerous filaments adhering to it, which appear to be the residue of the cellular envelope.

According to Bichat, parallel longitudinal fibres, forming a very thin layer, may be distinguished in the larger veins; but he admits, although they are quite real, that they are always difficult to be seen at the first glance. In the trunk of the inferior great vein (*vena cava inferior*), they are always seen, he observes, more distinctly than in that of the superior; and they are always more obvious in the divisions of the former than in those of the latter vessel, and also in the superficial than in the deep-seated veins. These longitudinal fibres, he asserts, are more distinct in the saphena than in the crural vein, which accompanies the artery. Lastly, he remarks, these fibres are proportionally more conspicuous in branches than in trunks. (*Anatomie Générale*, tom. i. p. 399.)

Notwithstanding the apparent correctness of this description, Magendie informs us he has sought in vain for the fibres of the proper venous membrane; and he remarks that, though he has observed very numerous filaments interlacing in all directions, yet these assume the longitudinal and parallel appearance only when the tube is folded longitudinally,—a disposition often seen in the larger veins.

By Meckel, on the contrary, the accuracy of the observation of Bichat is maintained. This anatomist states that he has, by the most minute dissections, assured himself that these fibres are longitudinal; but he admits that they are not uniformly present in all parts of the venous system, and that in degree and abundance they are liable to great variation. He follows Bichat also in representing these fibres as thicker and more distinct in the system of the inferior than in that of the superior *cava*, and in the superficial than in the deep veins.

In the inferior cava of the human subject, certainly, filaments or fibres may be recognised. But instead of being longitudinal, they may be made to assume any direction, according to the manner in which the filamentous tissue is removed. For this reason probably these fibres are to be viewed as part of the filamentous sheath In the saphena vein of the leg oblique fibres may be seen decussating each other; but it is doubtful whether these belong to the proper venous tissue or to the filamentous covering.

The nature of this proper membrane, or venous fibre, as it is sometimes named (Bichat), is not at all known. Its great extensibility, its softness, its want of elasticity in the circular direction, or fragility, its colour and general aspect, distinguish it from the arterial tunic. It possesses some elasticity in the longitudinal direction, and is retracted vigorously when stretched. It possesses considerable resistance, or in common language is tough. The experiments of Clifton Wintringham show that it sustains a considerable weight without breaking, and that this toughness is greater in early life, or in the veins of the young subject, than at a later period.[2] In short, it may be stated as a general fact, that venous tissue, though thinner, possesses greater elasticity and tenacity than arterial tissue. According to the experiments of the same inquirer, this property depends on that of the superior density of the venous tissue; the specific gravity of the matter of the *vena cava* being invariably greater than that of the aorta in the same subject, both in man and in brute animals.

From some experiments Magendie is disposed to consider it of a *fibrinous* character. But it exhibits in the living body no proof of muscular structure or irritable power. When punctured by a sharp instrument, or exposed to the electric or galvanic action, it undergoes no change or sensible motion.

This tunic is wanting in those divisions of the venous system termed *sinuses*, in which its place is supplied by portions of the hard membrane (*dura meninx*).

2*dly*, The inner surface of any vein which has been laid open and well washed is found to be smooth, highly polished, and of a bluish or blue-white colour. This is the inner or free surface of the inner venous membrane (*membrana intima*). It is exceedingly thin, much more so than the corresponding arterial membrane, much more distensible and less fragile. It bears a very tight ligature without giving way as the arterial does; but it also sustains considerable weight, which shows that it is tough and resisting. This is the membrane termed by Bichat *common membrane of dark or modena blood.* According to the views of this anatomist, it forms the inner or free surface, not only of all the venous twigs, branches, and trunks composing this system of vessels, but it is extended from the superior and inferior great veins over the inner surface of the right auricle and ventricle, and thence over that of the pulmonary artery and its divisions; and through this whole tract it is the same in structure and properties.

This doctrine has not yet been controverted. But perhaps it may be doubted, both with regard to the inner arterial membrane, that the inner tunic of the aorta and of the pulmonary veins is quite the same; and in regard to this inner venous membrane, whether that of the veins in general is quite the same with that of the pulmonary artery. The subject demands further research. Meanwhile strong confirmation is found in the interesting remark of Bichat, that the osseous or calcareous depositions which are common in various spots of the inner arterial

[1] *Diatribe Anatomico-physiologica de Structura atque Vita Venarum.* Caroliruhæ, 1819.
[2] *Experimental Inquiry on some parts of the Animal Structure.* London, 1740.

membrane, and especially at the mitral and aortic valves, are never found in the inner venous membrane, or at the tricuspid valve, or in the semilunar valves of the pulmonary artery. Have these depositions been found inside the pulmonary veins, and not inside the pulmonary artery? Ossific deposit in the valves of the pulmonary artery was seen by Bransby Cooper.

The inner or common venous membrane is, however, the most extensive and the most uniform of all the venous tissues. It is the only one which is found in the substance of organs, and is present where the cellular and proper membranes are wanting. This is the case not only with venous branches and minute canals as they issue from the substance of muscles, bones, and such organs as the liver, kidneys, spleen, &c., but is also very remarkably observed with regard to the venous canals of the brain. I have already noticed the absence of the cellular and proper tissues in these tubes; and I have now to remark, that the cerebral veins consist solely of the inner membrane while in the brain or membranes, and when in the sinuses, of this inner membrane, placed between two folds of the *dura mater*. When the jugular vein reaches the temporo-occipital sinuosity, it loses its proper membrane, while its common or inner membrane passes into the hollow of the *dura mater*, called *sinus*, and thus forms the venous canal. This fact is readily demonstrated by slitting open either the lateral or the superior longitudinal sinus, when a thin delicate membrane, quite distinct from the fibrous appearance of the *dura mater*, will be found to line the interior of these canals.

Valves. The inner surface of many veins presents membranous folds projecting obliquely into the cavity of the vessel. These folds, which, from their mechanical office, have been named *valves* (*valvulæ*), are parabolic in shape, have two margins, an attached and free,—and two surfaces, a concave turned to the cardiac end of the vein, and a convex turned in the opposite direction. The attached margin is not straight, as may be imagined, but circular, and adheres to the inner surface of the vessel. The free margin resembles in shape an oblong parabola; and the direction of the valve is such, that a force applied to its convex surface would urge it more closely to the vein, whereas a force applied to the concave surface would either obliterate the circular area of the vessel, tear the valve from the vein, or otherwise meet with resistance.

The size of the valves is variable. In some instances they are sufficiently large to fill the canal of the vessel, and in others they are too small to produce this effect. The obliteration of the circular area of the vessel is most perfect when there are two or three at the same point. Bichat ascribed the variable state of this quality to the dilated or contracted condition of the veins at the moment of death. This, however, is denied by Magendie.

In structure these valvular or parabolic folds are said to consist of a doubling, or two-fold layer of the inner membrane; and with this statement no fact of which we are aware is at variance. A hard prominent line, which generally marks the attachment of their fixed margin to the vein, is asserted by Bichat to consist of the proper venous tissue, the fibres of which, he says, alter their direction for this purpose; and when the common or inner membrane reaches this line, it doubles or folds itself to form the valve, which thus consists of two layers of the inner or common membrane. This, however, is denied by Hunter,[1] who considers them of a tendinous nature, and by Gordon, who made several unsuccessful attempts to split these two layers.[2]

Valves are not uniformly present in all veins. They are found, 1*st*, in the following branches of the superior great vein—the internal jugular, the azygos, the facial veins, those of the arms, &c.; 2*d*, in the following branches of the inferior great vein—the divisions of the posterior iliac, of the femoral, tibial, internal and external saphena, and in the spermatic veins of the male.

They are wanting in the trunk of the inferior great vein (*cava inferior*), in the renal, mesenteric, and other abdominal veins, in the portal vein, in the cerebral sinuses, in the veins of the brain and spinal chord, in the veins of the heart, of the womb generally, and of the ovaries, and perhaps in all other veins less than a line in diameter.[3] In the cerebral sinuses the transverse chords are supposed to supply their place.

In the lungs they were supposed to be wanting, till their presence was established by Mayer of Bonn.

In situation the valves vary considerably. In general they are found in those parts of venous canals at which a small vein opens into a larger. But even from this arrangement there are deviations. The only valve which is definite and invariable in its situation is the Eustachian (*valvula Eustachiana, valvula nobilis*), which is always placed at the cardiac end or beginning of the inferior *cava*, where that vessel is attached to the sinus of the right auricle. Shaped in general like a crescent, the attached margin of which is the arch of a large circle, and the free that of a small one, it proceeds from the left extremity of the sinus downwards, forwards, and towards the left side, where it is insensibly lost on the membrane of the auricular *septum*. At its lower end it generally covers the orifice of the large coronary vein. This membranous production is always larger, more perfect, and more distinct in the fœtus and in the infant, than in the adult. In the latter it is almost always reticulated; and sometimes the only vestige of its existence is a thin chord or two representing its anterior margin. I have seen it reticulated even at the age of sixteen or seventeen, and almost destroyed beyond thirty. Haller was much perplexed to account for the use of this membranous fold.[4] The conjecture of Bichat, that it is connected with some purpose in the fœtal circulation, is entitled to regard.

Dr Gordon mentions a third partial substance, which is occasionally found in local patches at various parts of veins. This I believe to be the deposit found at the union of two veins to form one trunk.

Besides the cellular or filamentous envelope, veins receive capillary arteries, to which there are corresponding veins. The arteries rise from the nearest small ramifying arteries; and the corresponding veins do not terminate in the cavity of the vein to which they belong, but pass off from its body, and join some others from different parts; and at last terminate in the common trunk somewhere higher.[5] Nervous branches, or rather filaments, are observed in the pulmonary artery and great veins only. Are they derived from the great sympathetic, as is generally said?

In the veins, as in the arteries, the anatomist recognises two extremities, the cardiac or collected, and the organic or the ramified. Examined physiologically, however, the terms *origin* and *termination* are not of the same import as when applied to the arteries. In reference to the veins, they become convertible terms; and it is the

[1] x. Of Veins, p. 182.
[2] *Anatomy*, p. 66, 67.
[3] Haller, lib. ii. sect. 2.
[4] Haller *de Valvula Eustachii*. Extat in *Disput. Anatomic. Select.* tom. ii. p. 189.
[5] Hunter, x. Of Veins, p. 181.

usage even of writers on anatomy to represent the veins as arising where the arteries terminate, and terminating at the organ from which the latter arise. This distinction must be kept in view in the following observations.

The cardiac extremity or termination of the veins is so well known as to render any minute explanation unnecessary.

The organic extremity or origin of the venous system is more obscure and difficult to be understood. It is indeed impossible to trace the origin of the small venous vessels, unless in the manner in which Leeuwenhoeck,[1] William Cowper,[2] Henry Baker,[3] Haller, and Spallanzani,[4] did in their observations on the transparent parts of animals in general cold-blooded. From the experiments of these observers, we know that a very small vessel, evidently tending and conveying blood *towards* a larger, connected with a venous branch, may be seen passing directly from a similar small vessel, as evidently conveying blood *from* a larger, which is connected with the arterial system. All that we know from this, however, is, that a vein containing red blood may rise from an artery conveying red blood. This is matter of observation; all beyond is little more than conjectural.

Haller, indeed, admits origins of veins as manifold as the terminations of the arterial system, a view in which he has been followed by almost all subsequent authors; and Bichat states it as a leading proposition, that the veins arise from the general capillary system. Neither conclusion is founded on strict observation; and while that of the former physiologist is derived chiefly from uncertain facts and loose analogies, the statement of the latter is too hypothetical and general to be either entirely true or wholly false.

Of one fact only are we certain. The blood which is conveyed into the small vessels and the substance of the tissues and organs is brought back by the veins. We have seen that the only origin which is strictly susceptible of demonstration is that of the red vein from the red artery. The point then to be ascertained is, whether colourless veins and absorbent veins arise from the several textures, as colourless and exhalant arteries terminate in them. The proper place for the further examination of this question is the subsequent section.

I must not omit to mention, nevertheless, that the veins have been shown to be connected at their ramified extremities with the lymphatics.

When the veins become distinct vessels, branches, and trunks, they become once more objects of sensible examination. In their course from their organic to their cardiac extremities they present various circumstances which merit attention.

1. In general every artery is accompanied by a venous tube, which is divided in the same manner, and furnishes or receives an equal number of branches. Thus the descending aorta is accompanied by the *vena cava inferior;* the common iliac arteries by common iliac veins; the anterior iliac, femoral, and popliteal, by anterior iliac, femoral and popliteal veins. These veins are deep-seated, and are generally named the concomitant veins (*venæ comites vel venæ satellites*). In some situations an artery may be accompanied either in its trunk or in its branches by two veins of equal size. Thus in general the brachial artery, and its branches the radial and ulnar, are each accompanied by two veins. The only situations in which the number of veins can be said to be exactly equal to that of the arteries, are in the stomach, in the intestinal canal, in the spleen, in the kidneys, in the testicles, and in the ovaries.

2. In the extremities and in the external regions of the trunk we find, in addition to the concomitant veins, an external layer of venous tubes immediately beneath the skin, (*venæ subter cutem dispersæ*, Pliny). These subcutaneous or superficial veins do not correspond to any artery; but as they are chiefly destined to convey the blood from the skin and other superficial parts, they open into the deep-seated veins. Thus in the case of the basilic and cephalic, two superficial veins of the arm, the former, after passing the bicipital fascia, forms in the sheath the brachial vein; and becoming the axillary in the axilla, receives the latter vessel. In the same manner the saphena (φλεψ σαφηνης, *vena manifesta*), or superficial vein of the leg, passes through the falciform process of the *fascia lata* to join the femoral vein.

From this it results that the venous canals are on the whole more numerous than the arterial. In a few situations only a single vein corresponds to two arteries, as in the penis, the clitoris, the gall-bladder, and the umbilical chord. Often also in the renal capsules and the kidneys two or more arteries have only one corresponding vein. In such circumstances the vein is always large and capacious.

It has been generally stated that the calibre and area of the venous tubes are much larger than those of the corresponding arteries, and consequently that the capacity of the venous system is much greater than that of the arterial. I acknowledge that I know not on what exact evidence the former of these propositions, the only one with which the anatomist is concerned, is made to rest. If it be mere inspection in the dead subject, or the effects of injection, little doubt can be entertained that the alleged greater calibre depends chiefly on the laxity and distensible nature of the venous fibre. The arterial tubes appear small in consequence of annular contraction, or the tendency which they have to collapse, when the distending force has ceased to operate. The venous canals appear large by reason of their distension and distensibility during life, from the tendency to accumulation in their branches in most kinds of death, except that by hemorrhage, and from a smaller degree of the physical property of shrinking and annular contraction when empty.

When a vascular sheath is exposed in the human subject, as in the operation for aneurism, or in the lower animals in the way of experiment, the vein generally appears larger than the corresponding artery. This, however, is never so considerable as it is represented by most authors, and certainly cannot afford grounds for the estimates which Keill, Jurin, and other mathematical physiologists have assigned to the relative capacity of the arteries and veins. It is also to be observed that something of this greater size depends on the increase of dilatation resulting from removing the pressure of incumbent parts. In young animals also the difference between the size of the veins and their corresponding arteries is so trifling as to be scarcely discernible. This shows that

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[1] *Arcana Naturæ Detecta: Opera Omnia*, tom. ii. p. 160, 168.

[2] *Philosophical Transactions*, No. 280, p. 1179. Cowper saw this communication of arteries and veins not only in cold-blooded animals, as the lizard, tadpole, and fishes, but in the omentum of a young cat and a dog.

[3] *On Microscopes, and the discoveries made thereby.* London, 1785, 2 vols. 8vo.

[4] *Experiments on the Circulation of the Blood*, by Lazaro Spallanzani; translated by W. Hall. London, 1801.

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something is to be ascribed to the incessant operation of a dilating force increasing uniformly with the duration of life.

Upon the whole, it is chiefly on the ground of their larger numerical arrangement that the veins collectively can be said to be more capacious than the arteries. On this subject some observations of Bichat are entitled to attention.[1]

3. The veins in general accompany the arteries. The venous trunk placed contiguous to the arterial in the same sheath, is divided into branches at the same points, and is distributed into the substance of organs much in the same manner. From this arrangement, however, certain deviations are observed in particular regions. Thus, in the brain, neither the internal carotid, nor the basilar artery, nor their large branches, are accompanied with veins. The small branches only have corresponding veins, which, as they unite to form large ones, pour their blood into the venous canals termed sinuses, the arrangement of which is unlike any other part of the venous system. In the chest also a different disposition of the venous from the arterial tubes is observed. The *venæ cavæ*, though conveying the blood to the pulmonic division of the heart, as the aorta conveys it from it, do not, however, correspond with the latter either in situation or in dependent branches. The *azygos* and the *demiazygos* veins, in like manner, which receive the intercostal veins, have no concomitant artery, but open into the superior *cava*, to which they may be viewed as appendages. *Lastly*, The portal vein, which is formed of the united trunks of the splenic, superior mesenteric and inferior mesenteric veins, corresponds to no individual arterial trunk, and forms of itself a peculiar arrangement in the venous system.

Some anatomists have dwelt much on the more superficial and less sheltered situation of the veins than of the arteries. On this point no positive inferences can be established. In the extremities the former are in general most superficial; but in the interior of the body, especially in the chest, the venous trunks are quite as deep-seated as the arterial.

The course of the venous canals is in general more rectilineal and less tortuous than that of the arteries. In no part of the venous system is such an inflection presented as that which the internal carotid makes in the carotic canal. The general result of this is, that a set of venous tubes is shorter than a corresponding set of arterial ones. The trunks also are less inflected than the branches.

4. The mutual communications of the venous system (*anastomoses, inosculationes,*) are more numerous and frequent than those of the arterial. 1. The minute veins communicate so freely as to form a perfect net-work. 2. In the twigs, though more rare, these communications are still frequent. 3. In the branches, though less numerous, they are nevertheless observed; and in this respect alone the venous must be greatly more numerous than the arterial inosculations, which are confined chiefly to the smaller and more remote parts of the system. These inosculations, indeed, between the venous branches constitute one of the most peculiar and important characters of their arrangement, in so far as by their means the communication is maintained between the superficial and deep-seated vessels of the system. Thus the emissary veins are the channel of communication between the cerebral sinuses and the temporal, occipital, and other external veins. The external and internal jugulars communicate by one or two considerable vessels; and the free communication between the basilic and cephalic by the median veins, that between them and the deep brachial vessel, and that between the saphena and its branches and the femoral vein, are sufficiently well known. The application of these anatomical facts to the ready motion of the venous blood is obvious.

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But of all the communications between the branches or large vessels of the venous system, the most important, both anatomically and physiologically, is that maintained by means of the *vena azygos* between the superior and inferior *cavæ*. The azygos itself is connected at its upper or bronchial extremity with the superior *cava*, and at its lower extremity it is in some subjects connected directly with the inferior *cava*, in others by means of the right renal vein, and in most by the first lumbar veins. By means of the *demiazygos*, again, it is connected with the left renal vein, or the lumbars of the same side, and in some instances directly with the inferior *cava*. To the azygos and demiazygos, therefore, belongs the remarkable property of connecting not only the venous canals of the upper and lower divisions, but those of the right and left halves of the body.

### *System of Capillary Vessels,—Terminations of Arteries,—Origins of Veins.*

Though we can scarcely, with propriety, speak of the *capillary tissue*, or the tissue of capillary vessels, we find it requisite to introduce in this place the general facts of the anatomical peculiarities of this important part of the human body.

The term *capillary system*, though much spoken of in physiological and pathological writings, is perhaps not always precisely defined or distinctly understood. According to Bichat, it is not only the common intermediate system between the arteries and veins, but the origin of all the exhalant and excreting vessels.[2] If we consider the modes in which arteries have been said to terminate, and veins to take their origin, we find, that in this view of the capillary system there are some things which are doubtful, and some which are inconsistent with the rest.

Haller, and most of the physiological authorities since his time, concluded, chiefly from the phenomena of injections, sometimes from microscopical observation, and, where these failed, from the obscure and uncertain evidence of analogy, that an artery traced to its last or minute divisions will be found to terminate in one or other of the following modes. 1*st*, Either directly in a red vein or veins; 2*d*, in excreting ducts, as in the lacrymal and salivary glands, the kidney, liver, and pancreas, the female breast, and the testicle of the male; 3*d*, in exhalants, as in the skin, in the membranes of cavities (serous membranes), the cavities of the brain, the chambers of the eye, the filamentous tissue, the adipose cells, the pulmonary vesicles, and mucous surfaces and their follicular glands; 4*th*, in smaller vessels, for instance lymphatics; and, 5*th*, in the colourless artery (*arteria non rubra*).[3]

A similar application of the same facts has assigned to the veins a mode of origin not unlike. If, therefore, we admit the definition given by Bichat, it follows that the capillary system consists, 1*st*, of minute arteries communicating with veins; 2*d*, of excreting ducts; 3*d*, of exhalants; and, 4*th*, of minute arteries or veins containing a colourless portion of the blood. It is obvious, however, that it is absurd to say that the system of capillary vessels at once comprehends and gives origin to the excretories and exhalants. In other respects the whole of

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[1] *Anatomie Générale*, tome i. p. 378.

[2] *Ibid.* vol. i. p. 471. *Système Capillaire*, article 1.

[3] *Elementa Physiologiæ*, lib. i. sect. 1, p. 22–29.

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this theory, for little of it is matter of strict observation, rests on very hypothetical grounds.

Of the different kinds of terminations assigned to arteries, and of origins assigned to veins, one only admits of sensible demonstration. Arteries, when they have so much diminished as to become *capillary*, are seen by the microscope, in some instances by the naked eye, to pass directly into corresponding capillary veins, or to end abruptly in some organ or membrane unconnected with any other vessel.[1] It is likewise certain that the microscope shows every capillary vein to arise from a capillary artery; and if there be any other mode of origin, it has not yet been demonstrated.[2] Only one other circumstance requires to be taken into account in this inquiry. This is, that the capillary artery and vein may contain either red or colourless blood; for, according to the size of the vessels, and the nature of the organs or tissues in which they are distributed, the blood which flows through them will be coloured or colourless. This view of the communication of minute arteries and veins, which is perfectly consistent with the known facts, affords the only explanation which it is possible to give of the singular division of the capillary system which Bichat has chosen.

This author considers the capillary system under three general heads: 1*st*, In organs in which it contains blood only, for instance, in the muscles, the spleen, some parts of the mucous membranes; 2*d*, In organs in which it contains blood and other fluids, for example, in bone, cellular tissue, serous membrane, part of the fibrous system, the skin, the vascular *parietes*, glands, &c.; and 3*d*, In organs in which it contains no blood, the instances of which are, tendon, cartilage, ligament, hair, &c.

Now, it is of little consequence to say that the tissues of the last two divisions contain other fluids than blood, when we are also told that the phenomena of injections, which prove that their capillaries communicate directly with arteries conveying red blood, the effect of irritating applications, mechanical or chemical, and the phenomena of acute or chronic inflammation, show that they may receive and convey red blood. The conclusion of this in common language is, that the capillary arteries and veins of the second order of tissues do not all contain red blood, but that many of them contain a colourless part of that fluid; and that all the capillary arteries and veins of the third order of tissues convey in the natural state colourless blood only. What, then, is the precise idea which ought to be formed of the intermediate system which Bichat conceived to exist between the minute arteries and veins, or what have been termed the venous *radiculæ?*

From the present state of facts it results that nothing more can be admitted to constitute the capillary system than those minute vessels, whether conveying coloured or colourless blood, in which inspection, microscopic observation, and injections show that arterial branches at once terminate, and minute veins (*radiculæ venosæ*) have their origin. It is clear that, physiologically speaking, these vessels can neither be regarded as arteries nor as veins strictly; for the characters on which this distinction is founded are necessarily obliterated in this system of vessels. There is no precise point at which the arterial tissue can be said to terminate, and none at which the venous structure can be said to commence.

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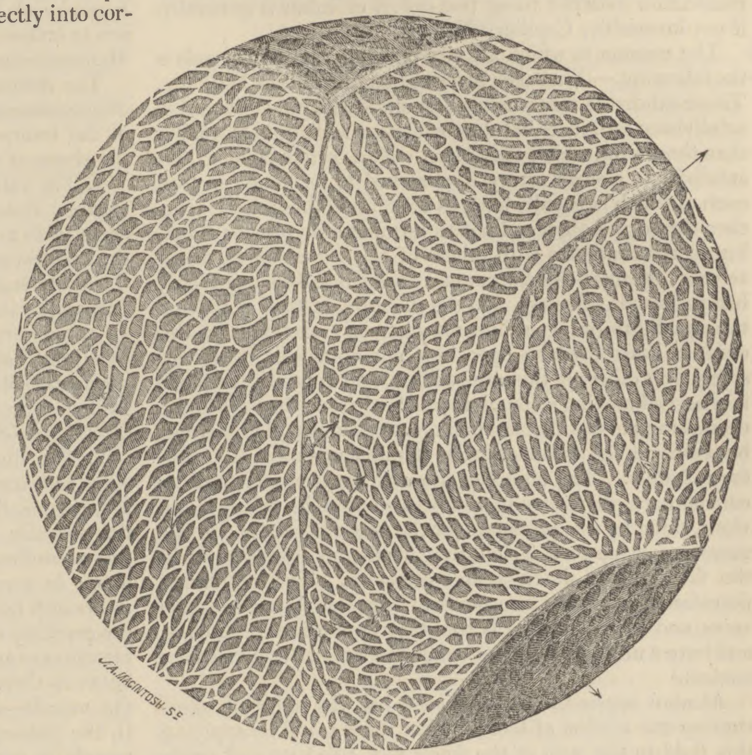
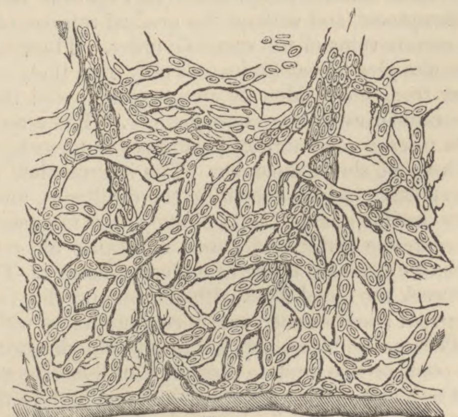
Physical and Anatomical characters of the capillary vessels.

One of the first distinct and intelligible descriptions of the physical characters and arrangement of the capillary vessels was given in 1831 by Dr Marshall Hall, from microscopical observations made on the vessels of the fin and tail of the stickle-back, the web of the frog's foot, the mesentery of the toad, and the lungs of the salamander, frog, and toad.




THE ARTERIES, VEINS, AND INTERVENING CAPILLARY VESSELS AS SEEN IN THE LUNG OF THE TOAD, HIGHLY MAGNIFIED.

In the web of the foot of the frog, the minute arteries are characterized by their straight course and small size, by the light colour and rapid motion of their contents, and by a distinct pulsatory movement, which extends not to the capillaries. The arteries are nearly equal in number to the veins.



CAPILLARIES IN THE WEB OF THE FOOT OF THE FROG (A. THOMSON).

The latter, which first strike the eye, are tortuous, red, and present the most distinct view of the blood moving within their canals in single globules or successive rows. Though Dr Hall could in no instance detect any anastomosis or in-

[1] Gordon, p. 56.

[2] *Ibid.* p. 26.

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Physical and Anatomical characters of the capillary vessels.

osculation between the minute arteries, except in the mesentery of the toad, this arrangement was frequent among the veins, and in the anastomosing branches of two apparent veins a double and contrary current of blood is sometimes observed. In no instance could Dr Hall observe a distinct termination of an artery or a vein, and the medium of communication between these two orders of tubes is generally, if not invariably, Capillary Vessels.

The manner in which arteries pass into capillary vessels is the following.—The large arteries first divide into branches. These subdivide into smaller branches, which by successive subdivision terminate in tubes, which are successively smaller than those from which they issue. At a certain point of this subdivision, a small artery is observed to terminate in two, each of which is equally large as itself; and these vessels further traced are observed not to terminate in smaller tubes, but to communicate with others of the same size as themselves. At this point the course of the blood becomes of only half its former velocity; and the globules, instead of moving too rapidly to be seen, become distinctly visible. To this order of vessels, which open into, and communicate exclusively with others of the same calibre, and in which the blood is observed moving so much more slowly than they did in the decreasing vessels, that the motion of individual globules may be observed, the author restricts the denomination of *Capillary System.* The object of the uniform diameter, and its concomitant phenomenon, retarded motion, he thinks is obvious, since by this arrangement the blood is retained in the vessels of organs, a sufficient time for the accomplishment of the functions of nutrition and secretion. The capillaries, therefore, are situate intermediate between the arteries and veins, and their character is that they form minute cylinders, and have a uniform diameter, while the arteries and veins are conical.[1]

Alcohol applied to these vessels has the effect of interrupting the motion of blood within them; and by applying this fluid to the web of the frog's foot, two layers of capillaries are brought into view; one superficial, in which the motion of the blood is suspended, the other deep-seated, in which it is still moving.

Of the pulmonary capillaries, the arrangement is slightly modified. The division of the minute arteries into capillaries is more immediate, and without those successive subdivisions observed in the arteries of the systemic circulation. On the other hand, the capillaries open into the veins with equal abruptness, and without the gradual reunion observed in the minute veins of the systemic order. These ultimate arteries also give off capillaries, not only from their extremities but from their sides, by minute pores; and the veins receive capillaries in the same manner. The arteries and veins in no case communicate by direct anastomosis, at least in the lung of the salamander. The intermediate vessels, on the contrary, which constitute the capillaries, inosculate in every possible manner, and infinitely more frequently than in the systemic order, and hence constitute an extensive network of cylindrical tubes, of uniform diameter. Through this network the blood flows with extreme rapidity in a uniform current; and as each artery communicates with several capillaries, the blood appears to run like diverging rays from a point or line, and to converge in the same manner, when it proceeds from the capillaries opening into the pulmonary veins. It may be inferred, that one effect of this arrangement is to distribute the moving globules over a surface as extensive as possible, and thus to expose the greatest possible number of them, in a given time, to the inspired air.

This is the distribution of the Capillary Vessels in the lung of the salamander. In the frog and toad, the lungs of which combine the vesicular and cellular arrangement, it is much the same, with this exception, however, that the arteries, previous to their termination in capillaries, follow the external margins of the vertical meshes of which the vesicles consist, while the veins run along their internal margins.

This account applies of course to the capillaries of the Saurial and Batrachoid Reptiles. But there is every reason to believe, that the same arrangement takes place in the Mammiferous class of animals.

The difference of the capillary network depends on three circumstances: 1. The calibre of the tubes; 2. the diameter of the interposed spaces between these tubes; and 3. on the shape of these spaces.

1. The calibre of the tubes varies in different tissues and organs. The smallest are still large enough to allow the blood *corpuscula* to pass one after the other; consequently, in man, the smallest capillaries are not much below 0·003 of one line. This rate is also given by the measurements of Weber from preparations injected and dried in the method of Lieberkuhn. In some parts they vary between 0·004 and 0·003 of one line; and Valentin estimates the smallest vessels of the stomach at 0·0057 in diameter, and in the ileum at 0·0048. Müller represents those of the kidney to range between 0·0037 and 0·0069 of one line.

2. The dimensions of the intervening spaces depend in some measure on the fulness of the tubes. The fuller these are, the smaller are the interstitial spaces. The spaces in the vascular network of the white substance of the brain are, according to C. H. Weber, 0·0142 broad, and 0·025 long; in length, consequently, from eight to ten times, and in breadth from four to six times larger than the diameter of the capillary vessels. In the capillary network of the mucous membranes and the external skin, the meshes are often only between three and four times larger than the diameter of the vessels—often of the same width, or even narrower. In the kidneys, Müller found the diameter of the capillary vessels, in relation to the intervascular spaces, as 1 to between 3 and 4.

3. As to figure, Henle distinguishes two principal shapes; the roundish and the oblong. But besides these, some assume the square figure, others the polygonal, and some are irregular.

Bichat describes two great capillary systems in the human body: 1*st*, The general one, or that which consists of the minute terminations of the aortic divisions, and the origins of the superior and inferior great veins; and, 2*d*, the pulmonary capillary system, or that which consists of the minute terminations of the pulmonary artery, and the origins of the pulmonary veins. The general capillary system further consists of an individual capillary system, not only for every organ, but in some instances for every tissue. The brain possesses an individual capillary system; and that of the membranes is evidently distinct from that belonging to the organ itself. The heart and the kidneys possess each an individual capillary system; and the liver may be said to have two, one formed by the communication of the hepatic artery and veins, and another consisting of the divisions of the portal vein, with the branches of the hepatic hollow vein; (*Vena cava hepatica*).

The organic properties of the capillary vessels are as little known as their structure. Many physiological and pathological writers, especially experimentalists, have ascribed to them a power which has at different times been called muscular, tonic, irritable, contractile; and have asserted that, because the larger arteries are provided with a fibrous membrane, which they have called muscular, and to which they have ascribed irritability, or the power of contraction when stimulated, their minute or

[1] A Critical and Experimental Essay on the Circulation of the Blood, p. 29.

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Capillaries.

capillary terminations must have the same property. This conclusion is completely unfounded for two reasons. 1*st*, I have already shown that the proper arterial tunic is not muscular in structure, and, according to the best experiments, possesses no property of contraction when stimulated. 2*d*, Although it be admitted that the proper arterial tissue is muscular and irritable, it is quite certain that observation has not hitherto shown that this tunic can be recognised in arteries smaller than a line in diameter; and in the capillaries properly so called, that is, in vessels which partake of the nature of artery and vein, no such structure has yet been observed.

It is not improbable, however, that the capillaries possess certain organic or vital properties; but all that has been taught on this subject is either hypothetical or derived from an insufficient and imperfect collection of facts. It is certain that the blood which moves through them is beyond the direct influence of the action of the heart, and can be affected by this only so far as it keeps the larger vessels constantly distended with a column of blood which cannot retrograde, and must therefore move forward in the only direction left to it. It has been therefore argued that the capillaries must have an inherent power of contraction, by which this motion is favoured. Is it not sufficient to say that they act merely as resisting canals, to prevent their contents from escaping, and to minister to the various tissues and organs those supplies of blood which the several processes of nutrition, secretion, &c. require?

The effects which the application of mechanical irritants, or chemical substances, as alcohol, acids, and alkalies, produced in the experiments of Hunter, Wilson Philip, Thomson, and Hastings, have been supposed to demonstrate the irritable nature of the capillary vessels. The conclusion is illegitimate, in so far as the results of these experiments are open to several sources of fallacy. In some instances these effects are to be ascribed to incipient inflammation, in others to shrivelling of the capillary structure, or crispation by chemical action, in others to actual coagulation of the blood of the capillaries; but none of them prove satisfactorily any peculiar properties in the vessels of which the capillary system is composed.

While the views of Reuss, and the experiments of Dutrochet, Wedemeyer, and Kaltenbrunner, render it probable that the capillaries possess some contractile power, they by no means prove that this is adequate to impel the blood through them, independently of the impulse of the heart. According to the hypothesis of Reuss, the arterial system is in a state of positive, and the venous in that of negative, electricity; and by the operation of this agent the blood is made to move from the former class of vessels through the capillaries into the latter. From the experiments of Dutrochet, again, on the transmission of fluids through organic membranes, that author infers that, by means of the inward and outward impulse, or that property which he denominates *Endosmose* and *Exosmose*, the blood flows through the capillaries into the veins. Lastly, Wedemeyer, who further maintains that the impulsive force of the heart is propagated to the capillary system, concludes, from the effects of injecting fluids, both mild and irritative, and from microscopic observation, combined with the effects of mechanical and chemical irritants, that the capillaries possess considerable contractile power, the operation of which is under the influence of galvanism, or nervous energy, or both; but that this, instead of promoting, ought to resist the motion of the blood through them.

*Erectile Tissue.* (*Vasa Erigentia,—Vascula Erectilia,—Tissu Erectile.*)

Erectile vessels.

The system of capillary arteries and veins does not present the same arrangement in all situations and in all the tissues of the human body. A peculiar arrangement of these vessels was early recognised by our countryman William Cowper, who states that he demonstrated the direct communication of arterial and venous canals, not only in the lungs, but in the spleen and penis, "in which," says he, "I have found these communications more open than in other parts."[1] This fact, however, was long overlooked by subsequent anatomists.

Among the terminations of arteries enumerated by Haller, one which he referred to the head of exhalants was that of a red artery or arteries pouring their blood into the spongy or cellular structure of the cavernous bodies of the nipple, the clitoris, and the penis, that of the wattles of the turkey, and the comb of the cock.[2] His detailed examination of those parts shows, that, with a correct knowledge of their anatomical structure, he had not a very distinct conception of the manner in which their vessels are disposed. It was afterwards observed, however, by John Hunter, that the spongy structure of the urethra and glans consists of a plexus of veins.

Bichat remarked that the spleen, and the cavernous body of the penis, instead of presenting, as the serous surfaces, a vascular or capillary net-work, in which the blood oscillates in different directions according to the impulse which it receives, exhibit only spongy or lamellar tissues, still little known in their structure, in which the blood appears often to stagnate instead of moving. As this peculiar structure was known in the cavernous body to be the seat of a motion long known by the name of *erection*, MM. Dupuytren and Richerand distinguished this arrangement of arteries and veins as a peculiar tissue, under the name of *erectile*,—a distinction which, though partly understood before, has only now been admitted as well founded in the writings of anatomical authors. According to the recent arrangements of M. Beclard this tissue comprehends not only the structure of the cavernous body, but that of the spongy substance (*corpus spongiosum*), which incloses the urethra, and forms its two extremities, the bulb and gland, the *clitoris*, the *nymphæ*, and the nipple of the female, the structure of the spleen in both sexes, and even that of the lips.[3]

It is unfortunate that the researches of anatomists on this erectile tissue have been restricted chiefly to the spongy body of the urethra and the cavernous body of the penis; and it is rather by analogy than direct proof that similarity of structure between them and the other parts referred to the same head is maintained. I shall here state what is ascertained.

The cavernous body of the urethra, or what is now termed its *spongy body*,[4] is represented by Haller to consist of fibres and plates issuing from the inner surface of the containing membrane, and mutually interlacing, so as to form a series of communicating cells,[5] into which the

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[1] *Philosophical Transactions*, No. 285, p. 1386.

[2] *Elementa Physiologiæ*, lib. ii. sect. 1, § 24.

[3] *Additions à l'Anatomie Générale de Xav. Bichat*, par P. A. Beclard, p. 118.

[4] Haller applies the name of *cavernous body* not only to the structure of the penis, but to that of the urethra. (*Elementa Physiologiæ*, lib. xxvii. sect. 1.)

[5] *Ibid.* lib. xxvii. sect. 1, § 33.

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proper urethral arteries pour their blood directly during the state of erection.[1]

The cavernous body of the penis is in like manner represented to be a part of a spongy nature, or to consist of innumerable sacs or cells separated by plates and fibres, which at the moment of erection are distended with blood poured from the arteries, and which is afterwards removed by some absorbing power of the veins.

This opinion, which was that of many subsequent anatomists, even Bichat himself,[2] was derived apparently from the facility with which the blood so deposited escapes, not, as it was believed, from divided vessels, but from *areolæ*, or interlaminar spaces. It appears, however, to have been at variance with what had been anciently taught by Vesalius, Ingrassias, and Malpighi, and positively stated regarding these vessels by Hunter; and modern researches have shown it to be completely erroneous. Cuvier and Ribes in France, Mascagni, Paul Farnese, Moreschi in Italy, and Tiedemann in Germany, have shown that there are no cells or spongiform structure in the erectile tissue of the cavernous body.

The first correct view of the structure of parts of this description in the human subject was given by Mascagni in his account of the arterial and venous communications in the spongy body of the urethra. In 1787 he announced in his work on the Lymphatics, that the parts called cavernous bodies, both in the *penis* and in the *clitoris*, are simply *fasciculi*, or accumulations of arterial and venous vessels without interruption of canal; but that between the arteries and veins of the spongy bodies a dilated cavity or minute cell is interposed. In 1795 repeated minute injections led him to doubt the existence of this sort of cell; and about the close of 1805 he publicly demonstrated the fact, that many veins of considerable calibre, collected in the manner of a plexus, with corresponding arteries, but small and less numerous, really form the outer and inner membranes of the urethra, the whole of the *glans penis*, and the whole substance of the spongy body. In each of these parts, and also in the spongy structure inclosing the orifice of the vagina, he ascertained by repeated injections that there are no cells, as was imagined, and that the arteries, reflected as it were, give origin to numerous veins,[3] which, forming an intimate plexiform net-work, constitute the whole glans, and the entire vascular body which surrounds the urethra and the entrance of the vagina.

In the cavernous bodies of the penis and clitoris he had not sufficient facts to ascertain the existence of the same structure, as he had never succeeded in injecting these parts so completely as the *glans* and the spongy part of the urethra. Eventually, however, he succeeded, especially in children, in injecting fully these cavernous bodies of the penis and clitoris. He found in their interior nothing but *fasciculi* of veins, with corresponding arteries, but rather smaller. He inferred, therefore, that these vessels, collected and ramified in various directions, constitute a vascular texture capable of expanding and shrinking, according to the quantity of blood conveyed to it.[4]

The general accuracy of this description has been since confirmed by the researches of Paul Farnese and Moreschi. The latter, especially, has shown, 1*st*, that the glans consists of arteries and a very great number of minute veins, which pour their blood into the cutaneous dorsal vein; 2*d*, that the urethra, and especially its posterior part, may in like manner be shown to consist of numerous minute veins, which terminate in a posterior branch of the dorsal vein, and communicate with the veins of the bulbous portion of the urethra; and, 3*d*, that in the cavernous bodies, though also receiving blood-vessels, these are much less numerous, and are chiefly derived from the urethral vessels.[5]

The same arrangement was recognised by Cuvier in the penis of the elephant, by Tiedemann in that of the horse, by Shaw in the human subject and in the horse,[6] and by Mr Houston in the tongue of the chameleon.[7]

Upon the whole, the facts collected by different anatomists on this subject furnish the following results.

If the arteries, on the one hand, be injected, they are found to terminate in very fine ramifications, the disposition of which is exactly the same as in other parts. If, on the other, the veins be injected, it is easy to perceive the two following circumstances: 1*st*, That they are much dilated at their origin, that is, that the venous *radiculæ* are really more dilated than might be anticipated from the other characters of these vessels; 2*d*, That the tubular dilatations to which they are accessory form very numerous inosculations or anastomoses, precisely as the capillary system of which they constitute a part. The effect of this arrangement is to give these vessels the appearance of being penetrated with sieve-like openings, resembling *areolæ*, or interlaminar spaces mutually communicating. As the whole difference, therefore, between the capillary vessels of this and other parts of the human frame consists in the minute veins (*radiculæ venosæ*) being dilated or distended in a peculiar manner, Beclard concludes that the erectile tissue of the cavernous body consists simply of minute arteries and dilatable veins interwoven in the manner of capillary nets. These distended venous cavities are indeed so remote from being cells, that they are truly continuous with veins, the inner membrane of which may be easily recognised among them.[8]

During erection the blood accumulates in this tissue; but the cause and mechanism of this accumulation are completely unknown.

Since these observations were made, Johann Müller of Berlin has, by injecting the arteries of the penis, been enabled to give an account of the characters of Erectile vessels, something more detailed and specific.

By injecting the principal artery of the penis before its subdivision, and dividing longitudinally one of the *corpora cavernosa*, the ramifications of the nutrient arteries are seen upon the inner side of the venous spaces, the arteries becoming gradually smaller, until they pass into the capillary net-work, where their divisions cannot be seen by the naked eye. Besides these nutrient ramified arteries there is seen, on careful inspection, another set of arterial branches, of

[1] "Sed et in pene, et in clitoride, et in papilla mammæ, et in collo galli indici, nimis manifestum est, verum sanguinem effundi, neque unquam ejus color totus de iis partibus evanescit, quæ ab effuso sanguine turgere solent." (*Elementa*, lib. xxvii. sect. 3, § 10.)

[2] *Système Absorbant*, sect. 3, p. 598.

[3] "Le arterie vi si ritorcono, e danno origine alle vene, e queste formano in seguito alcuni plessi, i quali accumulati in varia maniera, costituiscono tutto il glande, e tutta quella massa vascolare, che trovasi intorno al canale dell' uretra, e all' ingresso della vagina." (*Prodromo della Grande Anatomia di Paolo Mascagni*, capitolo ii. p. 61. Firenze, 1819, folio.)

[4] *Prodromo del Paolo Mascagni*, loco citato, p. 61.

[5] *Commentarium de Urethræ Corporis Glandisque Structura 6to idus Decembris* 1810 *detecta*, Alexandri Moreschii, Eq. Coron. Ferreæ, in Ticinensi primum, tum Bononiensi Archigymnasio Anatomes Professoris. Mediolani, 1817.

[6] *Medico-Chirurg. Trans.* vol. x. p. 338, 353. London, 1819.

[7] *Trans. of Royal Irish Academy*, 1828.

[8] *Additions*, p. 119.

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different size, shape, and disposition, which are given off nearly at right angles, from both the large and small trunks. These arterial processes are about one-hundredth part of one inch in diameter, and one-twelfth long, and are clearly seen by the naked eye. They project into the cavities of the spongy substance, and terminate either in blunt extremities or in dilated extremities, without undergoing any division or ramification. These short arterial processes are turned round at their extremities into a semicircle or more, and present a spiral appearance like the end of a cork-screw. This disposition suggested to M. Müller the name of Helicine, or Spiral or Screw-like Arteries (*Arteriæ Helicinæ*).[1]

The helicine arteries of the penis are more easily seen in man than in any other animal examined by Professor Müller. He found them in all the animals in which he sought for them; they are to be seen at the posterior part only of the penis in the stallion, but in the dog exist throughout the whole organ.

In man the helicine twigs of the penal arteries sometimes come off singly; at other times they form tufts or clusters, consisting of from three to ten branches, and having in general one very short common stem. The swelling at the extremity, when present, is gradual, and is greatest a little way from the end. The helicine branchlets given off from large arteries are not of greater size than those coming from small ones; and even the smallest capillary arteries of the *Profunda Penis*, which can be seen with the aid of a glass alone, give off helicine twigs of a much greater size than themselves.

Each helicine branchlet projecting into a venous cavity is covered by a thin membrane, which Professor Müller regards as the inner coat of the dilated vein; and when there is a tuft of helicine twigs, the whole tuft is covered with one envelope of a gauze-like membrane. This covering is considerably thicker on the helicine arteries in the posterior part of the *Corpus Spongiosum Urethræ*, than in the *Corpus Cavernosum;* but it is possible that this is in some measure connected with the state of repletion of the arteries; for when the injection has gone well, it becomes difficult to distinguish the external covering.

Professor Müller could not discover any apertures either on the sides or on the ends of the helicine arteries. But he seems to regard it as probable that there are minute apertures, which may be of that nature that they allow the passage of the blood in certain states and not in others.

The helicine arteries are not, as some may suppose, loops of vessels which have been incompletely filled, and which, after forming a coil, pass into venous spaces, as E. H. Weber found to be the case with the arteries of the maternal portion of the placenta. Müller, it is seen, distinguishes in the branches from the *Arteria Profunda*, p. 800, two orders of vessels; one *Rami Nutritii*, corresponding to the arteries of other organs which serve the purpose of nutrition, and pass continuously into the veins; the others, *Rami Helicini*, with shut ends, forming processes or shoots from the *Arteria Profunda*, bent in the manner of tendrils which project into the cells or spaces of the *Corpora Cavernosa*, and, according to the conjecture of Müller, pour the blood during erection through openings in their ends immediately into the spaces of the *Corpora Cavernosa.* Their diameter is between 0·07 and 0·08 of one line.

The helicine arteries are more numerous towards the root than near the point of the penis. They are observed in the *Corpus Spongiosum Urethræ*, especially towards its bulb; but they are not there so easily seen as in the *Corpora Cavernosa.* They have not hitherto been observed in the *Glans.*

Their structure is nearly the same in all the animals in which they have been examined. The helicine arteries of the ape bear the nearest resemblance to those of man; and in most animals they are less obvious than in the human subject. In the horse and dog, they give off from their sides small nutrient twigs, which render them more difficult to be seen in these animals than in man.

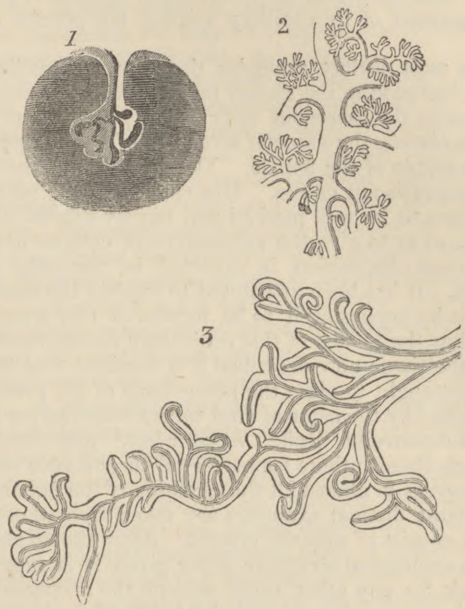


Fig. 1. One single Helicine Artery (Müller).
... 2. A portion of the *Arteria Profunda Penis* in Man, with the Helicine Arteries magnified.
... 3. Individual Helicine Arteries from the posterior part of the *Corpus Cavernosum Urethræ* in man; greatly magnified.

These helicine arteries, on the other hand, Valentin regards as artificial, that is, resulting from the mode of injection.[2] It is impossible here to enter into the details of his arguments. It is sufficient to say that Müller, after repeated researches, adheres to his original views; that Krause confirms his inference;[3] and that Hyrtl saw helicine arteries not only in the penis of man and the horse, but also an analogous formation in the wattles of the throat and head of the turkey-cock.[4] Henle thinks it undoubted that the greatest part of the tendril-shaped appendages of arteries, which at first sight appear entirely like the helicine arteries delineated by Müller, are artificial products. He makes, however, an admission that there may be some genuine or true helicine arteries.[5]

The spleen, M. Beclard thinks, may be said to resemble the cavernous body both in structure and phenomena; and he considers it as at once consisting of erectile tissue, and to be the seat of a species of erection more or less similar to that of the cavernous body. This organ, he argues, becomes the occasional seat of a motion of expansion and contraction; and he adduces the three following conditions in which it takes place. 1*st*, In experiments; when in a living animal the course of the blood in the splenic vein is arrested, the spleen swells, but returns to its former dimensions as soon as the circulation is restored. 2*d*, In diseases; the paroxysms of intermittent fever are

[1] Ueber die Arteriæ Helicinæ, von Johann Müller. Archiv fur Anatomie und Physiologie, Heft II., 1835.
[2] Müller's Archiv fur Anatomie und Physiologie, 1838. Seite 182.
[3] Muller's Archiv, 1837. Seite 31.
[4] Oesterreichen Jahrbuch, 1838, xix. 349.
[5] Allgemeine Anatomie. Seite 486. Leipzig, 1841.

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accompanied with obvious enlargement of this organ, which subsides at the conclusion of the paroxysm. 3*d*, It appears that the same phenomenon takes place during digestion.

Sir Everard Home, with the assistance of the microscopic inspection of M. Bauer, has made many observations on the structure of this organ. But his purpose appears to have been more particularly directed to ascertain the phenomena of its function and uses; and I cannot discover that his ideas on its intimate structure, and the arrangement of its capillary system, are precise or distinct.

The most distinct examples, therefore, of erectile tissue are to be found in the spongy texture which surrounds the *urethra*, in the cavernous body of the *penis*, in the vessels of the *clitoris*, the vascular structure of the *nymphæ*, and in the nipple of the female. The structure of the lips in both sexes is not unlike. The veins of these parts may be shown to be well marked and largely dilated at their origin, so as to give the appearance of cellular net-work. The same disposition is observed in the pulp of the fingers. It has been attempted to explain the motions of the iris by supposing it to be formed of this erectile tissue; but the justice of this conjecture seems doubtful.

In the tissue now described it is manifest that the physiologist ought to place the phenomena of the process distinguished by the name of vital turgescence (*turgor vitalis*) by Hebenstreit,[1] Reil,[2] Ackermann,[3] and Schlosser.[4] Though these authors suppose vital turgescence in different degrees in almost all the textures of the animal body, their most distinct examples are taken from those parts which consist of erectile vessels. After the explanation of the anatomical structure above given, it is superfluous to seek for any other cause except the arrangement of the minute vessels, and especially that of the veins.

*System of Exhalants, Exhalant System. (Vasa Exhalantia,—Système Exhalant.)*

Exhalants.

Are there such vessels as the exhalants described by physiological authors? Is their existence proved by observation or inspection? If not, what are the proofs from which their existence has been inferred?

The existence of minute arteries, the open extremities of which are believed to pour out various fluids in different tissues of the human body, has long been a favourite speculation with physiological anatomists. The decreasing vessels (*vasculorum continuo decrescentium multi sibique succedentes ordines*[5]), and exhalant orifices of Boerhaave, must be known to almost all. Haller ascribes to the skin, membranes of cavities (*serous membranes*), ventricles of the brain, the chambers of the eye, the cells of the adipose membrane, the vesicles of the lung, the cavity of the stomach and intestines, an abundant supply of these exhalant arteries or canals, which, according to him, pour out a thin, aqueous, jelly-like fluid, which in disease, or after death, is converted into a watery fluid susceptible of coagulation. The existence of these vessels, he conceives, is established by the watery exudation which appears in these several parts after a good injection of the arteries.[6]

As these minute canals, however, through which this injected fluid is believed to percolate, have never been seen, or rendered capable of actual inspection, their existence was denied by Mascagni, who ascribed the phenomena of exhalation to the presence of inorganic pores in the arterial parietes, through which, he imagined, the fluids transuded to the membranes or organs in which they were found. This mechanism, which was equally invisible with the Hallerian, was, for obvious reasons, denied by Bichat, who resolved to reject every opinion not founded on anatomical observation, and to determine the existence of the exhalants by this evidence alone. Obliged, however, to avow the difficulty of forming a distinct idea of a system of vessels, the extreme tenuity of which prevents them from being seen, he undertook to attain his object by what he terms a rigorous train of reasoning.

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This consists in the effects observed to result from successful injections of watery fluids, or of spirit of turpentine containing some finely levigated colouring matter; from the phenomena of active hemorrhage, which Bichat considers merely as exhalation of blood instead of serous fluid; and from numerous considerations unfolded in the further prosecution of the subject. In this manner he concludes, that the only points ascertained are, 1*st*, the existence of exhalants; 2*d*, their origin in the capillary system of the part in which they are distributed; and, 3*d*, their termination on the surfaces of serous and mucous membranes, and the outer surface of the corion or true skin.

The exhalant vessels, the existence, origin, and termination of which he thus proved, he distinguished into three classes. The first contains those exhalants which are concerned in the production of the fluids which are immediately removed from the body,—the cutaneous and the mucous exhalants; the second contains those exhalants which are employed in the formation of fluids which, continuing a given time on various membranous surfaces, are believed to be finally taken again into the circulation by means of absorption; and the third class consists of the exhalants concerned in the process of depositing nutritious matter in the different tissues and organs of the human frame. This arrangement is more distinctly seen in the following table.

| | | |
|---|---|---|
| Exhalants may be, | 1. Exterior, opening on natural surfaces or canals........................................ | Cutaneous.<br>Mucous. |
| | 2. Interior, opening on membranes, or within cellular textures............................ | Serous.<br>Synovial.<br>Cellular.<br>Medullary. |
| | 3. Nutritious. | |

Each organic tissue is in this system supposed to have its appropriate exhalant arteries, from which it derives the material requisite for its nutrition.

The clearness and regularity of this arrangement would render it desirable that the existence of these vessels were demonstrated with certainty. It is evident, however, that the regularity of arrangement is the only advantage which it possesses over the views of those authors whose method and opinions Bichat professed not to follow. The existence of exhalants is as little proved

[1] *Brevis Expositio Doctrinæ Physiologicæ de Turgore Vitali*, 1795. Ab Ernesto B. G. Hebenstreit, M.D. &c. Extat in Brera *Sylloge Opusculorum*, vol. ii. opusc. vi.

[2] *Archiv. fur die Physiologie*, i. band, 2. heft, s. 172.

[3] Ackermann, *Physische Darstellung der Lebenscraft*, 1797, i. band, s. 11.

[4] Georgii Eduardi Schlosser *Dissertatio de Turgore Vitali*. Extat in Brera *Sylloge*, vol. vii. opusc. ii.

[5] Haller, *Elementa*, lib. ii. sect. 1, and his notes on Boerhaave, *Prælectiones*, tom. ii. p. 245.

[6] "Aqueum humorem de arteriis perinde exhalare, olei terebinthinæ aliorumve pigmentorum, et vivi argenti iter persuadet, quod anatomica manu impulsum, aut omnino vivo in homine a consuetis naturæ viribus eo deductum, in ejus humoris, quam vocant, cameram depluit." (*Elementa*, lib. vii. sect. 2, § 1.)

General Anatomy. Exhalants. in the rigorous reasoning of Bichat as in the fanciful theories of Boerhaave, the generalizing conclusions of Haller, or the bold supposition of lateral porosities by Mascagni. This defect in his system has therefore been recognised both by Magendie and Beclard, the first of whom, though he admits the existence of exhalation as a process of the living body, allows that no explanation of its mechanism or material cause has been given, and asserts that Bichat has created the system of vessels termed exhalants; while the second thinks that anatomical observation furnishes no evidence of their existence.

The colourless capillaries, he observes, which are admitted by all, and the existence of which is satisfactorily established by the well-known experiment of Bleuland, proves nothing whatever concerning the existence of exhalant vessels; for these colourless arteries are observed to terminate in colourless veins, and there is no proof hitherto adduced of their proceeding further, or terminating by open mouths. He admits that the fact of exhalations in the living body, of nutrition, of transudation by arterial extremities, shows that these extremities possess openings through which the fluids of exhalation, the materials of nutrition, and the matter of injection, escape. But whether these openings are found at the point at which the capillary arteries are continuous with veins, or belong to a distinct order of vessels continued beyond these arteries, is a question which observation has not yet determined, and which it perhaps is unable to determine. Such is the present state of knowledge in relation to the existence of exhalant arteries. While the process of exhalation is admitted, we must avow, as Cruikshank did long ago, that we are unable to prove satisfactorily the existence of any set of vessels, or any mechanism by which it might be accomplished.

*Lymphatic System.* (*Vasa Lymphatica, Vasa Lymphifera, Lymphæ-Ductus* of Glisson and Jolyffe,—*Systême Absorbant,—Die Saugadern.*)

Lymphatics. In most situations of the human body, and especially in the vicinity of arterial and venous trunks, there are found long, slender, hollow tubes, pellucid or reddish, which present numerous knots, joints, or swellings in their course, and to which the name of lymphatics or absorbents has been given. It is most expedient to employ the former appellation only, as the latter implies the performance of a function, the reality of which has been much questioned of late years.

Though Eustachius had seen the thoracic duct in the horse, and some slight traces of a knowledge of vascular tubes, different either from arteries or veins, are found in the writings of Nicolaus Massa, Fallopius, and Veslingius, the merit of establishing their existence is generally ascribed to Caspar Asellius, a physician of Pavia. This anatomist, who had in 1622 seen the white-coloured tubes, then first named *lacteals*, issuing from the intestines of the dog, observed also a cluster of vessels less opaque near the portal eminences of the liver,—an observation which he afterwards repeated in the horse and other quadrupeds. The same vessels were also described and delineated by Highmore.

Passing over the uncertain and obscure hints given by Walæus and Van Horne, the first exact information after Asellius is that which relates to Olaus Rudbeck, who, in 1650, is said to have seen them in a calf, and to have demonstrated the thoracic duct, and the dilated sac, afterwards termed *receptaculum chyli*.

Glisson informs us that Jolyffe had in 1652 imparted to him the knowledge of a set of vessels different from arteries and veins; and it appears, from the testimony of Wharton, that Jolyffe had demonstrated these vessels in 1650.[1] In short, the discovery of lymphatics, and the correction of some errors of Asellius, are ascribed to the English anatomist, not only by Wharton and Glisson, but by Charleton, Plott, Wotton, and Boyle.

The existence of these vessels, thus partially demonstrated, was afterwards more fully established by the researches of Bartholin, Pecquet, Bilsius, Nuck, the second Monro, and Haller. It is chiefly to the exertions of William Hunter, and his pupils Hewson,[2] Sheldon,[3] and Cruikshank,[4] in this country, and to those of Mascagni[5] in Italy, that the anatomical world are indebted for the complete examination and history of this system of vessels.

The lymphatic vessels consist, in the members, of two layers, a superficial and a deep-seated one. The first is situate in the subcutaneous cellular tissue, between the skin and the aponeurotic sheaths, and accompanies the subcutaneous veins, or creeps in the intervals between them. A successful injection of these superficial lymphatics will show an extensive net-work of mercurial tubes surrounding the whole limb.

The deep-seated layer of lymphatics is found chiefly in the intervals between the muscles, and along the course of the arterial and venous trunks. In tracing both layers of lymphatics to the upper, fixed, or attached end of the members, we find they increase in volume and diminish in number. At the connection of the members with the trunk, they are observed to pass through certain spheroidal or spherical bodies, termed lymphatic glands or ganglions. The lymphatics of the upper extremity, after passing through the glands of the armpit, terminate in trunks, which open into the subclavio-jugular veins, one on each side of the neck. Those of the lower extremity, after passing through the glands of the groin, proceed with the common iliac vein into the abdomen, where they unite with other lymphatics.

The lymphatics of the trunk consist in like manner of two layers, a subcutaneous and deeper seated one, distributed in the chest between the muscles and pleura, and in the abdomen between the muscles and peritoneum. In the chest and belly, each organ possesses a superficial layer of lymphatics distributed over its surface, and pertaining to its membranous envelope; the other ramifying through its surface, and pertaining to the peculiar tissue of the organ. This twofold arrangement is most easily seen in the lungs, the heart, the liver, spleen, and kidneys.

In a similar manner are arranged the lymphatics in the external parts of the scull; on the face, where they are very numerous; in the spaces between the muscles; and on the neck, in which they pass through numerous glands. No lymphatics, however, have been found in the brain, the spinal chord, their membranous envelopes, the eye, or the ear.

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1 Francisci Glissonii *Anatomia Hepatis*, cap. xxxi.; Thomæ Wharton *Adenographia*, cap. ii. p. 98.
2 *Experimental Inquiries*, Part the Second; by William Hewson, F. R. S. London, 1774, 8vo.
3 *The History of the Absorbent System*, &c. by John Sheldon, surgeon, F. R. S. &c. London, 1784, folio.
4 *The Anatomy of the Absorbing Vessels of the Human Body*, by William Cruikshank. London, 1786, 4to.
5 Pauli Mascagni *Vasorum Lymphaticorum Corporis Humani Historia et Ichnographia*. Paris, 1787, folio. See also *Prodromo*, &c. capitolo i.

General Anatomy.

Lymphatics.

All the lymphatics hitherto known terminate in two principal trunks. One of these, termed from its site *thoracic duct* (*ductus thoracicus*, die Milchbruströhre, *le canal thoracique*), is situate on the left side of the dorsal vertebræ. It receives the lymphatics of the lower extremities, of the belly, and the parts contained in it; those of great part of the chest, and those of the left side of the head, neck, and trunk, and left upper extremity. The other lymphatic trunk, which is situate on the right side of the upper dorsal vertebræ, is formed by the union of the lymphatics of the right side of the head, neck, right upper extremity, and some of those of the chest. Both of these trunks open into the subclavio-jugular vein of each side.

That lymphatics terminate in branches of the venous system, has been asserted on the authority of various observers. Steno, for instance, states that he traced the lymphatics from the right side of the head, the chest, and pectoral extremity, in animals, into the right axillary vein; and he gives delineations of anastomotic connections of several lymphatics with the axillary and jugular veins. Similar facts have been reported by Nuck, Richard Hale, Bartholin, and Hartmann. Ruysch traced the lymphatics of the lung into the subclavian and axillary veins; Drelincourt those of the thymus gland in animals into the subclavians; and Hebenstreit saw those of the loins pass into the *vena azygos*.

Haller, though unwilling to deny the testimony of these observers, considers it liable to various sources of fallacy, and doubts the direct communication of the lymphatic and venous systems. By John F. Meckel the grandfather, nevertheless, this communication was maintained, from the circumstance that he found mercury injected into the lymphatics pass into the veins without any traces of extravasation. From injecting the lymphatics also he found the *inferior* cava full of mercury, not a particle of which had passed by the thoracic duct into the *superior* cava. Injecting afterwards an indurated lumbar gland from a pelvic lymphatic, when he found its lower half only was filled, he increased the pressure, with the view of filling the minute vessels of the gland. When this was continued a little, he observed the fluid metal pass into the *inferior* cava, and thus traced the minute lymphatics into the venous system.[1]

These facts have received too little attention, from the circumstance that Hewson, though not doubting them as stated by the author, regarded them as liable to considerable fallacy, and, along with William Hunter, imputed the effect in question entirely to extravasation. Both Hunter and Hewson, indeed, appear to have injected veins from lymphatics in the same manner in which Meckel did; but both saw reason to infer that extravasation had taken place. Cruikshank, again, states that he never saw a lymphatic vessel inserted into any other red veins than the subclavians and jugulars. The termination remarked by Steno and his successors constitutes in truth the common trunk or lymphatic vein admitted by Cruikshank,—a *thoracic duct* of the right side.

Recently this mode of termination has been revived by Tiedemann and Fohmann,[2] who state that, in the seal, the lactiferous vessels communicate with veins arising from the mesenteric glands, and pass thence into the venous trunks without proceeding through the thoracic duct. M. Lauth junior, of Strasburg, again, conceives that he has demonstrated that lymphatics communicate with veins within the substance of organs, and in the interior of the lymphatic glands;[3] an inference which at present requires further verification. The statements of Lippi of Florence,[4] that every lymphatic almost communicates freely with venous tubes, is still more improbable, and has been rendered exceedingly doubtful by the recent researches of Rossi.[5]

The connections of the ends of lymphatics with the organs and tissues from which they arise, termed their *origins*, are completely unknown. In some favourable instances the lymphatics of the intestinal canal are so filled with a reddish or whitish fluid after the process of digestion has continued for some time, that not only are their larger branches easily seen, but by the aid of the microscope some of the smaller may be traced to their commencement. This, which was ascertained by Cruikshank (p. 55 and 58), and confirmed by Hewson, Bleuland, and Hedwig, has been contradicted by the observations of Rudolphi and Albert Meckel. In all other parts, however, though a successful injection may show the course and distribution of many of the smallest lymphatics, yet no orifices are perceptible at the point at which they seem to stop, and we are uncertain whether these points are their origins. (Cruikshank.) Mere observation is here as unavailing as in regard to the termination of exhalants. The continuation of lymphatics with arteries, unless in the case of those which arise from the interior of arterial tubes (Lauth), is not satisfactorily established. It has been conjectured, however, that their ends or imperceptible origins are connected to the tissues to which they are traced, and that the lymphatics arise in this manner from these tissues.

The lymphatics are distinguished by being in general cylindrical in figure, and by varying in calibre at short spaces. In this respect they differ from the arteries and veins. It has been further justly remarked by Gordon, that the middle-sized lymphatics are remarkably distinguished from the corresponding parts of the arterial and venous system by three peculiarities: 1*st*, When two lymphatics unite to form a third, the trunk thus formed is seldom or never larger than either of them separately; 2*dly*, their anastomoses with each other are continual; and, 3*dly*, they seldom go a great space without first dividing into branches, and then reuniting into trunks.

The outer surface of a lymphatic is filamentous and rough, the inner smooth and polished, like that of small veins. It is impossible to observe the structure of these tubes in the middle-sized, or even in the large lymphatics; and anatomists have generally been satisfied with supposing that the structure of all of them is similar to that of the thoracic duct, or some other large vessels equally susceptible of examination. According to the observations of Cruikshank (chap. xii.), which have been verified by Bichat, the thoracic duct presents, 1*st*, a layer of dense, firm, filamentous or cellular tissue, exactly similar to that found inclosing arterial and venous tubes, which the latter regards as foreign to the vessel, but giving it a great degree of support and protection; 2*dly*, a proper membrane, delicate, transparent, and moistened inside by an unctuous fluid, which he seems inclined to

[1] *Nova Experimenta et Observationes de finibus Venarum ac Vasorum Lymphaticorum*, sect. 1, p. 4. Lugd. Bat. 1772.

[2] *Anatomische Untersuchungen uber die Verbindung der Saugadern mit den Venen.* Heidelberg, 1821.

[3] *Essai sur les Vaisseaux Lymphatiques.* Strasbourg, 1824.

[4] *Illustrazioni Fisiologiche e Patologiche del Sistema Linfatico-Chilifero mediante la scoperta di un gran numero di communicazioni di esso col venoso del* Professore Regolo Lippi. Firenze, 1825.

[5] Cenni sulla communicazione dei vasi linfatici colle vene. di Giovanni Rossi, Doctore, &c. . *Annali Universali di Medicina*, anno 1826, vol. xxxvii. p. 52.

ascribe to transudation. Muscular fibres, of which Sheldon speaks positively, Cruikshank represents, though seen in some instances (chap. xii.), yet to be more generally not demonstrable. Their existence, though admitted by Schreger and Soemmering, is denied by Mascagni, Rudolphi, and J. F. Meckel, and, I may add, by Bichat and Beclard. This account differs not much from that of Dr Gordon, who could not recognise distinctly more than one coat, similar to the inner coat of veins. The filamentous layer noticed by Bichat, and considered by Mascagni as an external coat, is of course excluded.

The knotted or jointed appearance of lymphatics is occasioned chiefly by short membranous folds in their cavity, called *valves*. These folds are thinner than the venous valves; but they are equally strong, and have the same shape and mode of attachment to the inside of the vessel. They are generally found in pairs, but never three at the same point. A single valve is sometimes found at the junction of a large branch with a trunk, or of a trunk with a vein. According to Cruikshank, there is considerable variety in the distribution of valves; but in general a pair of valves will be found at every one-twentieth of an inch in lymphatics of middling size. In the larger lymphatics they are less numerous than in the small. The structure of these valvular folds is as little known as that of the inner membrane, of which they appear to be prolongations. According to Mascagni, they sometimes contain a small portion of fine adipose substance.

The tissue which forms the lymphatic tubes is strong, dense, and resisting; and from the weight of mercury which they bear without rupture, it has been generally concluded that they are stronger in proportion to their size than veins. This tissue also possesses considerable elasticity.

The opposite states of lymphatics during digestion and after long fasting, and the phenomena of mercurial injections, prove that the tissue of which they consist is distensible and contractile. Though it does not exhibit appearances of muscular structure, it has been long supposed to be endowed with a property analogous to irritability. Such is the inference which Hunter, Hewson, Cruikshank, and others, have derived from various phenomena in the living and recently dead tissue.

Though Bichat doubts what he terms organic sensible contractility, yet he admits insensible contractility as necessary to the functions ascribed to lymphatics. Previous to his time Schreger, in different experiments, observed the first of these qualities, in consequence of the application not only of acids, butter of antimony, and alcohol, but even of hot water and cold air. Similar contractions and relaxations have been induced by mechanical irritation. Such phenomena are observed not only during life, but even after death; and if to this we add, that the thoracic duct is often after death large and flaccid, though empty, but in the living body is almost always contracted and scarcely visible, and that a portion of it included between two ligatures, and punctured, quickly expels its contents, it may be inferred that the lymphatic tissue possesses a considerable degree of this organic property.

*Lymphatic Gland or Ganglion, Kernel. (Glandulæ Lymphaticæ,—Glandulæ Conglobatæ,—Die Saugader-Drüsen.)*

Lymphatic glands.

This is the proper place to consider the structure of those bodies which are in common language termed *kernels*, to which anatomists have applied the name of *lymphatic glands*, and the French anatomists have more recently given that of *lymphatic ganglions*. The usual appearance, figure, and situation of these bodies are well known. In general they are spheroidal, seldom quite globular, and most commonly their shape is that of a flattened spheroid. In different subjects, and in subjects at different ages, they vary from two or three lines to an inch in diameter. The medium rate is about half an inch. Their surface is smooth; their colour grayish-pink, sometimes pale red, bluish, or of a peach-blossom tinge,—varieties which seem to depend on degrees of bloody transudation; for, when washed and slightly macerated, they assume the gray or whitish-blue colour. In a few instances they are jet black,—a peculiarity which seems to depend on a degree of black infiltration, or on the incipient stage of that change which has been termed *melanosis*, or melanotic deposition. The idea that it may be derived from the carbonaceous matter suspended in the atmosphere of great cities, has been shown by Cruikshank to be absurd. Its anatomical possibility may be justly questioned.



They are always situate in the celluloso-adipose tissue found in the flexures of the joints. They are found in small number at the bend of the ham, and that of the elbow; in the armpit and groin they are more numerous; in considerable number in the cellular tissue of the lumbar region, before the *psoas* and *iliacus* muscles; and they are most abundant round the neck. The posterior mediastinum, and the cellular tissue between the mesentery and vertebral column, abound with lymphatic glands mutually connected in clusters.

Each gland may be said to consist of a peculiar substance, inclosed in a thin membrane like a capsule. The capsule is a thin, pellucid, colourless substance, which is resolved by maceration into fine whitish fibres. It is very vascular; and Mascagni appears to have detected absorbents in it. It is connected to the proper substance by fine filamentous or cellular tissue. The capsule is considered by Beclard as a fibro-cellular membrane. The proper substance of lymphatic glands consists of a homogeneous pulp, in which injections have shown numerous ramifications of minute vessels. As these vessels are injected from the lymphatics which are seen to enter the body of the gland, they are believed to be continuous with them, and to be lymphatics arranged in a peculiar manner. These vessels are of two kinds, one entering the gland, called *vasa afferentia* or *inferentia*, entrant lymphatics; the other quitting, are called *vasa efferentia*, egredient lymphatics. This distinction is founded on the direction of the valves. In the *vasa inferentia* the free margins of the valves are turned towards the gland; in the *vasa efferentia* they are turned from it.

The number of entrant lymphatics varies from one to thirty, and, what is more remarkable, very rarely corresponds with that of the egredient lymphatics, which are in general much fewer. Cruikshank states that he has injected fourteen entrant lymphatics to one gland, to which only one egredient vessel corresponded. When the entrant lymphatic reaches the gland, it splits into many radiated branches, which immediately sink into its substance. The egredient lymphatics are generally larger than the entrants.

The arrangement of these vessels in the interior of the glands is best described by Mascagni, whose observations are confirmed by Gordon. To see this well, it is requisite to inject the entrant lymphatics of two glands in two different modes; one with mercury, the other with wax, glue, or gypsum. After a successful mercurial injection, the entrants are seen, before sinking in the gland, to divide into two orders of branches. One of them, which belongs chiefly to the surface or circumference of the gland, consists of large vessels, bent, convoluted, and in-

General Anatomy.

Lymphatic glands.

terwoven in every direction, communicating with each other, and swelling out into dilated cells at certain parts; and of smaller vessels, which form a minute net-work on the surface, and which seem to terminate in the cells or distended parts of the larger vessels.

From these distended parts or cells, again, arise many minute vessels, which, after winding about on the surface of the gland, unite gradually, and form the egredient vessels of the gland.

The wax, glue, or gypsum injection is employed to show the deep-seated or central vessels of the gland. The distribution of these is found to be quite the same as that of the superficial vessels.

The cells delineated by Cruikshank I am disposed to regard as mere dilated parts of the lymphatic vessels which constitute the intimate structure of the gland.

These minute tubes are connected by delicate filamentous tissue, which is more abundant in early life than afterwards.

Injections show the existence of blood-vessels which accompany the convolutions of the lymphatics in the glands; but no nerves have been found either in the glands or their capsules.

The white matter described by Haller and Bichat is not contained in the cellular substance, but in the cells of the lymphatic vessels themselves.

The three orders of tubes or canals, the anatomical characters of which have now been completed, constitute what has been termed the VASCULAR SYSTEM; (*Vasa; Systema Vasorum;* Das Gefass System; *Le Système Vasculaire.*) The great extent of its distribution, and the part which it performs in all the processes of the living body, both in health and during disease, must be easily understood. In every texture and organ arteries and veins are found; and in all, except a few, the art of the anatomist has demonstrated those colourless valvular tubes denominated lymphatics. The arrangement of the former, especially in the substance of the several textures, essentially constitutes what is termed the *organization* of these textures. Many anatomists have imagined that each texture has a proper matter, or *parenchyma*, by which it was supposed to be particularly distinguished, and which was conceived to consist of minute, inorganic, solid atoms. Whether this opinion be well founded or not, it is perhaps of little moment to inquire. At present it is certain that it is not susceptible of demonstration.

The phenomena of injections, in which he was eminently successful, led Ruysch to entertain the opinion, that every substance of the animal frame consists of nothing but vessels. This idea, though opposed by Albinus,[1] on the same grounds on which it was advanced, was nevertheless revived by William Hunter, who believed that the inorganic parts of animal bodies are too minute for sensible, or even microscopical examination. In every part, however minute, always excepting nails, hair, tooth enamel, &c. vessels may be traced; and even a cicatrix, he demonstrated, is vascular to its centre.[2]

By the aid of the microscope the researches of Lieberkuhn tended still more powerfully to favour this opinion.[3] But repeated observation of the effects of injection in every part and texture almost of the body, by Barth and Prochaska, has led the latter to conclude that this opinion, understood in the ordinary mode, is not tenable. Prochaska, who has investigated this subject with much attention, thinks he is justified in dividing all the substances of the animal frame into two,—those which may be injected, and those which cannot. In this manner he regards skin, especially its outer surface, muscle, various parts of the mucous membranes, the *pia mater*, the lungs, the muscular part of the heart, the spleen, the liver, kidneys, and other glands, as very injectible; but tendon, ligament, cartilage, &c. as not injectible.[4] Without entering minutely into the merits of this distinction, or the inferences which Prochaska deduces from it, it is sufficient, so far as all useful knowledge is concerned, to infer that blood-vessels are an essential constituent of every organic texture, however different; and if there be any other matter inherent in such textures, it must be derived from these as a secretion. Nerve, brain, muscle, osseous matter, and cartilage, are depositions or the product of nutritious secretion from the respective arteries of these organized substances.

*Nerve, Nervous Tissue.* (Νευρον,—*Nervus,*—*Tissu Nerveux,*—*Système Nerveux.*)

Nerves.

The nervous system of the animal body includes two general divisions. The first of these, named Brain and spinal Chord, is collected in a single and indivisible mass, and contained in a peculiar cavity, formed by part of the osseous system of the animal,—the vertebral column, and cranium, in the Vertebrated animals generally. The second division of the nervous system, with which alone we are at present concerned, is found in the form of long chords or threads mutually connected, and running in various directions through the body in the mode of ramification. To these the name of nervous trunks or chords, or simply nerves, has been long applied.

The structure of the nerves has been examined with different degrees of accuracy and minuteness by a great number of anatomists. The more ancient authors, who wrote at a period when observation was much corrupted by fancy, and most of those who gave descriptions in general systems, may be without much injustice passed over in silence. It is sufficient to say that some good facts are given in the works of Willis, Vieussens, Morgagni, and Mayer; that Prochaska, Pfeffinger, the second Monro, and Fontana, are the first who professedly wrote on the structure of the nerves; that the works of Reil,[5] Bichat, and Gordon, contain the most accurate information on the nervous chords in general; and that the treatises of Scarpa[6] and Wutzer[7] contain the best descriptions of the arrangement of those parts named ganglions and plexuses.

Lastly, by the microscopic researches of Ehrenberg, Treviranus, Berres, Müller, Purkinje, Valentin, Weber, Burdach, Remak, and Pappenheim, some facts, though rather discordant, have been communicated on the minute structure of the microscopic filaments.

All the nervous chords of the animal body may be distinguished in physical characters into two different orders, which, though frequently mingled with each other, neverthe-

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[1] *Annotationum Academicarum* lib. iii. [2] *Medical Observations and Inquiries*, vol. ii. [3] *De Villis Intestinorum.*

[4] Georgii Prochaska *Disquisitio Anatomico-Physiologica Organismi Corporis Humani ejusque Processus Vitalis.* Viennæ, 1812, 4to.

[5] J. C. Reil, *Exercitationes Anatomicæ de Structura Nervorum.* Halæ, 1797.

[6] *Anatomicarum Annotationum liber primus de Nervorum Gangliis et Plexibus.* Auctore Antonio Scarpa. Ticini, 1792.

[7] *De Corporis Humani Gangliorum Fabrica atque Usu Monographia.* Auctore Carolo Gulielmo Wutzer, Med. Chirurg. Doct. &c. Berolini, 1817.

less possess sufficiently different properties to enable the observer to distinguish them, independent of knowledge of their intimate structure.

The first order of nerves are firm, glistening white, marked by cross-stripes, and are distributed principally to the muscles of the trunk and the skin. The second order are soft, reddish-gray in colour, flat, much interwoven with each other, and belong more to the viscera, and accompany the bloodvessels. The former have knotty swellings only at their origins, and at spots where they form connections with nerves of the second sort; the latter are in all parts occupied by small knots. The white nerves of the first order are named animal, or Cerebro-spinal nerves; the gray nerves of the second are known as soft, entrophic, sympathetic, vegetative, or organic, also as vascular or Gangliar nerves.

The following description applies to the nerves of the first order, unless where the contrary is expressly stated.

Each nerve forms connections in three different ways. 1*st*, A nerve must be connected to some part of the central mass by one of its extremities,—the cerebral or spinal end; 2*d*, it must be connected to some texture or organ, or part of an organ, by the other extremity,—the organic end; and, 3*d*, it may be connected to other nerves by a species of junction called anastomosis (*ansa*), anastomosing or uniting point. By means of the first two connections, it is supposed to maintain a communication between the central mass and the several organs; and by the latter it is understood to be subservient to a more general and extensive intercourse, which is believed to be necessary in various functions and actions of the animal system.

Every nerve consists essentially of two parts; one exterior, protecting, and containing; the other interior, contained, and dynamic,[1] forming the indispensable part of the nervous structure.

The first of these, which has been known since the time at least of Reil by the name *neurilema* (νευρο εἰλεω εἰλημα, *nervi involucrum*), or nerve-coat (*Nervenhaut*, Reil; *Nervenhülle*, Meckel), has the form and nature of a dense membrane, not quite transparent, which is found on the outside of the nervous chord or filament, and invests the proper nervous substance. It must not, however, be imagined that the *neurilema* forms a cylindrical tube, in the interior of which the nervous matter is contained. The latter disposition, if it actually exists, applies to the smaller nerves only, and to some of those which go to the organs of sensation,—a peculiarity which we shall notice subsequently.

Any large nervous trunk, for example the spiral or median of the arm, or the sciatic nerve of the thigh, is found to be composed of several small nervous chords placed in juxtaposition, and each of which, consisting of appropriate *neurilema* and nervous substance, is connected to the other by delicate filamentous tissue. These, however, do not through their entire course maintain the parallel disposition in respect to each other, but are observed to cross and penetrate each other, so as to form an intimate interlacement of nervous chords and filaments, each of which, however minute, is accompanied with its investing neurilema. The neurilema, in short, may be represented as a cylindrical membranous tube, giving from its inner surface many productions forming smaller tubes (*canaliculi;* die Nervenröhre; primitive cylinders of Fontana[2]), in which the proper nervous matter is contained.

Of this arrangement the consequence is, that each nerve or nervous trunk, enveloped in its general neurilema, is composed nevertheless, of a number, more or less considerable, of smaller chord-like nervous threads (*funiculi nervei*, Prochaska; *chordæ, funes, Nervenstränge*, Reil), into which the nerve, by maceration and suitable preparation, may be resolved. Each chord, again, or *nerve-string*, as Reil terms it, though invested with a proper neurilem, may be further resolved into an infinite number of minute filiform or capillary filaments (*fila, fibrillæ, Nervenfasern*, Reil), which, invested in a delicate covering, are understood to constitute the ultimate texture of the nerve.

This threefold division may be easily observed in the brachial and spiral nerves of the arm, and still more distinctly in the sciatic in the thigh. The utility of understanding the internal arrangement from which it results will appear forthwith, when the structure of those parts termed ganglions and plexuses comes under examination.

Of this arrangement in different nerves, and in different regions, this membrane undergoes great modification; and all opinions on its nature derived from thickness or transparency are liable to considerably fallacy. Scarpa seems to view it as connected, in anatomical origin and character, with the hard membrane (*meninx dura, dura mater*). Reil, who devoted more care and time to the examination of its nature and structure than any other inquirer, represents it as consisting of cellular substance, many bloodvessels, and some lymphatics.[3] Bichat thinks it resembles the soft membrane of the brain (*pia meninx, pia mater*), and is derived from it.[4] The neurilema of the cerebral nerves may be regarded as consisting of soft membrane (*pia mater*) at their origin, but in all other situations as a species of filamento-fibrous membrane.

The connection supposed by Mayer to exist between the neurilema and the *pia mater* was disproved by Reil; and though its analogy with the denticulated ligament were established, it would prove nothing regarding the neurilema. Upon the whole, the idea of Reil is the most probable. According to the observations of this anatomist, who examined the neurilema after fine and successful injection, it is liberally supplied with bloodvessels. These proceeding from the neighbouring arteries penetrate the filamentous sheath of the nerve; and, immediately on reaching the neurilema, divaricating at right angles, generally run along the nervous threads (*funes*), parallel to them, forming numerous anastomotic communications, and divide into innumerable minute vessels, which penetrate between them into the minute neurilematic canals. So manifold is the ramification, and so minute the distribution, that in these canals not a particle of nervous substance is found which is not supplied with a vessel.[5] The arrangement of the veins is analogous.

It appears, therefore, that the neurilema is a tissue of membranous form, with a multiplied mechanical surface, liberally supplied with bloodvessels, from which the nervous matter is secreted and nourished. It is impossible, indeed, to doubt that, of the two parts which compose the nervous chord, it is the most perfectly organized; and that, though it may not be similar in structure to the *pia mater*, it is quite analogous in the use to which it is subservient. Like that membrane, it sustains the vessels of the nerve; it presents a multiplied surface, over which the vessels are distributed; and, by penetrating deep into the body of the nerve, it conveys the nutritious vessels in the most capillary form to the inmost recesses of the nervous substance.[6]

The arrangement which has been above described is the

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[1] The term *dynamic* is used to denote in a general sense the properties of animal substances.
[2] *Observations sur la Structure des Nerfs*, &c. apud *Traite sur le Venin*, &c., par M. Felix Fontana. Florence, 1781.
[3] Reil, *Exercitationes Anatomicæ de Structura Nervorum*, cap. i. p. 3.
[4] *Anatomie Générale*, p. 137, &c.
[5] *De Structura Nervorum*, cap. v. p. 19.
[6] Reil, *Exercitationes Anatomicæ de Structura Nervorum*, cap. i.

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only one which can be regarded as general. It varies in particular regions; and these varieties in the neurilematic disposition occur principally in the nerves which are distributed to the proper organs of sensation.[1] *1st*, The olfactory nerve is soft, pulpy, and destitute of neurilema, from its origin in the Sylvian fissure, to the gray bulbous enlargement which terminates its passage in the cranium; but as soon as it reaches the *canaliculi* or grooves of the ethmoid bone, and begins to be distributed through the nasal anfractuosities, it is distinctly neurilematic. *2d*, The optic nerve is still more peculiar in this respect. The instant it quits the optic commissure (*commissura tractuum*), it begins to be invested by a firm general neurilema, which sends into the interior substance of the nerve various membranous *septa* or partitions, forming separate canals, in which the nervous matter is contained. These partitions, however, are so thin, that at first sight the optic nerve seems to consist merely of one exterior membranous cylinder inclosing the proper membranous substance. *3d*, Lastly, we may remark, that the auditory nerve, or the soft portion of the seventh pair of most anatomical writers, is the only nerve in which this covering cannot be traced.

The neurilema is much thinner and more delicate in the nerves which are distributed to the internal organs, as the lungs, heart, stomach, &c., (nerves of the organic life, great sympathetic and pneumogastric nerves *par vagum*), than in those belonging to the muscular system.

The second component part of the nervous chord or filament is the proper nervous matter which occupies the cavity of the neurilematic canals. Little is known concerning the nature or organization of this substance. It is whitish, somewhat soft, and pulpy; but whether it consists of aggregated globules, as was attempted to be established by Della Torre and Sir Everard Home, or of linear tracts disposed in a situation parallel to each other, as appears to be the result of the inquiries of Monro, Reil, and others, or of capillary cylinders containing a transparent gelatinous fluid, as Fontana represents, seems quite uncertain. It has been presumed, rather than demonstrated, that it resembles cerebral substance. But this analogy, though admitted, would throw little light on the subject; for at present it is almost impossible to find two anatomical observers who have the same views of the intimate nature of cerebral substance itself. Whatever be its intimate arrangement, it appears to be a secretion from the neurilematic vessels. (Reil.)

The structure of the nervous chord may be demonstrated in the following manner. When a portion of nerve is placed in an alkaline solution, the whole, or nearly the whole, of the nervous matter is softened and dissolved, or may be washed out of the neurilematic canals, which are not affected by this agent, and the disposition of which may be then examined and demonstrated.[2] Aqueous maceration may likewise be advantageously employed to unfold this structure; for it separates and decomposes the cellular tissue by which the neurilematic canals are united, and subsequently occasions decomposition of the nervous substance, while it leaves, at least for some time, the neurilema not much affected. When, however, the maceration is too long continued, it is separated and detached like other macerated textures.

*Lastly*, If a large nerve be placed in diluted acid for the space of one or two weeks, the neurilema is gradually dissolved, and the nervous matter becomes so much indurated and consolidated, that it may be separated from the contiguous chords in filaments with great facility.[3] In undergoing this change, the portion of nerve becomes much shorter and considerably contracted,—is subjected, in short, to the process of crispation; so that unless a large nerve like the sciatic be employed for the experiment, it may be impossible to obtain the result in the most satisfactory form. These experiments, with many others of the same nature, were first performed by Professor Reil, and afterwards repeated and varied by Bichat and Gordon.

The minute structure of the nerves has been examined by Fontana, Prochaska, Bauer, Ehrenberg, Valentin, Muller, Wagner, Remak, and Purkinje. But the results at which they have arrived are far from agreeing with each other; and either from the difficulty of the subject, and the minuteness of the objects, or from imperfections in the observations, it is next to impossible to present an account consistent and intelligible.

M. Bauer found the optic nerve to consist of many bundles of very delicate fibres, connected together by means of a jelly-like, transparent, semi-fluid, viscid substance, easily soluble in water. These fibres consist of rows of globules, which are from $\frac{1}{2800}$th to $\frac{1}{4000}$th part of one inch in diameter, with a few at $\frac{1}{2000}$th part of one inch in diameter; the latter being the size of the red globules of the blood, when deprived of colouring matter. The Retina appeared like a continuation of the bundles composing the optic Nerve, consisting of the same sized globules connected into fibrous lines, and forming bundles radiating from the end of the nerve to the circumference of the Retina, where they disappear, terminating in smooth membrane.[4]

Before noticing the observations of Ehrenberg, it may be proper to state that he distinguishes the following forms of organic structure, as visible by the microscope in the Brain or its parts, the Spinal Chord, and Nerves.

1. A series of tubes which present, at definite intervals, globular or spheroidal expansions, so as to resemble a string of beads which do not touch each other, but have a short communicating space interposed between each bead. To these tubes Ehrenberg gives the name of Varicose, from their resemblance to the Varices of a vein, and Jointed or Articulated tubes, because of the slight resemblance to a set of joints. The best name for them is Moniliform, or bead-like, when they really resemble a string of beads. These tubes, which present to the microscope the appearance of parallel fibres, he shows by various proofs to have an internal cavity, and to contain a peculiar matter, to which he assigns the name and qualities of nervous fluid. They are confined chiefly to the white matter of the brain; but occur also in several of the sensiferous nerves.

2. A set of tubes, straight and uniform, without the alternate spheroidal enlargements, also hollow, and to which he applies the name of Simple Cylindrical Tubes. These are found chiefly in the nervous trunks and chords. These are generally larger and coarser than the Articulated Tubes; but in certain points the latter are found to pass into the former by gradually losing their bead-like enlargements. These tubes he further represents to be distinguished from the Cerebral Jointed Tubes, by containing in their interior a viscid, white, but less transparent matter, to which he applies the name of Medullary.

3. Besides the two now mentioned, Ehrenberg mentions

[1] By the term "proper organs of sensation" are understood those of sight, hearing, smell, and taste, which are confined to a fixed spot in the system.

[2] Reil, *de Structura Nervorum*, cap. i. p. 3 and 5.

[3] According to the experiments of Reil, nitrous acid diluted with water answers best. Muriatic acid, though equal or even superior in effecting solution of the neurilema, softens the nervous matter too much, and separates the component filaments too completely. (*De Structura Nervorum*, cap. iii. p. 16.)

[4] Philosophical Transactions, 1821 and 1824.

a substance consisting partly of very minute fine grains, with some coarser-grained matter disseminated, as is said in the language of mineralogy, through the fine-grained matter. The latter is confined entirely to the gray matter of the convoluted surface of the Brain, and the laminated surface of the Cerebellum.

The olfactory, optic, and auditory nerves, Ehrenberg found to consist of varicose or moniliform medullary tubules, directly continued from the moniliform tubes of the white cerebral matter. The moniliform tubules of the olfactory nerves are the thickest known, and vary from $\frac{1}{160}$th to $\frac{1}{400}$th part of one line in diameter. Those of the optic nerve are smaller, being from $\frac{1}{300}$th to $\frac{1}{500}$th part of one line in diameter; and tubules of the same dimensions are observed in the *Chiasma* or Decussation, in which the tubules are represented as crossing each other; while the Retina consists of articulated tubules $\frac{1}{2000}$th part of one inch in diameter, traversing medullary grains about $\frac{1}{500}$th part of one line in diameter. It contains also mace-like or club-shaped bodies, that is, bodies terminating in thick round ends.

The structure of the Auditory Nerve is peculiar. The simple tubules of this nerve Ehrenberg found considerably thicker than those of the others, and the spheroidal enlargements or *ampullulæ* flatter, and less permanent, yet everywhere distinctly seen. In other respects it was similar to the olfactory and optic nerves.

The great Sympathetic Nerve, in like manner, consists of articulated cerebral tubules; but there is at each extremity a mixture of simple cylindrical tubules.

The nerves now specified, the Olfactory, Optic, Auditory, and Great Sympathetic, are Articulated or Moniliform Nerves.

All the other nerves consist not of Articulated or Moniliform tubules, but of simple cylindrical tubules somewhat larger, being from $\frac{1}{120}$th to $\frac{1}{110}$th part of one line in diameter. These tubules are surrounded and enclosed by vascular networks, and contained within ligamentous or neurilematic partitions; and they contain a medullary substance, semifluid, but capable of expression from them, and of coagulation within their interior. These are *Tubulated Nerves.*

The ganglia vary in structure. All consist of articulated or bead-like cerebral tubules, which, either alone, as in the *Chiasma*, form the knot, or, as in all the ganglia of the sympathetic examined, are mingled with large cylindrical nervous tubules, enclosed within a close slender vascular network, between the meshes of which are deposited granules similar to those observed in the Retina.

The tubules and cylinders now specified, which correspond with the primitive cylinders of Fontana, are merely in juxtaposition, and do not intermingle in substance with each other.

Neither Ehrenberg nor Müller were able to recognise in the roots of the sensiferous and motiferous nerves any essential difference in microscopic structure.

In the hypoglossal and glossopharyngeal Nerves are seen only cylindrical tubes.

It is a remarkable proof of the difficulty of microscopical observation, that much, if not the whole, of this varicose or moniliform appearance in the nervous matter is called in question by other observers. Valentin, for instance, regards it as the effect of pressure or some similar force; and Henle is disposed to regard the appearances as probably chiefly dependent on chemical changes.

The nervous content or *medulla*, he remarks, is a tough, soft substance, which may be squeezed out by pressure, and must therefore be regarded as in some degree fluid. In the recent nerve, it appears to be quite homogeneous, and takes its peculiar form under particular circumstances.

As no good analysis of nervous matter has been given, Henle takes as equivalent the analyses of cerebral matter made by John, Vauquelin, Denis, and Couerbe. The essential result of all these researches is, that a saponaceous and a free fatty substance is found in connection with albumen and water in the nervous *medulla.* During life, and at the temperature of the body, this is an actual solution, not an emulsion; because in an emulsion the fat is only in a state of minute division, and contained in microscopical globules. But the nervous matter is only separated into globules after death; and even then not pure fat globules are formed, but only fat-like globules; and this probably is caused by the separation of the fat and albuminoid constituents.

Under the microscope this nervous matter forms globules which run together in irregular figures. The dark edge is thus rendered broader, and advances on all sides towards the axis of the nervous chord, and at length fills the whole tube. This is covered by granules and irregular lines, which gradually increase, and thereby give the nervous medulla a fine granulated aspect. Similar changes take place, though more quickly, in the nervous matter, when it springs from a wound or lacerated opening in the sheath; there are then formed irregular granular masses, or it retains the cylindrical shape which it had in the sheath. The same process is observed in the fine nerves, though less distinctly.

When the nervous tubules are subjected to pressure or stretching, previous to the action of chemical coagulating agents, there are formed oval swellings, and between these shrivelled puckerings, often with great regularity. By continuing the force, the oval swellings are converted into globules which are connected by thinner cylindrical portions. In this manner, says Henle, are formed the varicose swellings, that is the bead-like figures of the nerve fibres, which have been much mentioned since the descriptions given by Ehrenberg. He adds, that from any tough viscid matter, from mucilage, saliva, or albumen, it is possible to manufacture similar varicose fibres, by drawing the substances to a thread between the tips of two fingers. There is even an instant at which the thread is changed into a row or string of globules, and so remains until it is torn asunder.

It thus appears that the moniliform aspect and arrangement is the conjoined result of the physical and chemical properties of the nervous tubular content, and of certain mechanical treatment.

Müller, on the other hand, allows that the nervous matter and the cerebral matter has a great tendency to assume the varicose and moniliform arrangement.

From the statements now made only one conclusion can be deduced. This is, either that the minute atomical arrangement of nervous matter is such that it eludes microscopical research, and is placed beyond the boundary at which correct representations can be obtained; or that hitherto microscopical research has presented results so variable, and so discordant, that they convey little useful information. The greater part of microscopic anatomy is still in a state of great imperfection.

Soon after death, and particularly soon after treatment with cold water, there is formed in large nerves, along each edge, a second parallel-running dark line, which first arises quite close to the outer margin, and gradually turns inward from the same. Each fibre is therefore bounded by two dark outlines on each side; at the same time transverse streaks and wrinkles appear on the fibre, by which it has the aspect of a ligament. The two dark lines on each side are not quite continuous; they are often in one single point, below which, within or without, arises a new point, which is quickly split into two parallel lines, or meet with each other, forming, by inclosure, round or oval figures. This twofold outline is seen only in nerves of a certain size. In fine nervous fibres which swell only at certain points, this is seen only at the swellings.

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Very frequently, it may be said according to Henle, normally, coagulation, beginning from the margins, does not reach the axis of the nerve tube; and there is left in the middle a clear stripe which looks like a cylinder drawn along the length of the nerve-tube. This is sometimes straight, sometimes tortuous, and follows not exactly the outline of the outer margin. Often it lies closer to the one margin, or it draws near to it at one part of its course. This is seen equally in thick and in delicate tubules; in the former more distinctly; it is particularly remarkable when the external nervous *medulla* is coagulated uniformly, and in fine grains. This streak is the *Cylinder Axis* of Purkinje, who considered it to be the same with a structure previously described by Remak under the name of Primitive Band. Its diameter is variable; but often it is seen very much the same in nervous fibres of like diameter, that is, about one-fourth to one-half the size of the diameter of the whole tube. When the cut section of a nerve is turned to the eye, this clear streak appears in general round or oval, often irregular, triangular, or quadrangular. This streak is seen also to be bent like a hook or a shepherd's crook, and upon pressure it may be made straight. In some instances the coagulated parts are dissolved, and the clear substance remains with its dark outline as a pale soft isolated thread.

From all these circumstances, Henle concludes that the Nervous fibre consists of a cortical or outer and a medullary substance, which are chemically different.

It appears, however, doubtful whether the central streak (*Cylinder Axis* of Purkinje) is always present, and is always to be considered as a substantive and real formation; at least, Henle allows, that similar illusive formations arise from quite a different source.

The Cylinder Axis is not in all instances so regular as it is represented in the examples selected. Sometimes it is seen swelled in certain points, sometimes very much attenuated, often altogether interrupted, consisting only of a row of oblong drops, which after being discharged assume a globular shape. Often the coagulated substance extends far beyond the middle of the tubule; the central stripe is then quite irregular, jagged, corresponding to the outline of the coagulated substance. In short, Henle is inclined to the opinion, that this alleged cylinder axis of Purkinje, is a fluid which has become coagulated either after death or by reason of chemical changes. He remarks, that in nerves which have been stretched but not subjected to coagulating agents, the medullary matter is frequently formed into individual oval necklace-like globules connected with each other in rows, and which are thus connected throughout the whole streak. This, he thinks, would not be possible, were the *medulla* a solid cylinder. If a part of the medulla, he adds, escape through a lateral rent, often, also, there takes place in the matter protruded a discoloration of the central stripe, which is gradually lengthened, and often at its apex is parted into individual globules; a sure proof, he thinks, that the cylinder axis is in this instance fluid. Other similar proofs he adds. It seems to us doubtful whether the point is of sufficient importance to enter into further detail. It is enough for readers to know that this Cylinder Axis, or central portion of the nerve tube, is a sort of hypothetical part inferred to exist from certain microscopical phenomena, but the existence of which, as a fluid or as a solid, the result of certain changes, is at present problematical. Henle allows that amidst so many sources of illusion, it is difficult to arrive at any certain results regarding the cylinder axis.[1]

Kölliker is of opinion that the Cylinder Axis is not an artificial formation, but a substantive part of the nervous chord; and adduces various reasons in proof of his opinion. These, however, it is unnecessary here to consider.

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The Gray, Soft, or Organic Nerves, evince their peculiar characters most distinctly in the roots of the Sympathetic Nerve, especially in those branches which, accompanying the internal carotid artery, proceed from the superior cervical ganglion to the fifth and sixth pairs of cervical nerves; and on the branches which proceed downwards from the same ganglion upon the carotid artery.

These nerves are reddish gray in colour, gelatinous, transparent, but tolerably firm. The transverse stripes are not wanting in them; but they are not easily distinguished, are close, and proceed only from the inflections of the *Neurilema.*

According to Henle, this *Neurilema* has an external layer of longitudinal filamentous tissue, like that of the White Nerves. But upon the external layer follows a very dense layer of annular fibres, which resemble the filamentous fibres of the embryo, taken during the period of development. These are very clear, apparently homogeneous, flat fibres, from 0·002 to 0·003 of one line in breadth, with numerous round and oval cell-nuclei placed mostly on the flat surface, and arranged at intervals, many of which show the regular nucleus-*corpuscula,* and not a few are drawn out at both poles into apices. The oval nuclei are in the longest diameter 0·003 of one line. When the nuclei are oval or are elongated into fusiform *corpuscula,* their long diameter lies parallel to the long axis of the Nervous Fibre, and consequently at right angles to the long axis of the Nervous Bundle. The more the nuclei are elongated and attenuated, the weaker is the connection with the bundles, the more easily is it dissolved, especially after employing acetic acid, from the bundles; and then they roll together or are twined in a serpentine manner. This is best seen in the smallest branches of the *Nervi Molles,* which can be placed without injury upon the object-holder and observed by a powerful lens.

In the Gray Nerves are observed two sorts of longitudinal fibres. The one set differ in no respect from the primitive tubules of the White Nerves; they belong, however, for the most part, to the finest nerves, and are accordingly slightly varicose or moniliform. The other set resemble the fibres of the annular layer of the Neurilema; and in them a division of the fibres into fine fibrils occasionally takes place.

On the relative proportion of the two sorts of fibres depends, according to Henle, the external appearance of the gray nerves. The greater the number of the peculiar nerve-tubules, the closer is their likeness to the animal nerves. In the roots of the Sympathetic Nerve, the nerve tubules are present in proportionally small number. They lie detached and at distances of from 0·013 to 0·018 of one line, so that at between every four and six of the nucleus-covered fibres a nerve-tube follows. In this manner every nerve-fibre appears to be surrounded by fibres of the second sort, because the nerve presents upon every longitudinal section nearly the same figure. But in what relation the nucleus-covered fibres with their surfaces stand to the nerve-tubes is, to Henle, not clear.

More numerous than in the roots of the great Sympathetic are the Nerve Tubes in the greater part of the Nerves of the Viscera, in the branches which proceed from the Cœliac Ganglion, from the hypogastric plexus, and similar foci. In these we easily find within the gray branches, the primitive, several beside each other, forming secondary bundles. Nevertheless, their number is more considerable in the chord of the Sympathetic and in the Splanchnic

[1] Henle, Allgemeine Anatomie, seite 629.

**Nerves.**

Nerves. The Nerves of the heart have scarcely any but Nerve-tubes. These, as all those proceeding from the Sympathetic Nerve, are distinguished from those of the voluntary muscles by their tenuity only.

Nervous tissue, like all others, receives a proportion of what may be denominated the systems of distribution,—cellular tissue and bloodvessels. In the substance of the former, the disposition of which we have already remarked, we find the more conspicuous branches of the latter distributed. In a more minute and divided form they penetrate the neurilema and nervous substance. Reil, who derived his conclusions from the result of delicate and successful injections, perhaps overrated the quantity of blood which in the sound state they convey; for it is quite certain that, in the healthy state, hardly any red blood enters the nervous tissue, as may be easily shown by exposing the sciatic nerve of a dog or rabbit.

No good chemical analysis of nervous matter has yet been published. Every chemical examination of it has been conducted on the assumption that it is analogous to cerebral matter. Of this, however, there is no direct proof. In the analysis by Vauquelin, the neurilematic covering appears not to have been detached,—a proceeding always necessary to obtain correct results in this inquiry. The effects of acids and alcohol show that it contains albuminous matter; but beyond this it is impossible at present to make any precise statements.

This description may communicate an idea of the structure of the nervous chord in general. In particular situations this structure is considerably modified. The modifications to which we allude occur under two forms—ganglions (die Knoten), and plexuses (die Nervengeflechte).

**Nervous ganglions.**

Every ganglion consists essentially of three parts,—1*st*, an exterior covering; 2*d*, a collection of minute nervous filament; and, 3*d*, a quantity of peculiar cellular or filamentous texture, by which these filaments are connected, and which constitutes the great mass of the ganglion.

The ganglions are of two kinds, the spinal or simple, and the non-spinal or compound. These two kinds of bodies differ from each other,—1*st*, in the situation which they respectively occupy; 2*d*, in the kind of envelope with which they are invested; 3*d*, in the mode in which the nervous filaments pass through them and from them. By Wutzer, who considers the ganglion of Gasserius, the ciliary and the maxillary of Meckel, as cerebral ganglions, they are divided into three sets, those of the *cerebral* system, the *spinal* system, and the *vegetative*, or those connected with the organs of involuntary motion.[1]

Void of the dense strong coat with which the others are invested, the cerebral ganglions consist of soft secondary matter, connected to the filaments of one, or at most two branches, and are arranged with less complexity (Wutzer).

The spinal ganglions are said to possess two coverings, one of which resembles the hard cerebral membrane (*meninx dura*), the other the soft cerebral membrane (*meninx tenuis, pia mater*). The non-spinal or compound ganglions have also two coverings, which are merely different modifications of filamentous tissue, less dense and compact than in the former. Both these sets of ganglions being by maceration stripped of their tunics, and deprived of the soft, pulpy, cellular matter, are resolved into an innumerable series of nervous threads, most of which are minute and scarcely perceptible: all are continuous with the nerve or nerves above and below the ganglion. It appears that the nervous chord, when it enters the one apex of the ganglion, begins to be separated into its component threads, which diverge and form intervals, between which the delicate cellular tissue is interposed; and that these filaments are subsequently collected at the opposite extremity of the ganglion, where they are connected with the other nerve or nerves. Scarpa, to whom we are indebted for most of the knowledge we possess on this subject,[2] compares the arrangement to a rope, the component cords of which are untwisted and teased out at a certain part. *Lastly*, In the simple ganglions, the filaments of which they consist invariably follow the axis of the ganglion; but in the compound ones they are found to rise towards the sides and emerge from them; and upon this variety in the direction and course of these filaments depends the variety of figure for which these two orders of ganglions are remarkable. These nervous threads (*stamina s. fila nervea*), described by Scarpa, correspond to the medullary filaments (*fila medullaria*) of Wutzer. According to this anatomist, these filaments, when about to enter the ganglion, lay aside their neurilem: yet they are sufficiently tough to resist a certain degree of tension.

Wutzer mentions a cluster of vesicles or cells (*cancelli*) in the filamentous tissue of the ganglion; but he was not enabled by any means, mechanical or chemical, to ascertain their exact nature.

Probably the explanation of the nature of these vesicles or cells is to be found in the structure described by Henle. According to this anatomist, if, by means of two needles, a portion of a ganglion be torn and pulled to pieces, we find in the water in which the preparation is washed, a quantity of very peculiarly shaped *corpuscula*, which have received the name of gangliar globules, though only rarely are they globular. More frequently they are ovoidal, triangular, quadrangular, prismatic, kidney-shaped, wedge-shaped, often even quite irregular. In size these bodies are equally variable. The largest are seen in the ganglions of the cerebral nerves. In the Gasserian ganglion of the calf, Henle found some 0·033 of one line in diameter; the greatest part between 0·022 and 0·027 of one line. In the superior cervical ganglion of the same animal, the majority were from 0·009 of a line and less.

**Gangliar globules.**

These bodies are distinguished by their reddish-yellow colour and soft consistence.

In all, or almost all, there is seen an exactly round *corpusculum*, which shines like a drop of fat, and in large and small gangliar globules, has pretty uniformly a diameter from 0·001 to 0·0015 of one line. Concentric with this is observed a very fine-drawn and exactly circular line.

In all the rolling movements of the gangliar globules, the small glistening *somation* remains in the centre of the clear circle, and both continue perfectly round,—a circumstance which shows that both are *vesiculæ*, or globules inclosed within each other. The external one is transparent as water, and its diameter is from 0·006 to 0·008 of one line. Their size bears a proportion to the size of the globules.

If we compare the Gangliar Globules with other cells, the outer substance of the same might appear to correspond to the Cell, the clear vesicular part to the Cytoblast, and the glistening somation to the nucleus-corpuscle. One circumstance, however, which contradicts this interpretation, is, that the whole globule, consequently not only the cell, but also the Nucleus and the nucleus-corpusculum, is instantaneously completely dissolved by acetic acid.

On the deposited gangliar globules depends the yellowish colour and the swelling or enlargement of the nerves in the ganglion. These globules lie together in dense heaps; the most regular and rounded at the surface, the polyhedral in the substance of the ganglion.

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[1] *De Corporis Humani Gangliorum Fabrica*, &c., cap. i. ii. sect. 41, p. 52.

[2] *Anatomicarum Annotationum liber primus de Nervorum Gangliis et Plexibus.* Auct. Ant. Scarpa.

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Gangliar globules.

Between these globules pass the nervous threads or filaments to their destination, part of them unchanged and uninterrupted; while part of them are resolved into their primitive constituent filaments, and wind in multiplied bendings and turnings round the individual globules and heaps of globules.

Further, the extended nerve-fasciculi approach each other and form plexuses, in the meshes of which globules are received. Normally, the nerve-fibres keep mostly together in the axis of the ganglion, and are dissociated and follow the winding course more at the surface; because one central nerve-bundle is on all sides surrounded by gangliar globules. In other instances, the globules are in a greater degree accumulated on one side, form an eminence on the nerve in which they are seated, or the nerve-fibres are principally disposed at the surface, while the nucleus of the ganglion consists chiefly of gangliar globules. Henle thinks it probable that in the axis of the ganglion lie those nerve-fibres, which only break through the ganglion in order to run still farther away in the nervous chord; that, on the other hand, the external enclosing filaments of each separate ganglion for separation are fixed.

In the ganglion of the sympathetic nerve with the proper nerve-fibres of the gray nerves the gelatinous fibres are united, and these stand to the gangliar globules in a particular relation. This is, that the fibres of one bundle are expanded in a funnel-shaped fashion, in order to receive a gangliar globule or a row of these globules; then they are united in order to be again implaited. Thus it is often possible to extract a whole string of gelatinous fibres from one ganglion, which are enlarged like the pearls of a necklace, and contain globules in these enlargements.

For further details on this point, readers are referred to the General Anatomy of Henle, and the fourth book of the second volume of Kölliker, who, in figure 161, page 524, gives a delineation of the gangliar globules and the nerve-fibres in the first thoracic ganglion of the great sympathetic.[1]

The ganglions are well supplied with bloodvessels, derived in general from the neighbouring arteries. The intimate distribution is represented by Wutzer to be the following. The artery proceeding to a ganglion gives vessels to the filamentous tissue, and, perforating the proper coat, is immediately ramified into innumerable minute canals, the first order of which forms vascular nets on the inner surface of the tunic, while the residual twigs penetrate the flocculent texture, and the individual vesicles of the secondary or filamentous matter of the ganglion.[2]

This short exposition of the structure of the ganglions shows the mistaken notions of Johnstone, Unzer, Bichat, and others, on the structure and uses of these bodies. 1*st*, The idea, first advanced by Johnstone and Unzer, adopted by Metzger, Hufeland, Prochaska, Sue, and Harless, and afterwards applied with so much ingenuity by Bichat, that the ganglions are so many nervous centres or minute brains, is disproved by strict anatomical observation. 2*d*, That they are connected with the order of involuntary actions, and influence these actions, is not improbable; and has acquired a certain amount of verisimilitude from the facts and arguments adduced by Bellingeri, Charles Bell, Herbert Mayo, Longet, and other inquirers. Ganglions are not observed in any of the nerves proceeding to organs of voluntary motion. Sensation, circulation, nutrition, and secretion, are the functions over which they preside, or at least with which they are associated; and they seem to have considerable relation with, if not influence over, the involuntary motions. By some physiologists again this doctrine is limited and modified; and the sympathetic especially has been several times represented as a nerve pertaining solely and exclusively to the nutritious nerves. This, however, leads to the question of the exact functions of the gray or soft nerves, and cannot be considered in this place. 3*d*, Lastly, we remark, as a circumstance of some importance, that the only difference between a ganglion and any other part of a nervous chord is, that in the former the minute nervous filaments appear to be uncovered with neurilema, and lodged in a mass of cellular tissue, which is inclosed in the neurilematic capsule; while in the latter each nervous filament has its appropriate neurilema, and the cellular tissue, instead of being within, is on its exterior, and connects it to the contiguous filaments.

Nervous plexuses.

In various situations two, three, or more nervous trunks or chords mutually unite by means of some of their component threads, and after proceeding in this manner for a short space, again separate, but not in the same number of original trunks, or preserving the same appearance. In general, the number of chords into which they finally separate is greater than that of which they consisted before union. Three or four nervous trunks, for example, after uniting in this manner, will form on their final separation five or six nerves or nervous chords; and it is quite impossible to determine which of the latter order was derived from any one or two of the former, or what number of individual chords it has received from each. Between the two points, also, the first point of union and the last of separation, many of the more component threads are detached from two or more of their trunks, and, after first uniting with each other in an indistinct network, are again united to two or more of the nervous chords near the point at which they finally separate from the further end of union. This arrangement has been termed a *plexus*, *plait*, or *weaving*, in consequence of the manner in which the nervous chords are interlaced or plaited together. The arrangement which we have noticed as consisting of the more minute nervous threads has been called a *smaller plexus* (*plexus minor*). It is a subordinate plexus within a larger one.

The best and most distinct example of a plexus is that commonly named the brachial or axillary. This, as is well known, is situate in the space contained between the broad dorsal muscle (*latissimus dorsi*) behind, and the great pectoral muscle before, and is formed in the following manner. The fifth, sixth, seventh, and eighth cervical nerves, and the first dorsal, after following the usual connections (*ansæ*), pass downwards from the vicinity of the vertebræ between the middle and anterior *scaleni* muscles, and, nearly opposite the lower margin of the seventh cervical *vertebra*, or about the level of the first rib, begin to be united by the component threads of each nerve. Threads of the fifth and sixth cervical unite, sometimes to form a single chord, in other instances to be connected a short space onward with threads of the seventh cervical in a similar manner. The seventh and eighth form two kinds of union. When the seventh is large, it divides almost equally into two chords or branches, one of which is connected first with the fifth and sixth, afterwards with the eighth, and with the first dorsal by interlacement of minute nervous threads. The other either passes downward to form one of the separate brachial nerves, or is also connected with the eighth cervical and first dorsal in a plexiform manner.

From this arrangement immediately arise the individual

[1] Mikroscopische Anatomie oder Gewebelehre des Menschen. Von Dr A. Kölliker, Professor der Anatomie und Physiologie in Wurzburg. Zweiter band. Leipzig, 1850. Large 8vo, § 124, seite 544.

[2] *De Corporis Humani Gangliorum Fabrica*, &c., cap. ii. sect 41.

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Nervous plexuses.

nervous branches which form the nerves of the arm, and which are named brachial nerves. The interlacement of minute nervous threads between the seventh and eighth cervical and the first dorsal, is what Scarpa has termed the *plexus minor*. He says it is peculiar, in being quite uniform, and in connecting those nervous branches which, from their subsequent destination, are called *median* and *ulnar*.

This description, though not generally applicable, will communicate some faint idea of the nervous unions and interlacements termed *plexus* or webs. For more minute information on the distribution, arrangement, and configuration of this part of the nervous system, we refer to the work of Scarpa already quoted.[1]

Henle thinks that we may distinguish the Plexuses into two orders; the first, those in which the nervous trunks send mutually branches to each other; the second, those in which, simply placed beside each other, they lie for a long tract inclosed in one common sheath, and then divide again into different branches. The first kind Kronenberg names *Plexus per anastomosin;* the second, *Plexus per decussationem.* The last author adds a third; that, namely, in which both modes of arrangement are united, *Plexus Compositi.*

Plexiform arrangements are not confined to the exterior regions of the body. They are more numerous internally; and almost all the organs of the chest and belly have each a plexus, sometimes two, from which they derive their nervous chords.

Plexiform arrangements are generally situate in the neighbourhood of bloodvessels, and in some instances inclosing considerable arterial trunks more or less accurately. Thus the axillary plexus surrounds the axillary artery. The cœliac artery is surrounded with the solar plexus; and the coronary, hepatic, splenic, superior mesenteric, and renal, are also surrounded with plexiform nervous filaments. In some instances these nervous filaments are so intimately connected with the arterial tubes as to lead some anatomists to consider them as forming a peculiar network surrounding the vessel, and to exercise great influence on the circulation (Wrisberg, Ludwig, and Haase).

It is remarkable that the structure of the nervous chords which form a plexus has either appeared so simple as not to demand particular attention, or is so obscure as to be never noticed. Have the nervous chords and threads in such situations their usual envelope? Is the nervous matter in the chords quite the same as in other situations? Are there any other means of union, save the nervous substance itself? We believe there is no doubt that every chord in a plexus is provided with its neurilema, as in other places; but this neurilema is generally thinner and more delicate, and the general neurilema seems to be wanting. Its mechanical properties of cohesion and resistance have not been examined.

The view now given of the structure and arrangement of the nervous plexus leads Scarpa to consider them as nearly allied to ganglions. The same separation of the component threads or filaments of the nerve or nerves, the same interlacement, and the same or similar formation of new chords, appear to take place in both orders of structure. A ganglion, indeed, he conceives, is a condensed or contracted plexus; and a plexus is an expanded or unfolded ganglion. The anatomical purpose of both appears to be simply a new arrangement or disposition of nervous branches, previous to their ultimate distribution in the tissues or organs to which they are destined. This is nothing but the expression of a fact,—the interpretation in intelligible terms of an arrangement of organized parts, without reference to any supposed uses.

General Anatomy.

Nerves.

I have already shown what is meant by the organic end or termination of a nerve. Although the nervous trunks are distributed in every direction through the animal body, they do not terminate in all the tissues or organs indiscriminately, and have been observed to be lost in the following only: 1*st*, The proper organs of sensation, the eye, ear, nose, palate, and tongue; 2*dly*, the muscles, whether subservient to voluntary or to involuntary motion, as the heart, stomach, intestines, &c.; 3*dly*, the mucous surfaces; 4*thly*, the skin; 5*thly*, glands, salivary, liver, kidneys, &c.; 6*thly*, bones.

Nerves, therefore, are not organs of general distribution. According to Bichat, they have never been traced to the following tissues:—the cartilages, both articular and of the cavities; fibrous textures, viz. *periosteum*, *dura meninx*, capsular ligaments, aponeurotic sheaths, aponeurosis in general, tendon, and ligament; fibro-cartilaginous textures—those of the external ear, nose, trachea, and eyelids (cartilages of other authors); the semilunar cartilages of the knee-joint; those of the temporo-maxillary articulation; those of the intervertebral spaces; marrow; the lymphatic glands.

To this we may add the testimony of Walter of Berlin, who, after several laborious researches, came to the conclusion that the pleura, the pericardium, the thoracic duct, and the peritoneum, receive no nerves, and that, contrary to the opinions of the most eminent recent anatomists, no nerves terminate in the lymphatic or conglobate glands. Sometimes, indeed, these organs are perforated by one or two twigs, as he often had occasion to observe; but they instantly proceed to the next place assigned to them, and in which they are finally lost.[2] If, after this conclusion of Walter, personal testimony can be of any use, I may add, that I have examined the dura mater, the periosteum, and most of the synovial membranes repeatedly, to discover nervous filaments in them, and always without success; and I may say the same regarding the absence or non-appearance of nerves in the peritoneum and pleura.

The nerves have different uses in the different organs and tissues to which they are distributed. 1. In the organs of sensation they receive the material impressions made on the mechanical part of the organ. In the mucous membrane of the nasal passages, the filaments of the olfactory nerve are affected by aromatic particles, dissolved or suspended in the air. In the eye the retina receives the last image formed by the transmitting powers of the transparent parts. In the ear the terminations of the auditory nerve are affected by the oscillations or minute changes in the fluid of the labyrinth, occasioned by the motions of the tympanal bones. In the palate, tongue, and throat, the gustatory nerves are affected by sapid bodies dissolved in the mouth, or applied in a fluid state to the mucous membrane of that cavity. 2. In the system of voluntary muscles, the nerves retain the action of the muscular fibres in a state of uniformity and equality, and keep them obedient to the will. In the involuntary muscles they appear merely to keep their action equable, regular, and uniform; and in both they maintain a communication, consent, or harmony of action between different parts of the same system of organs, or even between organs concurring to the same function. 3. In the glandular organs the nerves certainly exercise some influence over the process of secretion; but what is the exact nature of this influence, or in what degree it takes place, is quite uncertain.

When we observe the nerves distributed to organs of sensation and organs of motion, it is a natural thought to inquire whether the nerves minister to both functions, and whether different nerves or different sorts of nerves minister to each function. It seems to have been an idea of considerable an-

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1 *Annotation. Anatom.* cap. iii. sect 9, p. 94, 95.

2 *Præfat. Tab. Nerv. Thoracis et Abdominis,* J. G. Walter. Berolini, 1783.

tiquity, that one set of nerves are sensiferous, and another set motiferous. Erasistratus derives the nerves of motion from the brain and cerebellum, and those of sensation from the membranes; and Galen distinguishes the nerves into Νευρα Αἰσθετικα and Νευρα Κινητικα, the former soft, from the brain, the latter hard, from the spinal marrow. This distinction was not altogether lost sight of among the anatomists and physiologists of the eighteenth century; but it was rather maintained as a probable speculation, than elucidated and enforced as an established doctrine, pregnant with important results. It was recognised by Glisson, and taught by Boerhaave,[1] and received and promulgated by his pupils, Tissot and Van Eems;[2] but opposed by Haller[3] and Cullen. The distinction was, nevertheless, maintained by Lecat, Morin, and Pouteau, the last of whom was led from various examples of persons, who, after injuries, had lost sensation, but retained the power of movement, to espouse it with considerable energy.[4]

In 1784 George Prochaska, Professor of Anatomy at Vienna, published on the functions of the nerves a commentary, in which he gave, after Haller, Caldani, Whytt, and Unzer, a more precise and correct view of the uses, properties, and powers of these organs, than had hitherto been formed. In this commentary he fully recognises the distinction between sensorial nerves, or those devoted to sensation, and motific nerves, or those ministering to motion; he shows that sensorial impressions, or impressions made on the sensitive nerves, are reflected or transmitted in a reflex direction to the motific nerves; that the latter nerves are thereby excited to action; that the purpose of this reflex operation is the preservation of the individual; and that the whole are under the influence of the *Sensorium Commune*. He distinctly states, that this reflected action is not regulated by physical laws, where the angle of reflexion is equal to the angle of incidence, but obeys peculiar laws impressed by nature, as it were, on the sensorium, and which laws we can understand from their effects alone. This reflex action further takes place either without or with the consciousness of the soul. The motion of the heart, stomach, and intestines, is independent of the cognizance of the soul; and in many other instances of sensorial impressions being transmitted to motific nerves, though the soul is conscious, it can neither prevent them nor promote them.[5]

The commentary of Prochaska is the first precise view of functions of the nervous system in modern times; and the first in which the automatic and instinctive phenomena enumerated by Whytt are referred to a reflex operation.

In 1811, Sir Charles Bell, in a tract containing *the Idea of a New Anatomy of the Brain*, stated that he had proved experimentally that "the posterior *fasciculus* of spinal nerves, which are gangliophorous, might be detached from its origin without convulsing the muscles of the back; whereas, on touching the anterior *fasciculus* with the point of the knife, these muscles were immediately convulsed." From this it seemed a probable inference that gangliophorous nerves had no concern in motion, and that nerves void of ganglion ministered in some way to that function.

In 1818, Charles Francis Bellingeri published at Turin,[6] a Dissertation treating, among other subjects, of the anatomy and physiology of the fifth and seventh pairs of nerves. In this he showed that the great portion of the fifth pair or trifacial nerve, which forms the large semilunar plexus called Gasserian ganglion, is a nerve not of motion but of sensation; that its three branches are distributed to certain parts of the eye, the nasal cavities, the palate and tongue; ministering in these parts not to motion, but to sensation, and probably to circulation, nutrition, and secretion; and that the small branch of that nerve (*nervus masticatorius*) is distributed to muscles (*temporalis, masseter, pterygoideus, buccinatorius*), and is a nerve of motion. He also showed that the seventh pair, or lateral facial, presides over sensation and motion in the functions of the head, face, and neck, but mostly over motion.

In 1821, Sir Charles Bell undertook to establish the principle, that of the two nervous trunks distributed to the face, viz., the *trigeminus*, or fifth cerebral nerve, and the *portio dura*, or seventh cerebral nerve, the lateral facial, the former presides over the sensations or common sensibility of the head and face; that it also possesses branches going to the muscles of mastication; whereas the latter nerve regulates the muscular motions of the lips, nostrils, and *velum palati*, and especially in associated action with the motions of respiration.

About the same time Magendie claimed the merit of showing experimentally the fact of the distinction between nerves ministering to sensation and nerves ministering to motion, and of proving that, of the double row of nervous roots issuing in parallel lines from the lateral regions of the spinal chord, the anterior are destined for motion, and the posterior for sensation.

Lastly, Mr Mayo, partly by dissection, partly by experimental inquiry and reasoning, arrived at the conclusion that almost all the branches of the large or gangliophorous portion of the trifacial nerves are nerves of sensation, while those of the small fasciculus, which is void of ganglion, are nerves of motion.

In this manner, by successive steps, has been established one of the most important doctrines on the functions of the nervous chords in modern physiology; and its justice has been confirmed by the labours of many observers. The distinction is most clearly proved by the original experiment of Sir Charles Bell. If the spine be laid open, especially in a cold-blooded animal, as a frog, and the posterior or gangliophorous roots alone be irritated, no movement is produced; but the moment the anterior roots are touched, the extremities are agitated by active convulsive motions.

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[1] Prælectiones Academicæ in proprias Institutiones Rei Medicæ, Editæ et Notis Auctæ, ab. Alb. Haller. VII. Tomi. 12mo. Goettingae, 1745.

[2] Hermanni Boerhaave, Phil. et Med. Doct., &c. Prælectiones Academicæ de Morbis Nervorum, Quas ex Manuscriptis collectas edi curavit Jacobus Van Eems, Medicus Leydensis. Tome I. and II. Lugduni Batavor. 1761. "Omnes (nervi) inserviunt motui vel famulantur sensui; sed in illis qui cordi, pulmoni, hepati, aliisque partibus vitalibus destinati sunt, sensus non deprehenditur. Qui motui inserviunt, abeunt ad musculos, et in iis ita mollescunt, ut in verum quasi cerebrum degenerent. Ramuli, qui sensibus famulantur, in ipsis organis mollitie fere diffluunt, uti patet in expansione nervi optici, olfactorii, ubi se applicat ad os ethmoides, et acoustici in labyrintho," p. 261.

[3] Elementa Physiologiæ, Liber X. Sect. VIII. § xxii., Tomus Quartus, p. 389.

[4] Memoire et Recherches sur la difference a etablir entre les nerfs du sentiment et les nerfs du mouvement, a l'occasion de quelques observations sur cette espece rare de paralysie, qui prive un membre de tout sentiment, sans lui oter l'usage du mouvement. Œuvres Postumes de M. Pouteau, Docteur en Medicine et Chirurgien en Chef de l'Hotel-dieu de Lyon. Tome II. p. 480. Paris, 1789.

[5] Georgii Prochaska, M.D., Professoris Anatomiæ, Physiologiæ et Morborum Oculorum in Universitate Vindobonensi, Operum Minorum. Pars II. Viennæ, 1800. 8vo. Commentatio de Functionibus Systematis Nervosi.

[6] Caroli Francisci Bellingeri E. S. Agatha Derthonensi. Phil. et Med. Doct. Amplissim Med. Collegii Candidati Dissertatio Inauguralis quam publice defendebat. In Athenæo Regio Anno MDCCCXVIII. Die IX. Maii; hora IX. na mututina. Augustæ Turinorum. 1818. Ex Anatome; De Nervis Faciei; Ex Physiologia; Quinti et Septimi Paris Functiones, &c.

Of the cerebral nerves, the first or olfactory, the second or optic, and the eighth or auditory, are pure nerves of proper sensation, and are distributed to the sensitive parts of the eye, the nasal cavities, and the cochlea and labyrinth, respectively. The third, fourth, and part of the sixth, or abducent, are motific nerves connected with the movements of the eye. The fifth or trifacial is a very peculiar nerve. The gangliophorous, or rather plexiform part of it, communicates with all the organs of proper sensation,—the eye, the ear in a small degree, the nasal cavities largely, and the palate, mouth, and tongue largely; and it is distributed extensively along with the minute arteries of the face. Of this arrangement the result is, that it is a nerve neither of vision nor of hearing, of smell nor of taste, or deglutition nor of touch, or physiognomical expression, exclusively; but over the whole of these faculties and their proper organs exercises a general modulating power. It maintains between them a mutual consent or harmony of action, absolutely necessary to the due separate exercise of each and the conjoined exercise of all. Lastly, by accompanying the arteries of the face, it regulates the circulation of that region, and may be the means of maintaining between the brain and the facial circulation those conditions and expressions which arise from various mental emotions; as paleness, blushing, indignation, the sense of joy, triumph, the sublime, and similar emotions.

Not less peculiar is the seventh, the small sympathetic of Winslow. Though mostly a motiferous nerve, yet it ministers to motions of a particular order. It is, however, as a nerve distributed to the skin of the face, a nerve contributing to, if not regulating animal sensation and involuntary motion. It is, in fact, as shown by Wrisberg, a double nerve, the large portion of which is devoted to the purposes of animal life, and the small one to those of organic life. It is a musculo-cutaneous nerve of the head and face.

In proceeding further in explaining the respective functions of the nerves, it is requisite to keep in view not only their gangliophorous character and the reverse, but their position as anterior and as posterior nerves, and nerves consisting of anterior and posterior roots.

The ninth pair (*nervus glosso-pharyngæus*), consists of two parts, one large, completing sensation to the root of the tongue and pharynx, the other smaller, moving the pharynx, and connected, notwithstanding, with the tenth pair, pneumogastric, and the great sympathetic.

The tenth pair (*nervus vagus*), or pneumogastric nerve, is chiefly a sensiferous nerve, regulating the sensations of the larynx, the œsophagus and stomach, and the lungs, and placing these organs in harmony as to function. One particularly, the recurrent branches, appear to be motiferous. All the other branches appear to regulate circulation and secretion.

To the accessory nerve, or eleventh pair, seems to belong the function of placing the pulmonary and laryngeal divisions of the pneumogastric in harmony and relation with the external muscles of the back and lateral regions of the neck.

Lastly, the hypoglossal, or twelfth pair, having mostly an anterior origin, are motiferous. They form the motiferous nerves of the muscles of the tongue.

It is to be observed, nevertheless, that though this distinction in functions belongs to particular nerves, yet nerves ministering to sensation, and regulating organic or involuntary functions, and nerves ministering to motion, and regulating either voluntary motions, instinctive motions, or involuntary but associated and necessary motions, are often closely connected, and proceed together in the same sheath, or in close apposition, to the same organ. This, which is observed in the fifth, the seventh, the ninth, tenth, and eleventh, is rendered necessary by the offices which the organs have to perform. The impulse or impression is communicated to the organ, and received by its sensiferous nerves. By these the proper sensation is transmitted, and the motiferous nerves are excited to action. This appears to be the mode in which such actions as sneezing, coughing, yawning, deglutition, and numerous other instinctive and associated actions are called into operation.

Of the spinal nerves it is almost superfluous to speak, after the explanations now given. The splanchnic or great sympathetic appears to be a nerve of organic sensibility and impression, and as such regulates the circulation of the abdominal organs, and transmits their impressions to the central connections. The further continuance of these by its spinal connections establishes a harmonic action with the spinal marrow, always for good purposes, but often under disease producing painful and destructive effects.[1]

The doctrine of reflected action in the nervous chords, as proposed by Prochaska, was either overlooked, and more or less disregarded; or it was thought that the phenomena referred to it were explained, as far as was practicable, by the doctrines of Robert Whytt and Haller. At the same time it was taught by Prevost and Dumas in 1823, that in what is called nervous action, or the operation of nervous influence, there must be, as in galvanism, two currents, an ascending and a descending one; the former proceeding from the ramified to the central end of the nerve, the latter from the central to the ramified or distributed end. In 1826, Sir Charles Bell, in a paper read to the Royal Society, promulgated the general proposition, that, *between the Brain and the Muscle, there is a circle of nerves; one nerve conveys the influence from the Brain to the Muscle; another gives the sense of the condition of the Muscle to the Brain.*[2]

In 1833, Dr Marshall Hall communicated to the Royal Society a paper on the Reflex Function of the *Medulla Oblongata* and *Medulla Spinalis*, in which he undertakes to demonstrate the existence of reflected or retrograding nervous influence, that is, one which proceeds from the ramified, or distributed to the cerebral or cerebro-spinal extremity of the nerve. According to the hypothesis here propounded, the spinal chord is the seat and centre, as it were, of two processes taking place in living animals. It receives sensations caused by impressions on the extreme points of the nerves; and, in consequence of this, it induces or stops actions on certain muscles and muscular organs. An impression acts upon the distributed extremity or extremities of a nerve; this is instantly conveyed by the nerve to the spinal marrow; and in the same instant, the spinal marrow either causes movement, or retains in a fixed state certain muscular organs. As this action or process consists of two parts, an incident impression, and a reflected one causing motion, it was denominated the Reflex Function of the Spinal Marrow; and as it consists in impression supposed to excite or cause movement, it was named by its proposer, excito-motory, and the nerves by the agency of which these movements were induced he denominates Excito-Motory Nerves.[3]

According to Dr Marshall Hall, there are two orders of Nerves. Incident Nerves, proceeding principally from the Cutaneous surface, and the surface of the Mucous Mem-

[1] For further information and illustrations of the principles now stated, I refer the reader to Arnold's Illustrations of the Nerves of the Head and Face—(Heidelberg, 1834. Folio)—and an account of the same work in the forty-third volume of the Edinburgh Medical and Surgical Journal, January 1835, p. 225.

[2] Philosophical Transactions, 1826. Read 25th January 1826.

[3] Philosophical Transactions for 1833. Part II.

General Anatomy. Nerves.

branes to the Spinal Marrow; and Reflex Nerves passing from the Spinal Marrow to a series of muscles destined to be moved simultaneously; and he thinks that he has proved the existence of, 1*st*, an incident motor action, and, 2*d*, an incident motor nerve.[1]

The incident motor branches are those of, I. the Trifacial nerve; II. The Pneumogastric; III. The Glossopharyngeal; and, IV. The Posterior Spinal nerves. To these there are corresponding reflex branches; and in the centre between the two, according to the doctrine, is placed the *Medulla Oblongata* and the Spinal Marrow, as the recipient of impressions and the generator of movements.

Under this system of nerves and nervous movements are placed all the great functions of the animal body; respiration; the acts of ingestion and egestion; the action of the uterus during parturition, and all those movements the object of which is the preservation of the individual from injury, whether arising within the system, or approaching from without.

It is unnecessary here to express upon the merits of this hypothesis any opinion. Its true character is that of placing facts long known and observed, under the head of a doctrine, new, and, it may be, more intelligible and tangible than the former. It is, nevertheless, still in the condition of a hypothesis, though a probable and convenient hypothesis. The further consideration of the subject belongs to the department of physiology.

It may have been observed, that, in speaking of the properties and uses of the nerves, as living and organized textures, we have been obliged to employ various terms which are in common use when speaking of the properties and uses of the nervous system; for instance, Sensibility, Impressions, Sympathy, Irritability, and similar denominations. These terms it would have been desirable to define with as much precision as the imperfections of language and the nature of the subject allow. This part of the subject, however, properly belongs to the doctrine of the functions of the living body, and as such it shall be considered under the head of Physiology.

In the fœtus the nerves are developed with remarkable perfection. I cannot speak from personal observation much earlier than the sixth month, when I have found the nerves of the extremities and voluntary muscles large and distinct. At the eighth month they are still more conspicuous. The anterior crural nerves are in the form of flat white cords, one and a half line broad, and their branches like good-sized threads. The sciatic is still more distinct. In the form of a thick cylindrical cord, fully a line in diameter, and not unlike a piece of whipcord, it is tough, stringy, and resists tension; and its constituent threads are well marked. I immersed a portion of this nerve, three and a half inches long, in *aqua potassæ*, when it first became much firmer and denser than before, assumed in two days the satin fibrous appearance first described by Fontana, and at length by solution of the nervous matter, was separated into chords and neurilematic canals. In this state, preserved in spirit of turpentine, it conveys a tolerably correct idea of the arrangement of the neurilematic canals.

The nerves of the involuntary muscles are equally distinct in proportion. Those of the lung, heart, and splanchnic system are distinct and manifest at the eighth month.

The neurilem is much more vascular in the fœtus than in the adult. In the same fœtus of about eight months I found the neurilem of the sciatic nerve, from the ischiatic notch to its divarication in the ham, covered with a thick network of minute vessels, all injected with dark blood.

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### *The Nervous Papillæ of Vater.—The Corpuscula of Pacini.*

Nervous Papillæ.

The limits assigned to this article permit not to consider in detail all the modes in which the nervous extremities terminate in the organs, and the membranous surfaces to which they are distributed. But one mode of termination has, since the year 1834, attracted so much the attention of anatomists, that it would be improper entirely to omit the mention of it. This is what are called the Corpuscula of Pacini.

In the year 1741, Abraham Vater, Professor at Wittemberg, made known the fact that the nerves of the thumb terminate, when traced to their extremities, in round or spheroidal bodies, to which he gives the name of *Papillæ Nerveæ*, and *Papillæ Cutaneæ*. This discovery of the peculiar mode in which the digital nerves terminate, was made known in an inaugural dissection by J. G. Lehmann, one of the pupils of Vater; and the preparation from which the description by Lehmann was formed, has been preserved in the Anatomical Collection of Wittemberg to the present time.

The description given by Lehmann, which must be regarded as virtually that of Abraham Vater, is not very minute. Vater, or Lehmann for him, states that he found in the body of a man who had been affected by a spasmodic attack in the right arm and the middle and ring fingers, the nerves distributed to the thumb terminated in numerous small eminences or *papillæ*, which required to be carefully and laboriously dissected from the fat in which they were inclosed. These bodies he compares to the ears of corn. Vater found *papillæ* of the same sort, in small number, attached to the extremities of two branches of the posterior crural nerve, distributed over the dorsum of the foot. This occurrence took place several years previously to the time, 2d November 1741, at which it was made known.[2] On the exact nature of these bodies Vater gives no opinion, further than is to be collected from his calling them Nervous *Papillæ*, and Cutaneous *Papillæ*, and mentioning them in connection with the *consensus* of the parts of the human body. It may be doubted whether he was aware of the signification of these bodies even in an anatomical point of view.

The fact now mentioned has been overlooked and neglected for an entire century; and no one seems to have thought it of sufficient importance after the dissertation of Lehmann to deserve mention. At length, in February 1834, M. Camus, in a minute account of the distribution and termination of the nerves of the hand, described, as existing in the palmar and anterior half of the lateral aspect of the fingers, certain minute bodies, opaque, pearl white, not larger than a grain of mustard-seed, attached to the extremities of the digital nerves. Similar minute opaque pearly-looking bodies, M. Camus found attached to the nerves in the plantar aspect of the foot, most numerous towards the roots of the toes, and in general smaller than those found terminating the nerves of the hands.[3]

Pacinian corpuscula.

It further appears that Philip Pacini, a physician in Pistoja, had seen these minute bodies in 1831, gave an account of them in 1835 to the Medical Society of Florence, described them in the *Nuovo Giornale* of Pisa, gave a second oral communication on them, and demonstrated their existence at the Scientific Congress held at Pisa in October 1839. From this circumstance, and Pacini publishing an enlarged

[1] The Diseases and Derangements of the Nervous System. By Marshall Hall, M.D., &c. London 1841. Page 48-50.

[2] Dissertatio de Consensu Partium Corporis Humani. Expositio simul Nervorum Brachialium et Cruralium Coalitu et Papillarum Nervearum in Digitis Dispositione. Quam P. Abrahamo Vatero pro G. Doctoris Exponet. J. Gottlob. Lehmannus Vitembergæ, die 2 Novembris 1741. Apud Haller Dissertationes Anatomicæ Selectæ. Vol. ii. Göttingen, 1747. Page 953.

[3] Archives Generales de Medicine. Fevrier 1834. And Edinburgh Medical and Surgical Journal, vol. xlii, 1834, p. 225.

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account of these *corpuscula* in 1840, these bodies have been usually designated as the corpuscula of Pacini, and the Pacinian bodies.

Pacinian corpuscula.

In 1836, they were mentioned by Cruveilhier, though not as essential parts of the nervous system; and they were again described by A. G. Andral.

In October 1843, M. Lacauchie announced to the Academy of Sciences at Paris, that he had found in the mesentery and mesorectum of various animals, especially the common cat, minute bodies which are manifestly the same as those seen by Pacini in the fingers. According to Lacauchie, they are ovoidal transparent bodies, with the long diameter somewhat more than one millimetre. With the aid of the microscope he distinguished a peripheral part formed of from 15 to 20 concentric layers, and a central hollow portion, which extends the whole length of the body, terminates at one apex in a shut end, and at the other communicates by means of a serpentine canal with the nearest lymphatic canals. These bodies have since been described more or less minutely by Mayer of Bonn, Pappenheim, and most of all by Henle and Kölliker, in a monograph in 1844, and by Strahl in 1848.

The Pacinian *corpuscula*, which must have been often noticed by observers who studied the chyliferous vessels in the cat, were seen by Pacini first in man, and afterwards in cattle. They are seen normally without exception in adults as in the fœtus and new-born infants. Usually they are numerous in the nerves of the hand and foot, in the palm and sole. They are besides observed in the sacral plexus, in the crural nerve, in some cutaneous nerves of the upper arm and fore-arm, in the epigastric plexus and nerves issuing from it, and in the neighbouring plexuses. Their number in the whole body must be considerable; and in a single hand from 60 to 200 have been numbered. They are either detached or accumulated in small heaps. In all cases they are attached by one end by a stem variable in length to an adjoining nerve. They are for the most part distinctly visible to the naked eye; elliptical or long-oval bodies of opal lustre; and through the more translucent middle, in the long direction, are observed slightly tortuous streaks. In adults their average length is from $1\frac{1}{2}$ to 2 millimetres. In the fœtus they are often so small that either they cannot be seen, or they are seen by the naked eye with great difficulty. At the point of division of the median nerve, and ulnar nerve, in the fingers, and the plantar nerve in the branches going to the toes, they are largest; at the tips of the fingers they are smallest. The stems or peduncles by which these bodies are attached to the nerves join the nerves either at a right angle, or so that they are inclined sometimes more to the central, sometimes more to the peripheral end of the nerve. Not unfrequently two bodies are attached by means of a bifurcated stem. The stems or peduncles appear to be continued backwards in a conical fashion into the *corpuscula*, by which they are easily distinguished by their transparency from the substance of the rest of the corpuscula. This prolongation amounts sometimes to one-fourth part and more of the entire length of the Pacinian body.

When the *corpusculum* is examined under the microscope, it presents numerous fine dark lines, which proceed on the outside or along the periphery of the *corpusculum* by the edges, and within, run parallel to the long axis of the *corpusculum*, and are separated from each other by clear, broader intervals. At the stalk-end of the capsule ($a$), the concentric lines incline to each other, and are continued then, as is observed in large Pacinian bodies, in fine dark lines, which may be seen compressed parallel and closely to the stalk. At the free end, on the other hand, the concentric and parallel lines of the corpuscle are united on both sides; yet here there is also often observed a white line penetrating into the interior of the *corpusculum*, (*ligamentum intercapsulare*,) which appears to correspond with the prolongation of the stalk on the other side. The fine, closely compressed, parallel lines of the proper stalk become towards the nerve progressively more subtile, and in most cases vanish altogether from the eye before they sink into the nerve. In the middle of a corpuscle there is observed a longitudinal space, more or less transparent, which follows in like manner the longitudinal axis of the *corpusculum*. The dark lines lying next to it are more numerous, more closely compressed on each other, and run almost entirely straight. These concentric dark lines appeared to the observer as the outlines of so many capsules placed in layers on each other; and this view was confirmed by careful dissection. In short, when the apex of one *corpusculum* is cut off, there is observed close to the opening a small quantity of fluid, the *corpusculum* collapses, and from the interior proceeds a new *corpusculum*, more sharply defined, and smaller and more pointed than the former. This operation may be repeated several times, always with the same phenomena, except that the size of the *corpusculum* diminishes, and the oval form passes more and more to the cylindrical.


Fig. 1. Nerves of one Finger with the Pacinian *Corpuscula* attached. Fig. 2. A Pacinian *Corpusculum* from the human body, magnified three hundred and fifty times. *a*. Stalk or Peduncle. *b*. Nervous fibre in stalk. *c*. External layers of capsule. *d*. Inner layers. *e*. Pale nerve-fibre in the central cavity. *f*. Divisions and terminations of nerve-fibre. From A. Kölliker.

A Pacinian body consists, therefore, of a greater or smaller number of capsules inclosing each other, which are separated

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Pacinian corpuscula.

from each other by a greater or less quantity of fluid, easily miscible by water. The spaces between the capsules filled with fluid are named by Pacini intercapsular spaces.

The dark parallel lines of the stalk correspond to tubes encased within each other of the sections of the membranes, which tubes are continued into the capsules, yet contain no fluid. The conical prolongation of the stalk within the *corpusculum* is formed in such a manner that the stalk of the inner capsule penetrates further into the same than the outer. The innermost tube of the stalk proceeds without expansion into the innermost capsule forming the central cavity.

The internal central cylinder Henle and Kölliker compare to the primitive nervous fibre. Henle discovered a nervous fibre in the central canal of the corpusculum.

The accuracy of these observations has been in general confirmed by Strahl, who proposes to restore the original merit of discovery to Vater by calling the bodies Vaterian *Corpuscula*.

The Capsules which give the Vaterian Corpuscula their peculiar shape vary much in number and width. Usually there exists, as the early observers represent, a system of internal capsules; but this does not always contain the same number of capsules; and the latter are not in all cases smaller than the outer, but often interrupted in consequence of their width.

The capsule walls consist of structureless filamentous tissue, in which are imbedded *Nuclei*. Fibrous structure Strahl did not recognize even with strong magnifying powers; and at most he only observed a difference of longitudinal and transverse fibres.

Most commonly only one particular nerve-fibre runs into each Vaterian body.

Anatomists are not agreed as to the nature or the uses of these bodies. All that is known is what is now stated; that by one extremity or pole they are connected with the nervous system, and by another with the lymphatic system. As to uses, it seems reasonable to think that in some manner they are concerned in the functions performed by the extremities of the nerve. But on this point there is great uncertainty. They appear not to be particularly connected either with sensation or with the sense of Tact as possessed by the fingers. In the extremities they are observed in spots in which these functions are not expressed with particular energy. They are generally in greatest number in the ball of the thumb; and they are situate in the toes, in parts at which neither sensibility nor Tact can be said to be considerable.

Pacini entertained the idea that they are connected with the development of electricity; and Henle and Kölliker were disposed to favour this opinion. Strahl subjected the opinion to the test of experiment, and arrived at the conclusion that in the Vaterian Papillæ no electricity or electro-magnetism can be demonstrated.[1]

## CHAP. II.—THE PARTICULAR TISSUES.

### *Cerebral System,—Brain.* (*Cerebrum.*)

Brain.

The brain or central part of the nervous system may be regarded as a continuous organ, consisting of three divisions, —the *convoluted*, the *laminated*, and the *smooth* or *funicular* portions. Of these divisions, which are distinguished according to the peculiar external configuration of each, the first part corresponds to what is named the brain proper (*cerebrum*); the second to the small brain (*cerebellum*); and the third to the oblong production contained in the vertebral column, and known under the name of the *spinal chord*.

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The convoluted portion presents two surfaces, an outer or convoluted, and an inner or figurate. The laminated portion in like manner presents two surfaces;—an outer or laminated, and an inner or central. The third has only one surface, which is exterior. These different surfaces, and their mutual relations, will be more minutely explained afterwards. At present we shall examine its physical and anatomical characters as an organic substance.

The three divisions of the central part of the nervous system are composed of a peculiar substance which may be denominated *cerebral matter*, inclosed in delicate vascular membranes. To exhibit the external characters of this substance, these membranes must be removed by careful dissection. When this is done, and the brain is inspected on its surface and after sections, the cerebral matter is observed to vary in colour, consistence, and intimate structure, in different parts of the organ. These varieties of cerebral matter are most easily distinguished, according to their colour, into *white* and *gray* or *cinereous*.

The white cerebral matter is of different shades in different parts of the brain. Its most usual hue is orange-white, or orange-white inclining to reddish-white, or purplish-white. This is most distinctly recognized in the mesolobe (*corpus callosum*), and in the body named *hippocampus major*. The consistence of the white cerebral matter is considerable. It is in general more tenacious and cohesive than the gray matter, and when indurated is less brittle.

A section made by a sharp scalpel appears smooth and of a uniform colour, traversed by reddish points and streaks. It presents nevertheless different appearances in different directions. In certain parts, for example the mesolobe, it presents the appearance of minute capillary lines, arranged in parallel juxtaposition, and giving what is named a fibrous appearance. In other regions, however, as in the white matter of the optic chambers, this cannot be recognized.

White cerebral matter has been examined microscopically by Della Torre, Prochaska, the Wenzels, Sir Everard Home, and M. Bauer.

If we trust the observations of Father Della Torre, the white and gray substance of the brain, *cerebellum*, *medulla oblongata*, and spinal chord, consist of an aggregation of infinite transparent globules, floating in a pellucid, crystalline and somewhat viscid fluid. The only difference which he admits among the matter of these several parts is, that he represents the globules to be largest in the brain, smaller in the *cerebellum*, and still more minute in the *medulla oblongata* and spinal chord. The arrangement of these globules in the central portion of the nervous system he further represents to be promiscuous.

Prochaska placed on a thin plate of glass minute slices of cerebral matter, so thin that they were translucent; and in this state he found it consist of innumerable globular particles, united by delicate, pellucid, flocculent matter, like filamentous tissue. These globules varied in size even in the same part of the brain. In general, however, he found them both in the brain and cerebellum to be rather more than eight times smaller than the globules of the blood. He was unable to ascertain anything regarding their intimate structure.

The Wenzels found the white cerebral matter to consist of very minute globules, or roundish atoms, resembling spherical cells containing proper medullary or white cerebral substance. The dimensions of these globules they did not attempt to estimate; but represent them in general as exceedingly minute, and all of the same size. They could not

[1] Zu den Pacinischen Körperchen (Papillæ. Von A. Vater.) Von Dr J. Carl Strahl. Müller's Archiv, 1848. Seite 165. Edinburgh Medical and Surgical Journal. Volume seventy-third, p. 118, 1850.

recognize any connecting medium. The globular appearance was retained in portions of brain exposed to the action of alcohol and muriatic acid, and in those even which had been dried after induration in alcohol.

M. Bauer placed a thin slice of white cerebral matter on a plate of glass previously moistened, and allowing a drop of water to fall on it, held obliquely, and thereby to diminish its cohesion, brought into distinct view innumerable loose globules, many fragments of fibres of single rows of globules, and bundles of fibres, some of considerable length.

The use of water in this mode of examination is to dissolve and remove a viscid, gelatinous, semifluid substance, on which the adhesive properties of the white matter seem to depend. If water is not used, the brain adheres to the glass, and the globular appearance cannot be recognized.

These globules vary in size from $\frac{1}{2400}$th to $\frac{1}{4000}$th of an inch in diameter; the general or average size being $\frac{1}{3200}$th. Those of the white matter are largest, that is $\frac{1}{2400}$th. They are translucent, whitish, and arranged in lines or rows of single globules, which are attached to each other by the viscid semifluid mucus. The strings or rows of globules are connected into bundles or *fasciculi* by the same medium. There is reason to believe that the translucency of the globules depends on an albuminous fluid, which on immersion in alcohol or acids is coagulated, and thereby rendered opaque.

When a portion of white cerebral matter is immersed in boiling oil, or is steeped for a few days in alcohol, dilute nitric or muriatic acid, or in a solution of corrosive sublimate, it acquires great firmness and solidity, and may be torn or broken like a piece of cheese, which it could not be before, in consequence of its tenacity. Certain parts, for example the mesolobe, appear then to be distinctly fibrous, or to consist of long capillary lines placed in close juxtaposition. On the length of these filaments or fibrils, however, nothing is ascertained. It is also undetermined whether the white cerebral matter is in all parts arranged in the fibrous manner.

White cerebral matter is well supplied with bloodvessels. These, indeed, are minute; but they consist both of vessels containing red and colourless blood. The division of these vessels gives rise to the appearance of red points (*punctula*) and streaks, which are exhibited on the surface of sections. It is believed to be less vascular than the gray cerebral matter.

On the chemical constitution of white cerebral matter we possess no accurate information; all the chemical analyses hitherto made having been directed to brain, without distinction of its different varieties. From the circumstance, however, of its becoming indurated on immersion in alcohol, acids, and solutions of corrosive sublimate, it is manifest that it contains much albumen. It is rendered yellow by nitric acid. If a portion of indurated brain be placed in the sun, or in a warm atmosphere, an oily or unctuous fluid exudes from its surface, which shows that it contains fatty matter; and if brain be immersed in ether, this fatty matter is partially removed.

The analysis of Vauquelin, which is probably very near the truth, shows that 100 parts of cerebral substance, not distinguishing between white and gray matter, consist of 80 parts of water, 7 of albumen, 4·43 of white adipose matter, 0·70 of red adipose matter, 1·12 of osmazome, 1·5 of phosphorus, and 5·15 of acids, salts, and sulphur. Upon the presence of the albuminous matter depends the solidification which the brain undergoes, when immersed in alcohol, acids, or solutions of the metallic salts, by which albumen is coagulated. Upon the presence of the white adipose matter depends the formation of those brilliant white crystalline plates, resembling cholesterine, observed by M. Gmelin, in the brains preserved in the Anatomical Cabinet at Heidelberg. The opinion of this chemist, that it pre-exists in the brain in the form of adipocerous or cholesterine matter, is to a certain extent probable. The elements, at least, of this matter, that is elaine and stearine, must exist in the brain.

Couerbe distinguishes in brain four fatty principles, Cerebrot, Eleencephol, Cephalot, and Stearokonot.[1]

The first is the solid white adipose matter of Vauquelin, the brain wax of Gmelin. Eleencephol is a yellow red oil disagreeable odour. Cephalot is a saponifiable article. Stearokonot, also saponifiable, is hard and pulverizable.

The gray or cinereous cerebral matter, though variable in colour like the white, is in general a mixture of ash-gray and wood-brown, darker than the former, but lighter than the latter. The colour varies at different ages. It is light in early life, and deeper as life advances.

The gray cerebral matter is softer and less viscid and tenacious than white cerebral matter. It is distinctly grannlar, both in the external surface and when torn or broken. This appearance, however, is most distinctly recognized after induration in alcohol or acidulous liquors. In the convoluted part of the brain, where it is most abundant, it does not present the fibrous or parallel linear arrangement, and is merely an aggregated mass of numerous minute granules. It is uncertain whether it presents the fibrous arrangement in other parts of the brain. An appearance of this kind is recognized in the unciform bundle at the inner end of the fissure of Sylvius, and also in the streaked bodies and the annular protuberance. But the appearance alluded to seems to depend not on the genuine fibrous arrangement of the granules of the gray matter, but merely on the gray matter being deposited in streaks and lines between the white. Meckel nevertheless maintains that the gray matter is also fibrous.

According to the observation of Sir Everard Home and M. Bauer, the gray cerebral matter consists of minute globular atoms, smaller than those of the white matter, or varying from $\frac{1}{3200}$th to $\frac{1}{4000}$th of an inch in diameter. These globules appear to be united, though more loosely, by a sero-albuminous fluid of a yellower tint than that of the white matter. Home supposes this albuminous fluid to be less abundant in the gray matter.

Gray cerebral matter is well supplied with bloodvessels, which are large and numerous. It must not be imagined, however, that all the vessels which are observed to enter this substance are therefore distributed to it. These large vessels necessarily penetrate the gray matter of the convoluted surface before they reach the white matter in the centre; and though they send branches to the former, they are ultimately distributed to the latter. The gray cerebral matter, nevertheless, is generally represented to be more vascular than the white; but the circumstance now stated renders this doubtful. The statement of Sir Everard Home, that "the finest and most delicate branches of the arteries and veins are only found in the cortical, *i. e.*, the gray substance," is contradicted by observation; for the vessels are certainly in general larger and more distinct in this than in the white matter. But if they are larger in the former, they are more numerous in the latter. On the whole, perhaps, there is little difference between the vascularity of the white and gray substance of the brain.

The chemieal constitution of gray cerebral substance has not been accurately examined. The results of analysis show, nevertheless, that it contains albuminous matter to the

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[2] Du Cerveau, consideré sous le point de vue Chemique et Physiologique. Paris, 1834. 8vo.

amount of about 7 per cent., with 0·70 of a peculiar red adipose matter, which is probably the cause of the peculiar colour.

These two varieties of cerebral matter are combined in various modes and proportions in the brain. In general the gray matter is found on the exterior, for instance on the convoluted surface of the brain, and on the laminated surface of the cerebellum; while the white matter is arranged in the central parts. Gray matter, nevertheless, is found in the interior, in the streaked bodies and optic *thalamus*, and in the moriform bodies (*corpora dentata*) of the cerebellum and olivary eminences.

Besides the two varieties of substances now mentioned, a third, of a deeper shade, is found in the brain. Thus, in the centre of the cerebral limbs is a quantity of cerebral matter of a dark or ink-spotted tint, which Vicq d'Azyr therefore named the black spot (*locus niger*) of the limbs of the brain. The nature of this black spot, which is quite uniform, is entirely unknown. It appears merely to be a modification of the gray matter.

A yellow-coloured substance has also been supposed to exist in the *centrum semicirculare geminum*, a narrow band between the striated body and optic thalamus. This substance is certainly firmer than the adjoining white and gray matter, and it is further peculiar in possessing a sort of tint between wax-yellow and wine-yellow. It is highly vascular. Of its other peculiarities, however, we know nothing; and we must be satisfied with regarding it as an anomalous species of animal substance, approaching to gray cerebral matter in colour, but infinitely firmer and more tenacious.

The microscopical observations made by Ehrenberg agree in some points with those made by Prochaska and Bauer; and in others they differ a little.

According to Ehrenberg, the substance of the circumference, or the convoluted part of the brain, consists of a thick, very delicate, vascular network, conveying often numerous blood-globules, and traversed by serpentine tendinous fibres. Besides the thick delicate vascular net of the first substance, Ehrenberg saw in the same, near its utmost edge and its remotest circumference, a very fine-grained soft substance, in which here and there are imbedded larger grains or *nuclei*. These large grains are free, and consist of granules or *nucleoli*, which are connected in rows by means of slender threads to the fine small threads of the substance singly. In the neighbourhood of the medullary substance, the fibrous character of the cortical matter always appears more distinctly; and in the same substance the bloodvessels are larger and less numerous.

The white or medullary matter of the brain shows more distinctly the arrangement of fibres, which proceed in the form of direct and enlarging continuations of the delicate cortical fibres, from certain eminences, that is, the linear or band-like origins of the convoluted surface, in a radiated manner, towards the brain. These are not simple cylindrical fibres; but resemble hollow strings of pearls, the component parts of which are not in contact, but are connected by a canal for a small space; or they resemble tubes or cylindrical canals dilated at intervals into minute bladders. These bladders or *ampullulæ* of the tubes were known to Leeuwenhoeck, who regarded them as globules of fat, which constituted the greatest part of the brain. The connecting canals also he has obscurely indicated. These tubes, uniformly straight, are generally parallel in direction, sometimes, however, crossing each other. Four times Ehrenberg recognized ramification in such individual canals; but anastomoses he never observed. These tubes vary in diameter from $\frac{1}{96}$th to $\frac{1}{3000}$th of one line.

In the neighbourhood of the base of the brain, and in the matter surrounding the ventricles, there are always seen, between these bundles of nodulated or jointed tubes, individual tubes much thicker than the rest. In these thick tubes it is often possible to recognize in their walls an external and internal boundary; or they present, besides their two external boundary lines, other two inner lines, which enable the observer to distinguish the width of the area of the internal cavity of the tubes. These nodulated linear parts of the brain are VARICOSE ARTICULATED TUBES OR CANALS.

The large cerebral tubules of the cerebral matter converge towards and pass into those parts of the base of the brain, where the peripheral nerves arise. Some of the large jointed-tube matter appears to terminate in or be connected with the cerebral cavities, in the walls of which it is well developed. Many jointed or varicose tubes pass into the spinal marrow, and thence immediately proceed to the spinal nerves.

In the spinal marrow the arrangement now described is in some respects reversed. In the brain the most vascular and delicate structure is placed at the exterior; while the least vascular, but perhaps more organized, viz., the varicose tubular structure, is placed at the interior. In the spinal chord the most vascular and delicate part lies in the centre; while it is covered externally by the coarse medullary matter.

Both substances are quite like those in the brain. From the external medullary matter, consisting of large varicose or moniliform tubes, the spinal nerves immediately proceed; and these varicose or jointed tubes, as they emerge from the investing *dura mater*, assume suddenly the form of nerve-tubes, becoming thicker and passing into the pure cylindrical form. These transitions are easily recognized in the posterior part of the spinal marrow.

The optic, the auditory, and the olfactory nerves are immediate continuations of, or productions from, the varicose medullary tubes of the brain. All the other nerves, excepting the sympathetic in the middle of its course, differ from the cerebral matter.

All the other nerves also consist only of cylindrical parallel-lying tubes, about $\frac{1}{120}$th part of a line in diameter, normally never anastomosing. These are the elementary nerve-tubes, which, united in *fasciculi* or bundles, again form larger bundles, which constitute the nerve-chords.

These are the chief facts ascertained by Ehrenberg regarding the minute structure of the brain and spinal chord. These have been mostly confirmed by Berres and Müller. By others, again, the accuracy of these results has been called in question. Thus the observations of Treviranus, Valentin, and Weber tend to show that all the primitive cerebral fibres or tubes are cylindrical, and that the varicose or moniliform appearance is an effect of compression, or the violence employed in subjecting them to microscopic observation. Müller, nevertheless, admits that the primitive cerebral tubes have great proneness to become varicose or beaded.[1]

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[1] C. G. Ehrenberg in Poggendorff's Annalen der Physik und Chemie, Jahrg. 1833. Band XXVIII. § 449–65, und 1834. Band XXXIV. § 76, 80. Also Beobachtung einer bisher unbekannten auffallenden structur des Seelenorgan bei Menschen und Thieren. Von C. G. Ehrenberg. Gelesen in der Akademie der Wissenschaften am 24 October 1833. Gedruckt im, Feb. 1836. Abhandlungen; seite 665. Translated, with Additions and Notes. By David Craigie, M.D. Edin. Med. and Surg. Journal, Vol. XLVIII. p. 257. Oct. 1837.

G. Valentin uber die Dicke der varicosen Faden in dem Gehirn und dem Ruckenmark des Menschen. In Müller's Archiv. 1834. § 401–410.

G. R. Treviranus Beitrage zur Aufklarung der Erscheinungen und Gesetze der Organischen Lebens Band I. Heft II. 1836–8, § 24. II. und Heft. IV. 1836.

E. H. Weber in Schmidt's Jahrbuchern der in-und-auslandischen Medicin. Bd. XX. § 5. und Henle ebendaselbst. § 339.

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The only points which, amidst the discordance of the results of different microscopical observers, from Leeuwenhoeck and Fontana to Ehrenberg, Berres, Treviranus, and Müller, can be regarded as established, are the following: that the convoluted portion of the brain consists of very minute granules or *nucleoli* arranged in rows so as to form fibres, which radiate from the periphery to the inner boundary of the convoluted portion; that near the inner boundary, and as they approach the white cerebral matter, this fibrous arrangement becomes more distinct; and that the white cerebral matter forming the walls of the ventricles and the base of the brain, is composed of tubular cylinders, mostly of large size, and having a cylindrical cavity; but whether these are varicose or not seems undetermined.

The parts named pituitary and pineal glands present several peculiarities deserving attention; but these more properly come under the head of Special than of General Anatomy.

*Flesh, Muscle.* (Μυς,—Μυες,—*Musculus,—Lacertus,—Tori.*) *Muscular Tissue.* (*Tissu Musculaire.*)

Muscle.

The ordinary appearance of the substance named flesh or muscle is familiar; and it is unnecessary to enumerate those obvious characters which are easily recognized by the most careless observer. A portion of muscle, when carefully examined, is found to consist of several animal substances. It is traversed by arteries and veins of various size; nervous twigs are observed to pass into it; it is often covered by dense whitish membranous folds (*fasciæ*), or by serous or mucous membranes, all which shall be examined afterwards; and it is found to contain a large proportion of filamentous tissue. But it is distinguished by consisting of numerous fibres disposed parallel to each other, and which may be separated in the same manner by proper means. The appearance, arrangement, and characters of these fibres demand particular notice.

Muscular Filament.

According to Prochaska, muscle in all parts of the body may be resolved, by careful dissection, into fibres of great delicacy, as minute as silk filaments, but pretty uniform in shape, general appearance, and dimensions. Their diameter appears not to exceed the $\frac{1}{40000}$th part of an inch, whatever be their length. They seem all more or less flattened or angular, and appear to be solid diaphanous filaments. Prochaska, not doubting that these muscular threads (*fila carnea*) are incapable of further division, terms them *primary muscular fibres*.

The microscopical examination of the atomic constitution of the muscular filament, which was first attempted by Leeuwenhoeck, and afterwards prosecuted by Della Torre, Fontano, Monro, and Prochaska, was resumed by Sir E. Home and M. Bauer, and subsequently by Hodgkin and Lister, Mr Skey, M. Mandl, Mr Bowman, Schwann, Henle, Remak, and Kölliker. According to the observations of M. Bauer, each muscular filament appears to consist of a series of globular or oblong spheroidal atoms, disposed in a linear direction, and connected by a transparent, elastic, jelly-like matter. (*Phil. Trans.* 1818, 1826.)

The primary muscular fibres are placed close and parallel to each other, and are united in every species of muscle into bundles (*fasciculi, lacerti*) of different but determinate size; and according as these bundles are large or small, the appearance of the muscle is coarse or delicate. In the deltoid the bundles are the largest. In the *vasti*, *glutæi*, and large pectoral muscles the bundles are greatly larger than in the *psoæ*. In the muscles of the face, of the ball of the eye, of the hyoid bone, and especially in those of the perinæum, these bundles are very minute, and almost incapable of being distinguished. The number of ultimate filaments which compose a bundle varies in different muscles, and probably in different animals. In a muscular fibre of moderate size in the human subject, Prochaska estimates them to vary from 100 to 200; and, in animals with larger fibres, at double, triple, or even four times that number. There is reason to conclude, from correct microscopic observation, that the largest do not exceed the eighth part of one inch, and that the smallest are not less than one-sixteenth.

General Anatomy.

Muscular Filament.

According to Mr Skey, a single muscular filament has a diameter of $\frac{1}{400}$th part of one inch. According to Mr Bowman, who has given the diameter of the primitive fibre in many animals, both of the Vertebrated classes and the Aspondylous tribes, the diameter varies from $\frac{1}{512}$th part to $\frac{1}{209}$th in the male, and from $\frac{1}{615}$th to $\frac{1}{784}$th part of one inch in the female of the human race. In the Mammalia and Birds, they are in general smaller. In the horse, from $\frac{1}{1100}$th to $\frac{1}{508}$th; in the cow, from $\frac{1}{370}$th to $\frac{1}{192}$th; in the sheep, from $\frac{1}{610}$th to $\frac{1}{520}$th. In the owl, the diameter of these primitive filaments are from $\frac{1}{1000}$th to $\frac{1}{600}$th; in the turkey, from $\frac{1}{700}$th to $\frac{1}{550}$th part of one inch.

When the muscular fibre is examined by the microscope, it is found to present transverse or cross lines, of great minuteness. These transverse streaks (*striæ*) are conceived to indicate circular annular markings going all round the fibre. They are placed closely together, but varying much in thickness and in number; a portion of the length of the fibre, equal to its diameter, containing, according to Mr Skey, from sixteen to twenty-five streaks.

These transverse lines are not seen with equal distinctness in all the muscular fibres of the voluntary muscles. When distinct, they present themselves in the form of rings, pretty well defined, the extremities of which may be distinctly traced, encircling the fibre, equidistant from each other, uniform in diameter, and apparently raised from the surface into ridges, having depressions between them. Mr Skey infers, as in certain lights light-coloured lines are seen, and dark intervening lines, that the light lines are the elevated *striæ*, and the dark-coloured lines are the intermediate depressions.

These alternate light and dark-coloured transverse lines are characteristic of voluntary muscles in all parts of the body, and in all animals. They are not observed in the muscles of organic life, or those of the involuntary organs, the heart excepted; for instance, the muscular fibres of the stomach, of the intestinal canal, and the bladder.[1]

The muscles which present these cross-lines are sometimes named Striped muscles; and as the aspect remotely imitates a string of beads, they are occasionally called Beaded muscles. In consequence of the stripes being found solely in the voluntary muscles, the latter are often called Striped and Beaded muscles.

The nature of these transverse lines and markings is not perfectly known. Prochaska appears to have believed that they were produced by minute flexuosities of fibrils, and connected in some manner with the filamentous tissues. Fontana believed that they were caused by small diaphragms or partitions of the primary filaments. Mr Skey remarks, that the *striæ* are invariably large as the fibre is small, while the broad fibres exceeding the average diameter of $\frac{1}{400}$th part of one inch, exhibit the most delicate and minute pencilling possible. He infers that these *striæ* are ridges or elevations on the longitudinal fibre, leaving between them depressions considerably smaller than the globules of the blood; that each fibre is divisible into *fibrillæ*, which are composed of many ultimate filaments, and which are arranged in

[1] On the Elementary Structure of Muscular Fibre of Animal and Organic Life. By F. C. Skey, F.R.S. Phil. Trans., Lond. 1837. Vol. xxi. p. 371. On the Minute Structure and Movement of Voluntary Muscle. By W. Bowman. *Ibid.* 1840, Art. xxi. p. 457.

parallel lines round the axis of the fibre; that the muscular filaments have a diameter of about the third part of a globule of the blood; that they are tubular, and contain a soluble glutinous substance; and that this structure belongs to all the external muscles, and all the internal muscles connected to any form of tendinous matter.

According to Mr Bowman, several of these views of Mr Skey are not susceptible of strict proof. Mr Bowman represents the primitive *fasciculi* of the fibre of voluntary muscles to consist of elongated polygonal masses of primitive component particles, or what he calls Sarkous elements, arranged and united together both by their ends and by their sides, so as to constitute in these directions respectively *fibrillæ* and disks, both of which exist together in the perfect unmutilated muscular filament, and either of which may, in certain cases, be detached separately. According to the same observer, the dark longitudinal striæ are shadows between *fibrillæ;* the dark transverse streaks are shadows between disks. The primitive fasciculus consists of primitive component segments or particles, arranged so as to form in one sense *fibrillæ*, in another disks; and which of these two present themselves to the observer, depends upon the amount of adhesion. Generally, in a recent fasciculus, there are transverse *striæ* or stripes, showing the division into disks, and longitudinal lines marking the division into fibrillæ. These *striæ*, in short, are the edges or focal sections of plates or disks arranged vertically to the course of the fasciculi, and each of which is composed of a single segment from each fibrilla.

Ultimate Filaments.

The *fasciculi* are not tubular and hollow, but consist of a true bundle of *fibrillæ*. That this is the fact, Mr Bowman argues, is proved by making a transverse section, which presents no appearance of any cavity.

By cutting a muscle across, these bundles are observed to differ, not only in size, but in shape. Some are oblong and rhomboidal, others present a triangular or quadrangular section, and in some even the irregular pentagon or polygon may be recognized.

According to the observations of Kölliker, the form most usual is that of the hexagon, not quite regular; and when two sides run into one, it assumes the shape of the pentagon. Bowman merely says, that they are in all animals polygonal, though in some instances they make a near approach to the cylindrical form. This is easily understood. If the angles be rounded, the filament that might be polygonal or hexagonal becomes cylindrical.

Sarkolemma.

These bundles or *fasciculi* are united by filamentous tissue of great delicacy. Each filament or fibril is inclosed in a sheath of peculiar matter, described by Schwann, and afterwards by Bowman, under the name of *Sarkolemma*, or Flesh Coat. This structure is entirely different, according to the last author, from filamentous tissue, either penetrating or generally investing. It may be discovered in unbroken fasciculi, in the form of a straight linear margin, quite unconnected with and independent of the *striæ*. The sarkolemma is tougher and firmer than the muscular filament.

The fibrils and fibres thus inclosed in *Sarkolemma* are united into Fasciculi, which are inclosed by filamentous tissue, and are penetrated by arteries, veins, and nerves. The whole are surrounded by filamentous tissue, which often contains fat; in many instances covered by fasciæ; in all attached by tendons.

This fascicular arrangement appears to be confined to the muscles of voluntary motion. It is not very distinct in the heart or diaphragm; and in the urinary bladder and intestinal canal it is not recognised. Nor is the parallel arrangement of the ultimate filaments always strictly observed in the involuntary muscles. The component fibres of this order of muscles are often observed to change direction, and unite at angles with each other. This fact, which was observed by Leeuwenhoeck, has been verified by Prochaska.

The colour of muscle varies. In man and the mammiferous animals, at least adult, it is more or less red; in many birds and fishes it is known to be whitish; in young animals it is grayish or cream-coloured; and the slender fibres which form the middle coat of the intestines in all animals are almost colourless. The colour of the muscles of voluntary motion in man is red or fawn; but repeated washing or maceration in alcohol or alkaline fluids renders them much paler.

The examination of the physical properties of muscle has occupied the industry of Muschenbroek, Croone, Browne Langrish, Wintringham, and others of the iatro-mathematical school. I cannot perceive that minute knowledge of these properties is of much moment to the elucidation either of its sound or its morbid states. Amidst the variable results obtained in such an inquiry, the only certain point is, that muscular fibre has less tenacity and mutual aggregation than most other tissues. It sustains much less weight and force of tension without giving way.

Chemical analysis has not yet furnished any satisfactory results on the nature of muscular tissue; but the general results of the numerous experiments already instituted show that muscle contains fibrin, albumen, gelatine, ex tractive matter (osmazome), and saline substances. It is difficult to say how far the gelatine is to be regarded as proper to muscle, or derived from the filamentous tissue in which it certainly exists. The saline matters are common to muscle with most other organic substances. There is reason to believe that fibrin in considerable quantity and albumen and osmazome in smaller proportion, are the proper proximate principles of muscle. Though the various proportions of these principles have been stated in numbers by chemists, it is impossible in the present condition of animal chemistry to place any reliance on them. It is also to be remembered that the relative proportion of the proximate principles varies at different periods of life. In early life the muscular fibre contains a large proportion of gelatine, and very little albumen, fibrin, or osmazome. In adult age, however, the gelatine is very scanty, and the fibrin is abundant. The albumen and gelatine found in muscle seem to be derived chiefly from the filamentous tissue and the aponeurotic intersections.

During life the muscular fibre possesses the property of shortening itself or contracting under certain conditions. These may be referred to the following heads: 1*st*, The will in the voluntary muscles; 2*d*, proper fluids in the involuntary muscles, as the blood to the heart, articles of food or drink in the stomach, chyme in the small intestines, excrement in the large intestines, urine in the bladder, &c.; 3*d*, mechanical irritants in all muscles; 4*th*, chemical irritants; and, 5*th*, morbid products generated in the course of disease.

This property of contracting has received various names: contractility, *vis contractilis* of L. Bellini; irritability of Glisson; *vis vitalis* of De Gorter and Gaubius; excitability, mobility, *vis insita, vis propria* of Haller; and the organic contractility of Bichat. It is peculiar to muscular fibre, and is found in no other living tissue.

The inquiry into the properties peculiar to muscles, and the influence of the brain and nerves over muscular contraction, forms an interesting subject of investigation, on which many facts have been communicated since the time of Haller and Whytt, and within the last forty years by Nysten, Le Gallois, Wilson Philip, Bell, Magendie, Flourens, Fodera, Rolando, and Longet. But it is too extensive to be considered in this place; and, for information

General Anatomy. Muscle.

on the subject, I refer to the ordinary physiological works, and to those journals in which these researches are detailed.[1]

The muscles have been divided, according to the manner in which the phenomena of contraction take place, into, 1*st*, muscles obedient to the will, or voluntary; 2*d*, muscles not under the influence of the will, or involuntary; and, 3*d*, muscles of a mixed character, the motions of which are neither entirely dependent nor independent on the will.

The first order comprehends all the muscles of the skeleton; the second includes the hollow muscles, as the heart, stomach, and intestinal canal; and in the third are contained such muscular organs as the diaphragm, intercostal muscles, bladder, rectum, &c.

The muscles have also been distinguished, according to their mechanical shapes, into long muscles (*musculi longi, vel teretes*), broad muscles (*musculi lati*), and irregular muscles, or those of mixed form. The long muscles are found chiefly in the extremities; the broad muscles in the trunk; and those of irregular shape either in the trunk, or passing from this to the extremities. From the direction of their fibres, several of them are distinguished into penniform and semipenniform.

### *Sinew, Tendon.* (*Tendo.*)

Tendon.

Sinew or tendon was united by Bichat with ligament, fascia, aponeurosis, and periosteum, under the general name of *fibrous system;* and the substance of this arrangement has been adopted by Gordon, Meckel, and Beclard. From personal observation, however, I am inclined to regard tendon as essentially distinct, at least in the present state of knowledge, from these substances. Examined anatomically, it does not bear a very close resemblance to any of them; and in its known chemical properties it is considerably different.

The appearance of this substance must be familiar. Almost cylindrical in shape, but flattened at the muscular end, and tapering where inserted, a tendon consists of numerous white lines as minute as hairs, of satin-like glistening appearance, placed parallel and close to each other. A tendon is easily divided, and torn into longitudinal or parallel portions; and by the forceps very minute fibres may be detached and removed with ease, its whole length. These facts show the great tenacity of this tissue, and the regular parallelism with which the component fibres are united. The last circumstance distinguishes them completely from ligaments and periosteum, in which the fibres cross in all directions, and in consequence of which these tissues cannot be so easily split or separated. These fibres are united by filamentous tissue.

Tendon is softened and more easily separable by maceration in water or alkaline fluids; it is crisped by acid fluids, and rendered translucent by immersion in oil of turpentine. It has not been injected, but it is presumed to have blood-vessels and absorbents. No nerves have been traced into it.

Tendon when boiled becomes soft and large, assumes the appearance of a transparent gelatinous substance, and finally, if the boiling be continued, is dissolved and converted into gelatine. This fact, which is well known to cooks, who prepare jellies from tendinous parts of young animals, shows that tendon consists principally of gelatine, disposed in an organized form.

A species of flattened tendons, to which the name of *aponeurosis* has been given, may justly be united with this tissue. The best examples are in the aponeurotic or tendinous expansion of the external oblique muscle of the abdomen, the aponeurotic part of the occipito-frontal muscle of the head, and the upper or broad end of the *tendo Achillis.* The anatomical structure and the chemical properties of each of these varieties of animal substance are quite similar, and somewhat different from that which has been termed *fascia.*

General Anatomy. Tendon.

### *White Fibrous System. Ligament.* (Δεσμος, οἱ Δεσμοι.) *Periosteum,—Dura Mater,—Fascia.*

Against the formation of this order of tissues fewer objections can be urged, though ligament and periosteum undoubtedly furnish its most perfect examples; and it may be doubted whether *fascia* ought to be referred to it, or arranged with tendon and aponeurosis. The *dura mater*, the *tunica albuginea*, and the fibro-synovial sheaths, are to be regarded as compound membranes. Ligament; periosteum.

Ligament and periosteum are easily shown to consist of strong whitish or gray fibres, as minute as threads or hairs, interwoven together in various directions, and thus forming an animal substance which is not to be split or torn asunder as tendon; but when ruptured by extreme force presents an irregular ragged surface or margin. Maceration in water or alkaline fluids separates the component fibres, and shows their irregular disposition more distinctly. They are crisped by affusion of boiling water, or immersion in acids; and they become translucent by immersion in oil of turpentine.

The properties of this tissue are chiefly physical. Those which are vital are referable to its organization and nutrition. That it is powerfully resisting, and is one of the toughest and strongest tissues in the animal body, is evinced not only by the numerous experiments recorded in the writings of the iatro-mathematical physiologists, but by the barbarous mode of punishment by rending the limbs asunder by horses. It is supposed to possess the exhaling ends of arteries and colourless veins. No nerves have been recognised; and Bichat expresses his ignorance of absorbents being traced into it.

Ligament when boiled yields a small portion of gelatine, but obstinately resists the action of boiling water, and retains both its shape and tenacity or cohesion. The crispation which it undergoes in boiling water, alcohol, and diluted acids, seems to indicate that albuminous matter forms its chief chemical principle.

As to their mechanical shape, the ligaments are divided by Bichat into two sorts; those in regular and those in irregular bundles. The former comprehends all the distinct clusters of ligamentous structure, which, sometimes in a cylindrical, sometimes in a flattened shape, connect the articulating ends of bones, and form the lateral ligaments of the various articulations. The latter consists of those loose parcels of ligamentous fibres which are found in various regions of the skeleton, not in regular cylindrical or longitudinal bands, but irregularly connecting bones not admitting of articular motion; for instance, at the *symphysis pubis* and the sacro-iliac junction. The division of Beclard into articular, non-articular, and mixed, is more comprehensive and more natural. The first are those which connect the articular extremities of different bones. The second are those which, attached to different parts of the same bone, convert notches into foramina, as in the orbital arch and the supra-scapular hollow, or close openings, and

[1] *Elementa Physiologiæ*, tom. iv. lib. xi. sect. 2; Whytt *on the Vital and Involuntary Motions*: *Journal de Physiologie*, tom. i. ii. &c. *Archives Générales*, passim. Müller's Archiv fur Anatomie und Physiologie, *passim*.

General Anatomy.

Ligament; periosteum.

give attachment to muscles, as the obturator ligament. The last are those which, like the sacro-ischiatic or the interosseous ligaments of the fore-arm and leg, connect bones susceptible of little or no motion, and especially give attachment to muscles. The two latter species of ligaments approach closely in their characters, physical and anatomical, to periosteum, and are probably to be regarded as modifications of this membrane.

The articular or perfect ligaments are naturally divisible into two subgenera,—the capsular and the funicular.

The *capsular* ligaments, or the fibrous capsules (Bichat), consist of cylindrical ligamentous sheaths attached all round to the ends of the articulating bones, and intimately interwoven with the periosteal tissue. Consisting essentially of fibro-albuminous matter strongly compacted, they are surrounded by cellular tissue, or rather celluloso-adipose tissue, and are lined internally by synovial membrane. Though the most perfect examples of the capsular form of ligament are presented in the scapulo-humeral and coxo-femoral articulations, less complete ones, nevertheless, are seen in the other joints. In those of the knee and elbow, an arrangement of this kind may be demonstrated; and minute capsules may be shown to connect the oblique articular surfaces of the vertebræ with each other.

The *funicular* ligaments, which consist of round chords or flat bands, are employed in connecting the articular ends of bones either without or within the cavity of the joint. Of those of the former description, the best examples are seen in the elbow and knee joints, and in the wrist and ankle, where they are termed *lateral* ligaments (*l. lateralia, accessoria*). Of the latter instances are the round ligaments (*ligamenta teretia*) of the shoulder and hip joints, and the crucial ligaments of the knee-joint. These receive an investment of synovial membrane.

Fascia.

Of the white fibrous tissues, one of the most important is that denominated *fascia*. Consisting in intimate structure of long fibrous threads placed in parallel juxtaposition, sometimes obliquely interwoven and closely connected by filamentous tissue, it forms a whitish membranous web, variable in breadth, of some thickness and great strength. Fascia is perhaps, not excepting the skin, the most extensively distributed texture of membranous form in the animal body. It not only covers, if not the whole, at least by far the greatest part of the muscles of the trunk and each limb, but it sends round each muscle productions by which it is invested and supported, and even penetrates by minute slips into the substance of individual muscles. Of several of the large muscles it connects the component parts, as is seen in the *recti abdominis;* to many it affords points of origin or insertion; and to all it furnishes more or less investment and support. Most of the tendons, especially the flexor and extensor tendons, are inclosed by it; and their synovial sheaths derive from it their exterior covering. At the extremities of the bones it is connected with the ligaments and periosteum, with which it is closely interwoven; and it forms a general investment to the articular apparatus.

Though fascia may thus be viewed as one membranous web consisting of many parts all directly connected with each other, it is the practice of anatomists to distinguish its divisions according to the region which they occupy. Thus, in the fore-part of the neck and chest is found a fascia, the relations and uses of which have been well described by Mr Allan Burns. In the cervical region we find a firm fascia descending from the occipital bone along the vertebræ, covering and connecting the muscles of each side till it reaches the loins, where, in the form of a thick strong membrane, it forms the *lumbar fascia* (*fascia lumborum*). It may further be traced over and between the *glutæi* muscles, connected afterwards with the broad femoral fascia (*fascia lata*), and thence over the knee and leg to the foot. Much in the same manner a membranous web, thinner and more delicate, but of the same structure, may be traced from the chest along the upper extremity, till at the wrist it is identified with the annular ligament, and in the hand with the palmar fascia. In all these situations the general fascial envelope sends slips or productions (*fasciæ intermusculares*) between the muscles, and into their substance.

*Yellow Fibrous System. Elastic Ligaments of* John Hunter. (*Ligamenta Flava,—Ligamentum Nuchæ,—Tissu Fibreux Jaune*, Beclard.)

Elastic ligaments.

The yellow ligaments (*ligamenta flava*) which connect the spinous processes of the vertebræ to each other differ considerably from the articular ligaments and the periosteum, and suggested to Beclard the necessity of establishing a particular order of fibrous tissues, to which he applies the denomination of *yellow or tawny fibrous system.* Under this he includes also the proper membrane of the arteries; that of the veins and of the lymphatic vessels; the membranes which form excretory ducts; that of the air-passages; the fibrous covering of the cavernous body of the urethra, and perhaps that of the spleen. The actions and occasional distensions of which these parts are the seat require, it is said, a tissue, the resistance and elasticity of which may at once counteract any extraordinary effort, and cause them to resume their original state, when the distending cause ceases to operate. In the lower animals this purpose is more conspicuous than in the human subject. The posterior cervical ligament (*ligamentum nuchæ*, Arab.; *cervicis*, Lat.) in the camel, giraffe, deer, and ox, counteracts the tendency to inclination of the head; and a similar membrane strengthens the abdominal parietes, and resists the weight and distending power of the *viscera*. In the feline tribe an elastic ligament inserted into the unguinal phalanges retains them extended so long as the muscles do not alter their direction. The shells of the bivalve molluscous animals, as oysters, mussels, &c., are opened by a similar fibrous tissue as soon as the muscles which close them are relaxed.

The disposition of the component fibres is the same in the elastic as in the common white fibrous system. Their colour, which is yellow or tawny, is generally more distinct in the dead subject. They are said to be less tenacious, but more elastic, than those of any other tissue. In respect to chemical composition, they appear to contain a considerable quantity of fibrin in a peculiar condition, combined with some albumen and a little gelatine. Their other properties are not very conspicuous.

*Bone.* (Οστεον,—*Ossa,—Tissu Osseux,*—Die Knochen.)

Bone.

Bone, which is the hardest and most durable of the animal solids, may be defined to be an organized substance, consisting of a combination of animal and calcareous matter, and constituting by its solidity the chief support of the soft parts generally.

In the vertebrated animals it is moulded into pieces of definite shape and size, which are connected either by ligaments, cartilage, or fibro-cartilage, and which constitute the skeleton of the animal. In the mammalia and birds these pieces appear in their most perfect characters, as to solidity, mechanical shape, and numerical extent. In the human subject, though in these respects they partake of the characters common to the bones of the mammalia, in several senses these characters are more conspicuous than in the lower animals.

General Anatomy.

Bone. External forms.

1. The bones of the human skeleton are distinguished, according to the varieties of mechanical figure, into long and cylindrical bones (*ossa longa* sive *cylindrica*), flat bones (*ossa lata* sive *plana*), and short or irregular bones (*ossa brevia* sive *mixta*).

The long bones are confined to the extremities, where they are subservient to the locomotive apparatus, by acting alternately as points of support and as levers movable by the muscles in different directions. Placed in the centre, they are surrounded almost entirely by muscles; and are observed to diminish in length, but increase in number, the farther they recede from their attachment to the trunk. From this inverse arrangement it results that near the trunk the members are distinguished for extent, and remote from it for variety and multiplicity of motion.

The long bones agree in presenting cylindrical or prismatic shafts (*diaphyses*) terminated by large, bulky, and extensive extremities (*epiphyses*). The former are generally small and slender compared with the latter and with the size of the limb, and thus afford room for the bellies of muscles attached to them. The large size of the latter is well suited for the extent of the articular surfaces; and being covered by slender tendons and the taper extremities of muscles, they do not in general add to the bulk of the member.

The shafts of the long bones are in general marked by longitudinal rough lines, to which muscles or fasciæ are attached, and between which are found plane or hollow surfaces for lodging the bellies of the muscles. These lines are rarely straight; and the slight obliquity which they observe gives the bone the appearance of being twisted. This is well seen in the *humerus* and *tibia*.

The extremities of the long bones are marked in general by eminences and hollows, or processes (*apophyses*) and depressions (*foveæ; fossæ*). These inequalities, if tipped with cartilage and synovial membrane, are for the purpose of articulation with other bones. When they are simply formed of bone, they are for the attachment either of ligaments or tendons.

The shafts of the long bones consist chiefly of dense compact bone, containing in the adult a longitudinal cavity, which is easily exposed by a longitudinal section of the bone. This cavity is not cylindrical, but tapers considerably at each end; nor is it in all instances equally complete. Largest and most capacious about the middle, where it is bounded by the solid, compact, bony walls of the *diaphysis*, as the latter diminish in density they increase in bulk by the formation of numerous minute intersecting columns of bone, which progressively increasing in number towards the end of the shaft, contract the cavity, until at length it is obliterated in the lattice-work and cells (*cancelli*) formed by their mutual intersection. This cavity is the medullary canal. It is seen in its most perfect form in the *humerus* and *femur*, in the *tibia* and *fibula*, and in the *radius* and *ulna*. In the phalanges it can scarcely be said to exist. The two forms of bony structure demonstrated in such a section are distinguished as the *dense* or *compact*, and the *loose*, *reticular*, or *cancellated*.

The medullary cavity is lined by a vascular filamentous membrane, with numerous cells, containing the variety of animal fat denominated marrow. The effect of this arrangement is to render the bone lighter than if perfectly solid, without any diminution of strength. This cavity is wanting in the original formation of the bone; and it begins to be formed when the matter of the *diaphyses* becomes dense and compact. It is again obliterated in consequence of fracture or other injuries, succeeded by adhesive or depository inflammation, when it is filled by gelatinous animal matter; and it is once more excavated as the walls of the diaphysis acquire solidity.

The flat bones are in general less connected with the locomotive apparatus than with the protecting part of the skeleton. By mechanical configuration they serve to contain various organs essential to the economy; and when they admit of motion, this is rarely locomotive, but connected with the purposes of the contained organs. The bones of the cranium and pelvis furnish the best examples of bones destined solely to protect, and as locomotive agents affording only points of support. The ribs, again, which are to be viewed as flat bones, not only form the protecting walls of the chest, and furnish support to the muscles of the upper extremities, but further undergo a slight motion, by means of which the dimensions of the chest are alternately enlarged and diminished. The vertebræ combine the characters of flat bones and irregular bones, approaching by their spinal plates to the former class, and by their bodies to the latter.

In number the flat bones vary according to the purpose to which they are applied, and the nature of the cavities which they form. In the cranium and pelvis their numerical extent appears to bear relation chiefly to the facility of ossification,—a process which advances with equal rapidity in each individual piece. In the chest, again, this property is regulated by the kind of motion which the ribs are destined to undergo. The vital organs of circulation and respiration would no doubt have been more securely protected had they been inclosed, like the brain, in a continuous and complete osseous case; but by this arrangement the motions of inspiration and expiration must have been very limited.

The flat bones agree in being convex and concave in opposite directions; in possessing two surfaces, an external and an internal, and a circumference; and in consisting of an external and internal table or thin plate of bone, with loose cancellated structure interposed. This arrangement is most conspicuous in those of the cranium, in which the cancellated structure is distinguished by the name of *diploe*. It is nevertheless equally distinct in the ribs, the scapula, and the pelvic bones. In some instances in the latter, the diploe is obliterated, and the two tables approach each other so closely, that they form one bone; and occasionally this is destroyed, and the bone appears perforated. These effects are the result of long-continued muscular action.

The cancellated structure of the flat bones is lined by a vascular filamentous membrane, containing a small proportion of marrow, less oleaginous than that of the long bones, and entirely resembling those of the cancellated structure of their epiphyses.

The short bones are situate in parts requiring the combination of mobility and solidity; for example, the vertebral column, the *carpus* and *metacarpus*, the *tarsus* and *metatarsus*. Considerable extent of surface, numerous articular and ligamentous connections, with few muscular or tendinous insertions, are their leading external characters.

They consist of a single thin external plate of bone, inclosing a large proportion of cancellated structure, lined by vascular filamentous tissue, containing semifluid marrow, without much oil. While this arrangement combines very small specific gravity with sufficient firmness and solidity, it renders them more liable to derangements of organization than other parts of the osseous system.

Though the bones are thus distinguished according to general characters, it is often impossible to apply them accurately. The same bone may unite the characters of long and short bone, or flat and short bone, or long and

Bone. External forms.

flat bone. All the long bones indeed are in their epiphyses similar to the short bones.

In external figure the bones present certain eminences or processes (*apophyses*), and pits or cavities (*foveæ; fossæ*). The eminences are either articular or non-articular. The former, which are covered with cartilage or fibro-cartilage, belong to the subject of the connections of bones. The latter may be referred to three heads: 1*st*, eminences of insertion for ligaments, tendons, or aponeuroses; 2*d*, eminences of reflection for the transit of tendons round a pulley; and, 3*d*, eminences of impression, or those which correspond to various soft parts in contact with the bones.

The eminences of insertion appear in various shapes, and are distinguished into tuberosities and tubercles (*tubera*), spines (*spinæ*) or spinous processes, styloid processes (*styli*), crests (*cristæ*), and lines (*lineæ*), which are generally rough and elevated. These impressions are always more conspicuous in the male than in the female, in the old than in the young, in the robust and muscular than in the delicate and feeble, and in carnivorous than in herbivorous animals. In some instances, as in the case of the ischial tuberosity, the great trochanter and anterior tuberosity of the humerus, the eminences present individual facettes for the attachment of each tendon or muscle.

Of the eminences of reflection, the best examples are in the unciform process of the pterygoid process of the sphenoid bone, and the lower extremity of the *fibula*.

The depressions are either articular or non-articular. The latter consist of cavities of insertion, reception, transmission and motion, impression and nutrition.

The first, which give attachment to ligaments, tendons, or aponeuroses, are useful in augmenting the extent without increasing the size of bones. The pterygoid cavities, the digastric *fossa*, and that at the base of the great trochanter, afford examples of these cavities.

Of the cavities of reception, examples are seen in the cerebral and cerebellic *fossæ*, and in the grooves for arteries or nerves; for instance, that at the lower margin of the ribs, and the various openings in the cranium for the transit of vessels and nerves.

Cavities of motion are those over which tendons play in the contraction of muscles; the bicipital groove, the hollow between the ischial spine and tuberosity, and that in the *fibula* for the *peronæi*, are examples.

The cavities of impression alternate with the eminences, and are to be regarded as in general the cause of these eminences.

The cavities of nutrition are those minute orifices through which vessels convey to the substance of the bone, or the medullary membrane, the materials of its nutrition. Each long bone has one considerable hole of this kind in its shaft, and numerous minute ones in its extremities. The former is the orifice of a canal to the medullary cavity. The latter are supposed to belong chiefly to the cancellated structure.

Internal structure.

2. Several attempts have at different times been made to ascertain the atomic constitution of bone, but without much success. Malpighi, though he corrected the extravagant fiction of Gagliardi regarding the osseous plates and nails, fancied bones to be composed of filaments, which Leeuwenhoeck represented as minute tubes (*tubuli*). By Clopton Havers, again, the ultimate particles of bones were imagined to be fibres aggregated into plates (*laminæ*) placed on each other, and traversed by longitudinal and transverse pores (*pori*).[1] This view was adopted by Courtial, Winslow, Palfyn, Monro, and Reichel, who was at some pains to demonstrate this arrangement of plates and minute tubes by microscopical observation. These notions were first questioned by Scarpa, who, in 1799, undertook to show by examinations of bone deprived of its earth by acid, and long macerated in pure water, that it consists, both externally and internally, of reticular or cellular structure. So far as I understand what idea this eminent anatomist attaches to the terms *reticular* and *cellular*, I doubt whether this opinion is better founded than any of the previous ones. After repeating his experiment of immersing in oil of turpentine bone macerated in acid, I cannot perceive the reticular arrangement which Scarpa describes. Recently bone has been submitted to microscopic examination by Mr Howship, who revives the opinion of the existence of minute longitudinal canals, as taught by Leeuwenhoeck, Havers, and Reichel, but with Scarpa maintains the ultimate texture not to be laminated, but reticulated. Lastly, the existence of fibres and plates, which is admitted by Blumenbach, Bichat, and Meckel, apparently on insufficient grounds, is to be viewed as an appearance produced by the physical, and perhaps the chemical qualities of the proper animal-organic matter of which bone consists. Though it does not demonstrate, it depends on, the intimate structure of this body.



Bone. Internal structure.

The minute structure or atomic constitution of bone is probably the same in all the pieces of the skeleton, and is varied only in mechanical arrangement. When a cylindrical bone is broken, and its surfaces are examined with a good magnifying glass, or when minute splinters are inspected in a powerful microscope, it appears to be a uniform substance without fibres, plates, or cells, penetrated everywhere by minute blood-vessels. Its fracture is uneven, passing to splintery. In the recent state its colour is bluish-white; but in advanced age the blue tinge disappears. Delicate injection, or feeding an animal with madder, shows the vascularity of this substance.

To have a clearer and more accurate idea of the minute structure of bone, it is requisite to break transversely a long bone, and examine its fractured surface by a good glass, or to examine in the same manner the transverse fracture of a long bone which has been burnt white in a charcoal fire. The broken surface presents a multitude of minute holes, generally round or oval, which are larger towards the medullary cavity, but become exceedingly minute towards the outer surface of the bone. Of these minute holes no part of the bone, however compact in appearance, is destitute; and the only difference is, that they are more minute, and more regularly circular towards the outer than towards the medullary surface. These circular holes are transverse sections of the *tubuli* of Leeuwenhoeck, the longitudinal pores of Havers (*Osteologia*, p. 43 and 46), the pores and *tubuli* of Reichel, and the longitudinal canals of Howship. They communicate with each other by means of their great multiplicity and slight obliquity and tortuosity. They contain not blood-vessels exclusively, but divisions of the vascular filamentous tissue, which secretes the marrow. They are seen very distinctly in bones which have been burnt. After many care-

[1] The principal authors on the structure of bone are, Dominici Gagliardi *Anatome Ossium, novis inventis illustrata.* Romæ, 1689. Malpighi, *De Ossium Structura: Op. Post.* Clopton Havers, *Osteologia Nova.* London, 1691. Delasone, *Mémoire sur l'Organisation des Os: Mém. de l'Académie*, 1751. G. C. Reichel, *De Ossium Ortu atque Structura.* Lips. 1760. Ext. in Sandifort *Thesaur.* vol. ii. p. 171. Antonii Scarpa *de Penitiori Ossium Structura Comment.* Lips. 1799. Republished in *De Anatome et Pathologia Ossium Commentarii*, Auctore A. Scarpa. Ticini, 1827. Papers by Mr Howship in the 6th and 7th volumes of the *Medico-Chirurgical Transactions.*

General Anatomy. Bone. Internal structure.

ful examinations, I have never been able to observe holes in longitudinal fractures of bones; and I therefore infer that there are no transverse pores.

These capillary pores are seen in the flat bones of the scull. I find them in the compact matter of the outer and inner tables of the occipital bone when well burnt, in which they seem to pass gradually from the lattice-work of the *diploe* to the distinct pores of the tables. I doubt, however, whether these pores can be said, as in the long bones, to indicate canals. They seem rather to belong to a very delicate cancellated structure. The pores are most numerous and distinct in the bones of young subjects.

Though these circular pores are most distinct in calcined bones, and might therefore be thought to be the result of the burning, yet that they are not, I infer from the circumstance that they are seen by a good glass in the transverse fracture of splinters of the femur and other large bones.

If a portion of bone be immersed in sulphuric, nitric, muriatic, or acetic acid properly diluted, it becomes soft and pliable, and when dried, is found to be lighter than before; yet it is impossible to discover that any particle of its substance has been removed, or that its mechanical shape and appearance are changed.

If a portion of bone be placed in a charcoal fire, and the heat be gradually raised to whiteness, it burns first with flame, and at length becomes quite red. If then it be removed carefully and slowly cooled, it appears as white as chalk, is found to be very brittle, and to have lost something of its weight. Yet neither in this case does any part of its substance appear to be removed, nor is its mechanical figure or appearance altered.

Chemical examination, however, informs us that in the first case a portion of earthy matter (phosphate of lime) is removed by the agency of the acid, and held suspended in the fluid, while the pliant but otherwise identical piece of bone consists chiefly, if not entirely, of animal matter; and that, in the second case, this animal matter is removed by destructive decomposition, while the earthy matter is left little changed by the action of fire. Every particle of bone, therefore, however minute, consists of animal or organic, and earthy or inorganic matter, intimately united; and it is impossible to touch, with the point of the smallest needle, any part of bone which is not thus constituted. A piece of bone consists not of cartilaginous fibres varnished over, as Herissant imagined, with earthy matter, but of a substance in which every atom consists of animal and earthy matter intimately combined.

There is therefore no ground for dividing osseous tissue into compact and spongy, as the old anatomists did; for though the middle parts of long bones are denser and heavier than their ends, or the bodies of the vertebræ, the difference consists not in chemical composition, but in mechanical arrangement. On dividing the head of a long bone, the lattice-work, or *cancelli*, as they are named, are formed by many minute threads of bone, crossing and interlacing with each other. But each thread is equally dense, and consists of the same quantity of animal and earthy matter, as the most solid part of the centre of the same bone. These threads, however, instead of being disposed compactly so as to take a small space, are so arranged that they occupy a large one, and present considerable bulk.

Though bone has been submitted to analysis by many eminent chemists, the results hitherto obtained cannot be said to be quite satisfactory. The most recent is that of Berzelius, who, in 100 parts of bone from the thigh of an adult, gives the following proportions: of gelatine 32·17, blood-vessels 1·13, phosphate of lime 51·04, carbonate of lime 11·30, fluate of lime 2·00, phosphate of magnesia 1·16, hydrochlorate of soda and water 1·20.

These results by no means agree with those obtained by Fourcroy and Vauquelin, who found neither fluoric acid nor phosphate of magnesia, but discovered oxides of iron and manganese, silica, and alumina, in bone. Sulphate of lime, which was found in the experiments of Hatchett, was shown by Berzelius to be formed during calcination. It is, however, obvious that a little more than a third part of bone consists of animal matter, which appears to be either gelatine, or a modification of that principle; and that the remainder, nearly equal to two thirds, consists of earthy matter, which is chiefly phosphoric acid combined with lime. The carbonic acid said to be united with lime may result from the decomposition of the animal matter. The other saline substances are not peculiar to bone, but, being common to it and the other animal tissues, and even the fluids, may be supposed to be derived from the blood left in the bone at the moment of death.

The animal matter of bones was at one time presumed to be cartilage; but this appears to be an assumption, derived from the superficial resemblance which it bears to this substance. It does not appear to be mere gelatine; for though this principle is obtained from bone, and bones are economically used in manufacturing glue, they do not furnish the same proportion of jelly as tendon, nor are they so useful in making soups, as was once paradoxically maintained by some chemists. It is probable that the gelatine is under a peculiar modification, or combined with some principle which is not well understood. The sulphur formed during calcination seems to show that this animal matter contains albumen. There is no fat in bones; and in the experiments in which this substance was found, it is evident that marrow had been mingled with the bones employed.

Organization.

Though bones were arranged by the ancients among the bloodless organic substances, they receive a considerable proportion of this fluid, and injection shows them to be highly vascular. In early life especially these vessels are numerous; and even in the grown adult, when death takes place by strangulation or by drowning, the bones are found to be naturally well injected. In old age the vessels are less numerous, but they are larger. From the capillary vessels distributed through their substance, bones derive the pale blue or light pink colour by which the healthy bone is characterized. When this tint becomes intense, it indicates inflammation or some morbid state of the vessels of the bone. When it is lost, and the bone assumes a white or yellow colour, the part so changed is dead.

Anatomists distinguish three orders of vessels which enter the substance of bones; the first, those which penetrate the bodies of long bones to the medullary cavity (*arteriæ nutritiæ, arteriæ medullares*); the second, those which go to the cellular structure of the bone; and the third, those which go to the compact or dense matter of the bone. The view is only partially correct. The large vessels termed nutritious certainly proceed chiefly to the cavity of the bone, and are distributed in the medullary membrane. These, however, are not the only vessels which proceed to this part of the bone. *First*, I have often traced several large vessels, entering not by the middle, but the ends of the long bones, into the loose cancellated texture, and actually distributed on the *medulla* in this part of the bone. In dried bones also the canals of these vessels may be demonstrated, extending from the surface to the body of the bone. *Secondly*, the nutritious vessels are not constant; and when they are wanting, those of the ends of the bone, or of the *cancelli*, are much larger and more numerous than in ordinary circumstances.

Bone. Organization.

The communication between these and the branches of the nutritious vessels, which is admitted by Bichat, may be easily demonstrated. The *third* order of vessels are those which may be termed *periosteal*, in so far as they consist of an infinite number of minute capillaries, some red, some colourless, proceeding from the periosteum to the bone, and contributing to maintain the connection between the two. The short bones and the flat bones, which are destitute of nutritious arteries, receive blood from the two latter orders, but principally from the periosteal vessels. In the scull these vessels are often highly injected in apoplectic subjects, and in persons killed by drowning or strangulation.

The veins of bones are peculiar in their arrangement. The nutritious artery is accompanied by a social vein; the articular and periosteal vessels are said to be destitute of corresponding venous vessels. According to Dupuytren, however, minute venous capillaries arise from the substance of the osseous tissue, precisely as in other tissues, and, uniting in the same manner, form twigs, branches, and trunks, which finally terminate in the neighbouring veins. Lymphatics are not found in bones, nor have nerves been traced into their substance.

Marrow.

To complete the anatomical history of bone, it is requisite to examine shortly the marrow. The interior of the long bones contains a quantity of fat, oleaginous matter, which has been long known under the name of *marrow* (*μυελος οστιτης, medulla*); and a similar substance, though in smaller quantity, is found in the loose cancellated tissue of the flat and short bones. It is in the first situation only that it is possible to examine the anatomical characters of this substance. It is sufficiently similar to fat or animal oil in other parts of the body, to lead us to refer it to that head. In other respects its chemical qualities have not been much examined; but an analysis by Berzelius shows that it consists chiefly of an oily matter, not unlike butter in general properties. The filaments, blood-vessels, albumen, gelatine, and osmazome found by this chemist in marrow, and which did not exceed 4 parts in the 100, are derived from the filamentous tissue, in which the medullary particles are deposited.

Medullary membrane.

The medullary membrane, which has been considered as an internal periosteum, is imperfectly known. There can be no doubt, however, of its existence, which is demonstrated by opening transversely or longitudinally the medullary canal of a long bone, and boiling it for about two hours. The marrow then drops out; and it will be found to be deposited in the interstices of a filamentous net-work of animal matter, like fine cellular tissue, which may be traced not only into the lattice-work of the extremities, but into the longitudinal canals of the cylindrical bones. It is traversed by blood-vessels, which are observed to bleed during amputation. No nerves have been found in it. The medullary membrane, in short, may be regarded as an extensive net-work of very minute capillaries united by delicate filamentous tissue. From these capillaries the marrow is deposited as a secretion. (Mascagni, Howship.)

Developement.

3. The progressive formation of the osseous system has given rise to many researches by Kerckringius, Vater, Baster, Duhamel, Nesbitt, Haller, Dethleef, Reichel, Albinus, John Hunter, Scarpa, Senff, Troja, Meckel, Howship, Medici, Serres, Lebel, Schultze, Beclard, and Dutrochet; and it is a proof of the complicated nature of the subject, that it continues to give rise to fresh investigation. The inquiry resolves itself into two parts,—the history of the process of ossification as it takes place originally in the fœtus and infant, and the history of its progress as a process of repair when bones are divided, broken, or otherwise destroyed or removed.



Bone. Developement.

From the first formation of the embryo to the termination of fœtal existence, and thenceforth to the completion of growth, the bones undergo changes in which various stages may be distinguished. In the first weeks of fœtal existence it is impossible to recognise any thing like bone; and the points in which the bones are afterwards to be developed consist of a soft homogeneous mass of animal matter, which has been designated under the general name of mucus. Some time between the fifth and the seventh week, in the situation of the extremities, may be recognised dark opaque spots, which are firmer and more solid than the surrounding animal matter. About the eighth week, the extremities may be seen to consist of their component parts, in the centre of each of which is a cylindrical piece of bony matter. Dark solid specks are also seen in the spine, corresponding to the bodies of the vertebræ; and even the rudiments of spinous processes are observed in the shape of minute dark points. In the hands and feet rings of bone are seen in the site of the metacarpal and metatarsal bones. All the joints consist of a semi-consistent jelly-like matter, liberally supplied by blood-vessels. At ten weeks the cylinders and rings are increased in length, and are observed to approach the jelly-like extremities, which are acquiring the consistence of cartilage, and when divided present irregular cavities. At the same time the parts forming the head are highly vascular; and between the membranes are deposited minute points of bony matter, proceeding in rays from a centre, which, however, is thinner and more transparent than the margin. (Howship.)

Between thirteen weeks and four months the cavities in the jelly-like cartilaginous matter receive injection. The membranes of the head are highly vascular, transmitting their vessels through the intervals of the osseous rays, which are occupied abundantly by stiff, glairy, colourless, mucilaginous fluid.

In the seventh month the bony cylinder of the thigh-bone and its epiphyses contain canals perceptible to the microscope. In the head the bones are proceeding to completion; the pericranium and dura mater are highly vascular; and a quantity of reddish semitransparent jelly between the scalp and the scull, which contain numerous minute vessels, Mr Howship regards as the loose cellular state of the fœtal pericranium. This is, however, doubtful. The cylindrical bones have at this period no medullary cavity, but present in their interior a loose bony texture.

Between the seventh and eighth months, in a fœtus ten inches long, the humerus consists of a cylinder of bone placed between two brownish, firm, jelly-like masses, which correspond to the epiphyses, inclosed by periosteum, which adheres loosely by means of filamentous and vascular productions. The radius is a thin bony rod, also between two jelly-like epiphyses. The ulna is still thinner, more slender and flexible, and even compressible. The interosseous ligament is a continuous duplicature of the periosteum. The metacarpal bones are much as before, only larger. The hands and fingers are complete; but the phalanges consist of minute semi-hard grains, inclosed in periosteum, which forms a general sac to them, and to the intermediate connecting parts. The middle and unguinal phalanges can scarcely be called osseous. The *femur*, like the *humerus*, is an osseous cylinder between two jelly-like epiphyses, enveloped in loosely adhering periosteum. The *tibia* and *fibula* are like the *radius* and *ulna*. The metatarsal bones are cylindrical pieces, firm, but not very hard. The first phalanx of the toes is complete; the other two, though the toes are fully formed, are much of the consist-

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Bone. Developement.

ence of cartilage. The carpal and tarsal bones are in the state of the epiphyses, but of a gray colour.

In this state of the osseous system, the periosteum, which is continuous, and appears to make one membrane with the capsular ligaments and the deep-seated portions of the fascia, adheres to the bone chiefly by arteries and filamentous productions; and so loose is this connection, that a probe may be inserted beneath it, and carried round or inwards, unless where these connections are situate. Another point where the periosteum adheres firmly is at muscular insertions, to the *humerus* at the insertion of the deltoid, and to the *femur* at that of the *glutæus*.

In the vertebral column the bodies of the vertebræ and the spinous plates are formed; and minute specks are beginning in the site of the transverse processes.

In the scull the parietal bones are well-formed shells of bone, though very deficient at the mesial plane, the anterior margin, and the upper anterior angle. The pericranium is distinctly membranous and vascular; and the red jelly-like fluid noticed by Mr Howship is exterior to this membrane.

At the period of birth the cylindrical bones contain tubular canals filled with a colourless glairy fluid, and terminating in the surface of ossification. As the bones previous to this period are homogeneous, and contain no distinct medullary cavity, but present in their interior a soft or loose bony texture, it is reasonable to suppose that the developement of the longitudinal canals is connected with the formation of the medullary cavity. At birth, in the *femur* may be distinguished a medullary cavity beginning to be formed, about half a line broad, but still very imperfect.

After birth, the two processes of the formation of tubular canals and medullary cavity go on simultaneously; and at the same rate nearly, the outer part of the cylindrical bones acquires a more dense and compact appearance. The epiphyses, also, which are in the shape of grayish jelly-like masses, begin to present grains and points of bone. Previously to this, Mr Howship represents them, while still cartilaginous, as penetrated by canals or tubes, which gradually disappear as ossification proceeds. The carpal and tarsal bones appear to observe the same course in the process of ossification.

In the bones of the scull, however, a different law is observed. The osseous matter is originally deposited in linear tracts or fibres, radiating or diverging from certain points termed centres of ossification. Each bone is completed in one shell without *diploe* or distinguishable table. Afterwards, when they are completed laterally, or in the radiating direction, the cancellated arrangement of the *diploe* begins to take place apparently in the same manner in which the medullary cavity and compact parts of the long bones are formed.

In the process now described, it is important to observe that the bony matter is deposited round the soft parts, and that the cavities, holes, and canals of bones are merely parts in which the previous existence of vessels, nerves, ligaments or tendons, prevents the subsequent formation of bone.

It has been generally supposed that the formation of cartilage is a preliminary step to that of bone. This, however, seems to be a mistake, arising from the circumstance that cartilage is often observed to be converted in the living body into bone. Neither in the long nor in the flat bones is any thing like cartilage at any time observed. The epiphyses, indeed, present something of the consistence of cartilage, but it has neither the firmness nor the elasticity of that substance. It is a concrete jelly, afterwards to be penetrated by calcareous matter. The flat bones are from the first osseous; and though their margins are soft and flexible, in consequence of their recent formation and moist state, they have still a distinct osseous appearance and arrangement, and bear no resemblance to cartilage. In short, true bone seems never at any period of its growth to be cartilaginous.

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The progressive growth of bones is effected by accretion of new matter to their extremities. The cylindrical bones elongate by the addition of new matter to the extremities of their *diaphyses*, and the flat bones by the enlargement of their margins. The latter fact is established by simple inspection during the process of ossification of the cranial bones. In proof of the former, the experiment of John Hunter is decisive. In the *tibia* of a pig he bored two holes, one near the upper, the other near the lower end, with an interval of two inches exactly, and inserted into each hole a small leaden shot. After some time, when the animal had grown, and the length of the bone was increased, on killing it, the space between the leaden shots was found, as at first, to be exactly two inches,—thereby showing that no elongation had taken place between the perforations. The experiment was often repeated with the same result.

The period at which ossification is completed varies in different individuals. It may be said to be indicated by the completion of the medullary canal, by the ossification of the *epiphyses*, and their perfect union with the osseous cylinder (*diaphysis*). The first circumstance is indefinite. The two latter, though more fixed, are still liable to great variation. The epiphyses are rarely united before the age of 14 or 15; and they may continue detached to the 20th or 21st year. In general, however, they begin to unite or to be *knit*, as is said, between the 15th and 20th years.

That the main agents of original ossification are the periosteum and its arteries, the proofs are manifest. The formation of bone can be ascribed to the vessels of two agents only,—the periosteum and the medullary membrane. That the latter is not concerned in the production of bone in the fœtus, must be inferred from the fact that at that period it cannot be said to exist. To the periosteum, therefore, and its vessels must be ascribed the process of fœtal ossification. Of this a cumulative proof is found in the circumstance, that the periosteum adheres more firmly at the ends than the middle of the bones; and that the pericranium and *dura mater*, which perform the part of periosteum to the bones of the scull, are visibly concerned in the formation and successive enlargement of these bones. But though the periosteal vessels are the main agents of ossification originally, there is reason to believe that the medullary vessels contribute to its growth and nutrition after it is formed. This may be inferred from the phenomena of fractures, of diseases of the bones, and of those experiments in which the medullary membrane is injured. The periosteum, however, does not act by ossification of its inner layers, as Duhamel, misled by a false analogy between the growth of trees and bones, laboured to establish.

A peculiar form of the osseous system requiring notice are the sesamoid bones. These, which derive their name from their minuteness, (σησαμη, a *grain*), most of them, excepting the knee-pan, being of the size of a grain or pea, are confined to the extremities, and are situate chiefly in positions in which they give points of support to the tendons of the flexor muscles. (Tendons of the *gemelli*, *tibialis posticus*, *peronæus longus*, &c.) The peculiarity of these bones is, that they are formed invariably in the substance of fibrous organs, as tendons in the case of the knee-pan and the sesamoid bones of the *gemelli*, *tibialis posticus*, and *peronæus longus*; or ligaments

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in the case of those situate between the chiro-phalangeal and podo-phalangeal articulations. With this peculiarity their mode of ossification corresponds. At first albuminous or fibro-albuminous, in process of time they are penetrated by calcareous matter, and present an osseous texture, which, however, is much less firm than that of genuine bone. The period at which this deposition commences and is completed varies in different individuals; and hence scarcely in any two persons of the same age is the number of sesamoid bones the same. Though the patella may be ossified at the 20th year, the minute sesamoid bones are sometimes not formed before the 30th or even the 40th. In the patella, when ossified, we find a medullary organ; but it is uncertain whether the others acquire this mark of osseous character. These bones resemble the epiphyses in uniting, when divided, by fibro-albuminous matter.

Junctions. 4. The bones of which the skeleton consists are united in two modes; 1*st*, by movable junction (*diarthrosis*); 2*dly*, by immovable junction (*synarthrosis*). Both modes of union bear the general name of *articulation*, though this term would with greater propriety be confined to the first or movable union. By this are connected all the bones concerned in locomotion, and some of those devoted to the organic functions, as the ribs and the lower jaw. The second is employed in the union of bones forming the walls of cavities.

In the movable union, the articular surfaces are united in two modes. In the first, in which one bone moves on the other with different degrees of freedom, the articular surfaces are covered by cartilage and synovial membrane, and the bones are united by ligaments and tendons. In the second (*amphiarthrosis*), in which the motion is confined to a species of torsion or imperfect rotation, the bones are united without articular surface by fibro-cartilage. The first is exemplified in the articulations of the extremities; the second is seen in the union of the bodies of the *vertebræ* and the bones of the pelvis.

The several forms of movable union with free motion, or articulations proper, may be referred to four heads, according to the nature of the motions performed. The first is the motion of radio-central opposition, or pivot-motion in every direction, in which the bone moves in its articular cavity, not only backwards and forwards, or by flexion and extension, but by abduction and adduction, and, by the succession of these motions, may describe a cone with the apex at the joint, or what is termed circumduction. This most extensive form of motion is found in the scapulo-humeral and coxo-femoral articulations only. The second form of articular motion is antero-posterior opposition, or cardinal motion (*cardo*, a hinge), in which the bones move on each other by flexion and extension, as a gate on its hinges. This, which is sometimes named limited opposition, is found in the femoro-tibial and humero-cubital joints, and all those which undergo flexion and extension. The third form of motion is that of rotation, in which the bone revolves on its axis,—an infrequent variety, confined chiefly to the humerus and femur. The fourth, which is the gliding motion, though common to all articular surfaces, is nevertheless the peculiar motion of the carpal and tarsal bones.

In the immovable union the surfaces are united in three modes. The first is by mutual indentation, or what is named suture (*sutura vera*), in which the margin of one bone is dovetailed by alternate serrated teeth and notches, into that of another. The second is by juxtaposition (*harmonia*), in which the margin of one bone is simply fitted to that of another. A peculiar variety of this is, when the acute margin of one bone is received between the bifid margin of another, as the azygos process of the sphenoid bone is received by the plates of the *vomer*; (*schindylesis*.) The third mode of immovable union is by implantation or insertion (*gomphosis*), as the teeth are inserted into the alveolar cavities of the superior and inferior maxillary bones.

Bone. Junctions.

The following table exhibits a view of these modes of junction, with their appropriate appellations.

### JUNCTIONS OF BONES.

I. IMMOVABLE; (*SYNARTHROSIS*.)

Continuous Bony Surfaces, united by Bone and Membrane.

| | | | |
|---|---|---|---|
| Mutual Indentation. | *Sutura.* | α *S. Serrata*, sive *Dentata*. | Coronal, Sagittal, and Lambdoidal Sutures. |
| | | β *Sutura Limbosa*. | Spheno-parietal Suture. |
| | | γ *Sutura Squamosa*. | Temporo-parietal Suture. |
| Juxtaposition. | *Harmonia.* | *H. Simplex.* | *H. Schindylesis.* |
| Implantation. | *Gomphosis.* | | The Teeth in the *alveoli*. |

II. SEMIMOVABLE; (*AMPHIARTHROSIS*.)

Continuous Surfaces, united by Fibro-Cartilage.

| | | | |
|---|---|---|---|
| Rotation and Torsion. | *A. Rotatio.* | | The Bodies of the *Vertebræ*. |
| Cardinal Opposition. | *A. Lateralis.* | *Symphysis.* *Synchondrosis.* *Synneurosis.* | Bones of the Pelvis. |

III. MOVABLE; (*DIARTHROSIS*.)

Contiguous, Cartilaginous Surfaces, united by Ligaments.

| | | |
|---|---|---|
| Radio central Opposition. | 1. Unlimited Opposition, Circumduction, and Rotation. | (*Arthrodia*). The Scapulo-humeral Articulation. (*Enarthrosis*). Cup and Ball-joint. The Ilio-femoral. |
| | 2. Unlimited Opposition, and Circumduction. | (*Arthrodia*). Temporo-maxillary, and Sterno-clavicular. (*Enarthrosis*). Cup and Ball-joint. Radio-carpal, Chiro-phalangeal, &c. |
| | 3. Limited Opposition, Flexion, and Extension. | (*Ginglymus*). Cardinal Joint. Femoro-tibial, Phalangeal. |
| | 4. Rotation. | (*Diarthrosis Trochoides*). (Lateral *Ginglymus*). Radius and Ulna, Atlas and Axis. |
| | 5. Gliding. | (*Diarthrosis Planiformis*). *Amphiarthrosis* of some authors. The Carpal and Tarsal Bones; the Oblique Processes of the Vertebræ. |

### *Teeth.* (*Dentes.*)

Every tooth consists of two hard parts; one external, white, uniform, somewhat like ivory; the other internal, similar to the compact structure of bone. Teeth

The first, which is named enamel, is seen only at the crown of the tooth, the upper and outer part of which consists of this substance. It is white, very close in texture, perfectly uniform and homogeneous, yet presenting a fibrous arrangement. Extending across the summit of the tooth in the manner of an incrustation, it is thick above, and diminishes gradually to the root, where it disappears. This fact is demonstrated by macerating a tooth in dilute nitric acid, when the bony root becomes yellow, while the crown remains white.

The enamel is not injectible, and is therefore believed to be inorganic. It is also filed and broken without being reproduced; nor does it present any of the usual properties which distinguish organized bodies. The piercing sensation which is communicated through the tooth from the impression of acids seems to depend on the mere chemical operation, and not on the physiological effect. On the whole, the enamel is to be viewed as the inorganic result of a process of secretion or deposition.

The bony part of the tooth is the root and that internal part which is covered on the sides and above by the enamel. It consists of close-grained bony matter, as dense as the compact walls of the long bones, or the petrous portion of the temporal bone. The fibres which are said to be seen in it are exactly of the same nature as those in bone.

In the interior of the bony part of each tooth is a cavity which descends into the root, and communicates at its extremity with the outer surface by openings corresponding with the number of branches into which the root is divided. This cavity, which is large in young or newly formed teeth, and small in those which are old, contains a delicate vascular membrane, which has been named the pulp of the tooth. It is best seen by breaking a recent tooth by a smart blow with a hammer, when the soft pulpy membrane may be picked out of the fragments by the forceps. It then appears to be a membranous web with two surfaces, an exterior adhering to the bony surface of the dental cavity by minute vessels; the other interior, free, and, so far as can be determined of a body so minute, resembling a closed sac.

The developement and growth of the teeth is a process of much interest.

At what time the first rudiments of teeth appear seems not to be determined with accuracy. In the fœtus, between the seventh and eighth month, I can merely distinguish in the centre of the vascular membrane of the alveolar cavity a minute firm body like a seed. I have, however, seen the crowns of teeth formed in fœtuses which, I have reason to believe, had not attained the seventh month. But whatever may be the exact period, the process is nearly as follows.

While the bones of the upper and lower jaw are in the process of formation between the third and fourth months, (fourth and fifth, Bichat, tom. iii. p. 93,) a series of soft, membranous, vascular sacs inclosed within the general cavity of the periosteum, may be recognised at their lower and upper margins, which are still without those osseous plates which afterwards constitute the *alveoli.* Each of the sacs now mentioned consists, like a serous membrane, of two divisions,—one external, attached to the periosteum, the other folded within it, and forming a closed cavity. The outer or periosteal deposits in the intervals between each sac, bone, which eventually constitutes the transverse *septa* of the *alveoli.* From the inside of the inflected portion the process of dentition commences some time between the fifth and seventh month, by the deposition of matter from the vessels at the lowest point of the alveolar division of the sac. This matter is to constitute the crown of the tooth, which is invariably formed first. After the deposition of the first portions, these are pushed upwards by the addition of successive layers below them, and necessarily carry the inflected part of the sac before them. As this process of deposition advances, the tooth gradually fills the sac, and rises till it reaches the level of the alveolar margins. If a tooth be examined *in situ,* near the period of birth, it is found to consist of the crown, with portions of enamel descending on every side, and forming a cavity in which a cluster of blood-vessels proceeding from the sac is lodged. In the mean time, bone is deposited from the periosteal division all round each sac, so as to form the *alveoli.*

After the enamel has been deposited the bone begins to be formed; and as this process advances, the tooth is still forcibly thrust upwards by the addition of matter to its root. When the latter is well completed, the vessels become smaller and less abundant, until, when the tooth is perfect, they shrink to a mere membrane, which lines the cavity of the tooth, and still maintains its original connection with the alveolar membrane, by the minute vascular production which enters the orifice or orifices of the root.

Physiological authors have thought it important to mark the period at which the teeth appear at the gums; and in general this takes place about the sixth or seventh month after birth. This mode of viewing the process of dentition, however, gives rise to numberless mistakes on the period of teething. The process, as we see, commences in the early period of fœtal existence; and the time at which they appear above the gums varies according to the progress made in the womb. In some the process is rapid, in others it is tardy; and even the stories of Richard III. and Louis XIV. receive confirmation from the fact of 19 examples cited by Haller, of infants born with one or more teeth above the gum. Generally speaking, the crown is completed at the period of birth; and, according as the formation of the root advances with rapidity or slowly, dentition is early or late.

What is here described is the process of the formation of the first or temporary set of teeth, which consist, it is well known, of twenty. In that of the second set the same course is observed. In the same manner is observed a row of follicular sacs, though not exactly in the original *alveoli,* yet attached to the sacs of the temporary teeth by vascular membranes; in the same manner deposition begins at the bottom of the free surface of the sac by the formation of the crown; and in the same manner the crown is forcibly raised by the successive accretion of new matter to its base. The moment this process commences, a new train of phenomena takes place with the primary teeth. The follicular sacs of the new or permanent teeth are liberally supplied with vessels for the purpose of nutrition; and as these blood-vessels increase in size, those of the temporary teeth diminish; and the supply of blood being thus cut off, the latter undergo a sort of natural death. The roots which, as being last formed, are not unfrequently incomplete, now undergo a process of absorption; and the tooth drops out in consequence of the destruction of its nutritious vessels. Some authors have ascribed this expulsion to pressure, exercised by the new tooth. They forget, however, that before the new tooth can exert any pressure, it must be in some degree formed; and to this a vascular system is indispensable.

The increased number of the teeth when permanent, the enlargement of the jaws, and the consequent expansion of the face, though interesting, are foreign to the present inquiry.

*Gristle, Cartilage.* (*Cartilago,—Tissu Cartilagineux.*)

Cartilage.

The cartilaginous system or tissue is found at least in three different situations of the human body; 1*st,* on the articular extremities of the movable bones; 2*d,* on the connecting surfaces or margins of immovable bones; 3*d,* in the parietes of certain cavities, the motions and uses of which require bodies of this elastic substance.

The organization of gristle is obscure and indistinct. On examination by the microscope, its surface is pearl-white, uniform and homogeneous, firm and glistening, with numerous minute pores. William Hunter represents the articular cartilages as consisting of longitudinal and transverse fibres. (*Phil. Trans.* vol. xlii.) Herissant represents those of the ribs as composed of minute fibres mutually aggregated into bundles connected by short slips, and twisted in a spiral or serpentine direction. (*Mém. de l'Acad.* 1748.) By Delasone, the articular cartilages

General Anatomy. Cartilage.

are said to consist of a multitude of minute threads, mutually connected and placed at right angles to the plane of the bone, but so as to radiate from the centre to the circumference. (*Ibid.* 1752.) The general fact of fibrous structure is confirmed by Bichat, who states that it is possible to recognise longitudinal fibres, which are intersected by others, oblique or transverse, but without determinate order. In its purest form no blood-vessels are seen in it, nor can they be demonstrated by the finest injections. In the margins of those pieces of gristle, however, which are attached to the extremities of growing bones, blood-vessels of considerable size may often be seen, even without the aid of injection. In young subjects a net-work of arteries and veins, which is described by Hunter under the name of *circulus articuli vasculosus,* may be demonstrated all round the margin of the cartilage at the line between the epiphysis and it. They terminate so abruptly, however, that they cannot be traced into the substance of the latter. The most certain proofs, however, of the organic structure of this substance are the serous exudation which appears in a few seconds on the surface of a piece of cartilage after division by the knife; and the fact that it becomes yellow during jaundice, and derives colour from substances found in the blood. Neither absorbents nor nerves have been found in it. The cellular texture said by Bichat to form the mould for the proper cartilaginous matter appears to be imaginary.

The articular cartilages adhere to the epiphyses by one surface, which consists of short perpendicular fibres placed parallel to each other, and forming a structure like the pile of velvet. This is easily demonstrated by maceration, first in nitric acid, and then in water. The free or smooth surface is covered by a thin fold of synovial membrane, which comes off in pieces during maceration. The existence of this, though recently denied by Gordon, was admitted by William Hunter, and may be demonstrated either by boiling, maceration, or the phenomena of inflammation, under which it is sensibly thickened. All other cartilages are enveloped, unless where they are attached to bones, by a fibrous membrane, which has been therefore named *perichondrium.* The existence of this may be demonstrated by dissection, and also by boiling, which makes it peel off in crisped flakes.

The chemical properties of cartilage have not been accurately examined. Boiling shows that it contains gelatine; but as much of the matter is undissolved, it may be inferred that it is under some modification, or united with some other principle, perhaps albumen. Immersion in nitric acid or boiling fluids induces crispation, and it dries hard and semitransparent like horn.

### *Fibro-Cartilage, Chondro-Desmoid Texture.* (*Cartilago Fibrosa,—Tissu Fibro-Cartilagineux.*)

Fibro-cartilage.

Intermediate between the cartilaginous and the fibrous tissues, Bichat ranks that of the fibro-cartilages, which comprehends three subdivisions: 1*st*, the membranous fibro-cartilages, as those of the ears, nose, windpipe, eyelids, &c.; 2*d*, the inter-articular fibro-cartilages, as those found in the temporo-maxillary and femoro-tibial articulations, the intervertebral substances, and the cartilaginous bodies uniting the bones of the pelvis; 3*d*, certain portions of the periosteum, in which, when a tendinous sheath is formed, the peculiar nature of the fibrous system disappears, and is succeeded by a substance belonging to the order of fibro-cartilages.

Beclard follows Meckel in rejecting the first subdivision, the individuals of which are quite similar to ordinary cartilage, in wanting the distinct fibrous structure, and being covered by perichondrium, the fibres of which have caused them to be regarded as fibro-cartilages. On this principle Beclard gives the following view of the fibro-cartilages.

General Anatomy. Fibro-cartilage.

1*st*, Fibro-cartilages free at both surfaces; those in the form of *menisci*, which are placed between the articular surfaces of two bones (*fibro-cartilagines inter-articulares*). These are seen in the temporo-maxillary, sterno-clavicular, and femoro-tibial articulations, and occasionally in the acromio-clavicular and the ulno-carpal joints. These ligaments are attached either by their margins or their extremities, and are enveloped in a thin fold of synovial membrane. 2*d*, Fibro-cartilages attached by one surface. Of this description are those employed as pulleys or grooves for the easy motion of tendons; for instance, the chondro-desmoid eminences attached to the margin of the glenoid cavity for the long head of the *biceps*, and at the sinuosity of the ischium for the tendons of the *obturatores.* 3*d*, Fibro-cartilages, which establish a connection between bones susceptible of little individual motion, as the intervertebral bodies; or which unite bones intended to remain fixed, unless under very peculiar circumstances, as those which form the junction of the pelvic bones. (*Symphysis pubis; sacro-iliac synchondrosis.*)

The peculiarities of these substances consist in their partaking in different proportions of the nature of cartilage and white fibrous tissue, and, consequently, in possessing the toughness and resistance of the latter with the elasticity and flexibility of the former. The structure of the fibro-cartilaginous tissue is easily seen in the intervertebral bodies, and in the cartilages uniting the pelvic bones. In the former, white concentric layers, consisting of circular fibres placed in juxtaposition, constitute the outer part, while the interior contains a semifluid jelly. The concentric fibrous layers are cartilage in a fibrous shape. In the latter situation the fibrous structure is equally distinct, while the cartilaginous consistence shows the connection with that organic substance. A similar arrangement is remarked in the inter-articular cartilage of the temporo-maxillary articulation, and in the semilunar cartilages of the knee-joint. In all, the fibrous is said to predominate over the cartilaginous structure. Their physical properties are distensibility and elasticity. Though they are at all times subjected to considerable pressure, they speedily recover their former size. Though their chemical composition is not exactly known, they evidently contain much gelatine.

### *Gland. Glandular System.* (*Glandulæ.*)

Gland.

The name *gland*, though rather vaguely used, may be properly restricted to designate organs of a definite structure, consisting of arteries, veins, and excretory tubes, arranged in a peculiar manner, and destined to separate from the blood a fluid of peculiar chemical and physiological properties. The organs of this description may be arranged in two general divisions,—the follicular glands, or those which occur in an isolated form; and the conglomerate glands, or those which, being of larger volume, are understood to consist of numerous small glands combined in one general organ. The former embraces the sebaceous glands of the skin and the muciparous glands of mucous membranes; in the latter are comprehended the lacrymal and salivary glands, with the tonsils, the pancreas, the liver, the kidneys, the testicles of the male, and *mammæ* of the female, and perhaps the prostate gland. To a third head, denominated that of *imperfect glands,* Meckel refers such organs as the thymus, the suprarenal capsules, the thyroid, and the spleen. But since the term *imperfect* implies here a contradiction, and since it is by no means ascertained, either that these organs secrete, or that their secretions are removed by the lymphatics, it is manifest that they cannot be justly associated with the organs above defined as examples of glands.

The follicular glands, though most minute, are nevertheless distinguished by the most simple and intelligible structure. They consist of small hollow spherical sacs, or minute membranes moulded into the saccular form, in the attached surface of which are distributed numerous minute arteries and veins, and the free surface of which is smooth and covered with the fluid secreted. The quantity of vascular substance with filamentous tissue surrounding the attached surface of these glands, makes them occasionally project from the surface of the membrane to which they are attached. In ordinary circumstances, however, they cause no elevation, and appear in the form of simple sacs with a narrow orifice. These glands belong to two textures only of the animal body,—the skin and the mucous membrane. In the former they are named *sebaceous glands*, from the fluid which they secrete containing a small portion of fatty matter. In the latter they are named *follicles*, *crypts*, or *muciparous glands*.

In certain regions of the mucous membranes, for instance in the male *urethra*, the crypts are arranged in such a manner that they constitute large sinuous cavities, the free surface of which secretes serous mucus copiously. These cavities, which have the further effect of increasing much the superficial extent of the membrane, are denominated *lacunæ*. The peculiarity of this form of mucous gland appears to consist in its membranous sac having unusual extent, and consequently in the glandular vessels being more expanded than in the ordinary glands.

The structure of the conglomerate glands is more complicated. Each gland consists of numerous minute portions of definite figure, named lobules; and each lobule may be resolved into granules, also of definite shape, intimately connected by filamentous tissue. These granules, which have since the time of Malpighi been denominated *acini*, are found to consist of clusters of minute arteries and veins aggregated together, with minute tubes for conveying away the secreted fluid. On these points anatomists are agreed. They are seen most distinctly in the liver and kidney, and may be demonstrated in the pancreas, testicles, and female breast, by injection. Every *acinus*, in short, may be said to consist of two parts, a vascular or supplying, and a tubular or excreting.

On the manner in which these two parts of the *acinus* communicate, however, there is less certainty and precision. In this difficulty, as the point is scarcely a matter of observation, conjecture has been resorted to; and the opinions of anatomists have been divided between two parties. According to one, at the head of which may be placed Ruysch, Haller, William Hunter, and Hewson, the minute arteries terminate directly in the excretory ducts, without intermediate substance. According to the other opinion, which is that of Malpighi, between the arteries and the excretory tubes there are placed minute membranous *vesiculæ* or pouches, in the substance of which the arteries, still more minutely divided, are distributed, and from the free surface of which the process of secretion goes on. In short, each *acinus*, according to Malpighi, is a separate follicle, and the conglomerate glands consist merely of numerous follicles, combined so as to form a large general secreting organ.

Between these two views of the intimate nature of the glandular tissue there is less difference than at first sight might be imagined. The chief difference is in the ultimate arrangement of the glandular capillaries. According to the view of Malpighi, these capillaries are arranged in clusters, as it were, round the beginning of the excretory pore, so that even in this condition the termination of the former class of vessels is the commencement of the latter. Conversely, it may be said, that since the delicate membrane in which the secreted fluid first appears necessarily receives the capillary terminations, the latter cannot be said to communicate directly with the excretory tubes. The correct view of the matter is, that by the term *vesicles* are not to be understood large sacs, but merely the rounded recess of the membrane which forms the excretory tubes. Further, since the researches of Hewson and Monro show that in the kidney and the testicle the arteries are convoluted, it may be inferred that this is the character of the capillary arrangement of the glands; and that it is requisite to the performance of the process of secretion that the vessels be disposed in such a tortuous manner as to prevent too rapid motion of the blood.

The conglomerate glands, we have seen, consist chiefly of minute vascular ramifications infinitely subdivided. In all the glands, excepting the liver, these vessels consist of arteries to convey blood to the organ, and veins to return it to the system; and in all the glands, excepting the liver, it is a peculiar circumstance that the same arterial trunk conveys blood for nourishing the gland, and for supplying the materials of the secretion. All the secretions, therefore, excepting that of the liver, are derived from arterial blood. The liver alone, besides receiving a considerable artery, derived from the cœliac trunk, is remarkable for being chiefly supplied with blood from a large venous trunk, formed by the union of the veins of the stomach and spleen, and the mesenteric and mesocolic branches, and which after this union is again subdivided into ramifications in the substance of the gland. Injection shows that the branches and twigs of this vein anastomose freely with those of the hepatic artery; and though it might be imagined that the latter is intended chiefly to nourish the gland, and the former to supply the materials for secretion, this circumstance, with the fact that in some rare instances the *vena portæ* is not distributed in the liver, shows that at present this opinion must be adopted with caution.

Besides arteries, veins, and excretory tubes, glands are supplied with lymphatic vessels, which are arranged in two sets, superficial and deep. The former are confined to the surface of the organ, over which they may be seen creeping in every direction, and belong chiefly to the membranous coverings of the glands. The deep-seated lymphatics are those which penetrate the substance of the glands, and in general accompany the large blood-vessels.

Every gland receives a proportion of nervous branches, generally from the nerves of the sympathetic system. These branches accompany the blood-vessels in penetrating the substance of the glands, and are distributed much in the same manner as the arteries before their ultimate division. They exercise some influence over the process of secretion; but the nature and extent of this influence are still undetermined.

Each gland contains a quantity of filamentous tissue, which envelopes the blood-vessels, tubes, lymphatics, and nerves, and constitutes a large proportion of the mass of the gland. The simple tissues, thus united, are inclosed in a general membranous covering, which also partly contributes with these tissues to retain it in its situation. These membranous coverings vary in different glands. In the liver and pancreas it is the peritoneum; the kidneys are inclosed in a peculiar tunic; the testes are contained in a fibrous membrane; and the *acini* of the lacrymal

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and mammary glands appear to be covered by a form of condensed filamentous tissue.

### CHAP. III.—ENVELOPING TISSUES.

*Skin.* (*Cutis, Pellis.*) *Cutaneous Tissue, Dermal Tissue.* (*La Peau, Tissu Dermoide,*—Die Haut, Das Fell.) *Fell*, old English; *with its appendages, Scarf-skin or Cuticle, Nail, Hair.* (*Cuticula, Epidermis,—Tissu Epidermoide et Tissu Pileux.*)

Skin.

Skin has been said to consist of three parts, true skin (*cutis vera*), mucous net (*rete mucosum*), and scarf-skin or cuticle. Haller, Camper, and Blumenbach, are inclined to deny the existence of the mucous net in the skin of the white, and to admit it in that of the negro only; and in point of fact, indeed, its existence has been demonstrated in the negro race only, and inferred by analogy to exist in the white. "When a blister has been applied to the skin of a negro," says Cruikshank, "if it has not been very stimulating, in twelve hours after a thin transparent grayish membrane is raised, under which we find a fluid. This membrane is the cuticle or scarf-skin. When this with the fluid is removed, the surface under these appears black; but if the blister had been very stimulating, another membrane, in which this black colour resides, would also have been raised with the cuticle. This is *rete mucosum*, which is itself double, consisting of another gray transparent membrane, and of a black web very much resembling the *pigmentum nigrum* of the eye. When this membrane is removed, the surface of the true skin, as has been hitherto believed, comes in view, and is white like that of a European. The *rete mucosum* gives the colour to the skin; is black in the negro; white, brown, or yellowish in the European." (*Experiments on the Insensible Perspiration*, &c. London, 1795.)

Bichat denies the existence of a mucous varnish (*corpus mucosum*) such as Malpighi describes it, and regards the vascular surface of the corion as the only mucous net.

According to Chaussier the skin consists of two parts only, the *derma* (*δεgμα, cutis vera*) or corion, and the *epidermis*, cuticle, or scarf-skin; the first embracing the organic elements of this tissue; the second being an inorganic substance prepared by the organic, and deposited on its surface. This opinion is adopted by Gordon, according to whom the skin consists of two substances placed above each other, like layers or plates (*laminæ*), the inner of which is the true skin, the outer the cuticle or scarf-skin. Beclard, on the contrary, thinks that a peculiar matter, which occasions the colour by which the several races are distinguished, is found between the outer surface of the corion and the cuticle; and that no fair race is destitute of it except the *albino*, the peculiar appearance of whom he ascribes to the absence of the mucous net of the skin.

The *corion* of the human skin (*pellis, corium, derma, cutis vera*) seems to consist chiefly of very small dense fibres, not unlike those of the proper arterial coat, closely interwoven with each other, and more firmly compacted the nearer they are to its outer or cuticular surface. The inner surface of the corion is of a gray colour; and in almost all parts of the body presents a number of depressions varying in size from $\frac{1}{12}$th to $\frac{1}{10}$th of an inch, and consequently forming spaces or intervals between them. These depressions, which correspond to eminences in the subjacent adipose tissue, have been termed *areolæ*. They are wanting in the corion of the back of the hand and foot only.

The outer or cuticular surface of the corion is smooth, of a pale or flesh-red tinge, and is much more vascular than its inner surface. It presents further a number of minute conical eminences (*papillæ*), which, according to the recent observations of Gaultier and Dutrochet, are liberally supplied with blood-vessels, and are the most vascular part of this membrane. In the ordinary state of circulation and temperature during life these eminences are on a level with the surrounding *corion*; but when the surface is chilled, this membrane shrinks, while the papillæ either continue unchanged or shrink less proportionally, and give rise to the appearance described under the name of *goose skin* (*cutis anserina*). This surface was said by the older anatomists to present numerous orifices or pores; but according to Gordon, if we trust to observation, no openings of this kind can be recognised, either by the eye or the microscope, except those of the sebaceous follicles. The hairs, indeed, are found to issue from holes in the corion, but they fill them completely.

In certain situations, for instance at the entrance of the external auditory hole, at the tip of the nose, on the margins of the eyelids, in the armpits, at the nipple, at the skin of the pubes, round the anus and the female pudendum, are placed minute orifices, from which exudes an oleaginous fluid, which is quickly indurated. These openings lead into the cavities of small sacs called follicles (*folliculi*) or sebaceous glands (*glandulæ sebaceæ*). These sacs, the structure of which is noticed above, consist of hollow surfaces secreting an oleaginous fluid, which is progressively propelled to the orifice, where it soon undergoes that partial inspissation which gives it the sebaceous or suet-like aspect and consistence.

The corion is liberally supplied with blood-vessels, nerves, and absorbents. After a successful injection, its outer surface appears to consist of a uniform net-work of minute vessels, subdivided to an infinite degree of delicacy, and containing during life blood coloured and colourless. It can scarcely be doubted that this vascular net-work (*rete vasculosum*) is the only texture corresponding to the *reticular body* of the older anatomists.

It is well known that this membrane, when boiled sufficiently long, is converted into a viscid glutinous liquor, which consists chiefly of gelatine (Chaptal, Seguin, Hatchett, Vauquelin, &c.), and that glue is obtained from it for the purposes of art. As, however, in these operations a portion of matter is left undissolved, and as glue is completely soluble in water, while skin resists it for an indefinite time, it may be concluded, that though the chief constituent of the corion is gelatine, it is under some peculiar modification not perfectly understood. The union of this organized gelatine with the vegetable principle denominated *tannin* forms leather, which is insoluble in water.

Cuticle.

Cuticle or scarf-skin (*epidermis, cuticula*) is a semi-transparent, or rather translucent layer of thin light-coloured matter, extended continuously over the outer surface of the corion. Its thickness varies, being thinnest in those parts least exposed to pressure and friction, but thickest in the palms and soles. It is destitute of blood-vessels, nerves, and absorbents; and there is reason to believe, from observing the phenomena of its reproduction, that it is originally secreted in the form of a semi-fluid viscid matter by the outer surface of the corion; and that, as it is successively worn or removed by attrition, it is in like manner replaced by a constant process of secretory deposition. This semifluid viscid matter, which in truth is found between the outer surface of the corion and the firm cuticle, is the substance mentioned by Malpighi, and so often spoken of as the mucous net (*corpus mucosum*). It is inorganic; and it is impossible to explain its production otherwise than by ascribing it to the outer vascular surface of the corion.

General Anatomy. Skin. Cuticle is rendered yellow and finally dissolved by immersion in nitric acid. It is also dissolved by sulphuric acid in the form of a deep brown pulp. These, and some other experiments performed by Hatchett, show that it consists chiefly of modified albuminous matter.

This description shows, that if strict observation be trusted, the mucous net has no existence, at least in the European. In the Negro, Caffre, and Malay, however, a black membrane is said to be interposed between the corion and cuticle, and to be the cause of the dark complexion of these races. On this subject I refer to the description given by Cruikshank, which is the best (*Experiments*, &c. p. 31, 41, and 43); the Essay of M. Gaultier, already quoted; and the observations of Beclard. What is found in the skin of the mixed or half-caste races, *i. e.* the offspring of an African and a European, or of a mulatto and European? and how is the transition between this colouring layer and its insensible diminution effected?

Nail. Nail is a substance familiarly known. On its nature and structure we find many conjectures, but few or no facts, in the writings of anatomists; and almost all that has been written is the result of analogical inference rather than of direct observation. It is known that the nails drop off with the scarf-skin in the dead body; that they are diseased or destroyed by causes which act on the outer surface of the corion, and produce disease of the cuticle; and that, if forcibly torn out, the surface of the corion to which they were attached bleeds profusely and inflames. In other respects they are inorganic; but these facts warrant the conclusion that the root of the nail is connected with the organic substance of the corion, and that the whole substance is the result of a process of secretion similar to that by which the cuticle is formed.

According to the experiments of Hatchett, they consist of a substance which possesses the properties of coagulated albumen, with a small trace of phosphate of lime.

Hair. The *root* of a hair is not only that part which is contained in the bulb, but the portion which is lodged in the skin. The *middle part* and the *point* are those which project beyond the surface of the skin. The *bulb* is a small sac fixed in the inner surface of the corion, in the contiguous filamentous tissue, and in which the root is implanted.

Every hair is cylindrical, tapering regularly from the root to the point, and solid, but containing its proper colouring matter in its substance. The colour varies, but the root is always whitish and transparent, and softer than the rest; the fixed or adhering part of the root is almost fluid. When hair is decolorized, it becomes transparent and brittle, and presents a peculiar silvery-white colour; and as hairs of this kind are few or abundant, it gives the aspect of gray, hoary, or white hair.

The bulb, though visible in a hair plucked out by the root, is too small in human hair to be minutely examined; and Chirac, Gaultier, and Gordon, have therefore described its structure and appearances from the bulbs of the whiskers of large animals, the seal for example, in which it is much more distinct. According to researches of this kind, every bulb forms a sort of sac or follicle, which consists of two tunics, an inner one, tender, vascular, and embracing closely the root of the hair; and an outer, which is firmer and less vascular, and surrounds the inner one, while it adheres to the filamentous tissue and the inner surface of the corion. When the hair issues from the bulb, it passes through an appropriate canal of the corion, which is always more or less oblique, but which, as has been already said, it fills completely; and it afterwards passes in a similar manner through the scarf-skin. Nervous filaments have been traced into the bulbs of the whiskers of the seal by Rudolphi and the younger Andral. The bulb or follicle, in short, is organic, and forms by secretion the inorganic hair.

General Anatomy. Hair.

The structure of hair appears to be either so simple, or so incapable of being further elucidated, that anatomists have not given any facts of consequence regarding it. Its outer surface is believed to be covered with imbricated scales, because in moving a single hair between the finger and thumb it follows one direction only.

Hair is believed to be utterly inorganic, though the phenomena of its growth, decoloration, and especially of the disease termed Polish plait (*plica Polonica*), have led various authors to regard it as possessed of some degree of vitality. These phenomena, however, may be explained by the occurrence of disease in the bulbs or generating follicles. Hair is insoluble in boiling water; but Vauquelin succeeded in dissolving it by the aid of Papin's digester. From the experiments of this chemist, and those of Hatchett, it may be inferred that hair consists of an animal matter, which appears to be a modification of albumen, a colouring oil, and some saline substances.

*Mucous Membrane, Villous Membrane.* (*Membrana Mucosa, M. Mucipara, M. Villosa,—Tissu Muqueux,* Bichat.)

Mucous membrane. The organic tissue or membrane to which the name of *mucous* or *villous* has been applied, consists of two great divisions, the gastro-pulmonary and genito-urinary.

The first or gastro-pulmonary division comprehends that membranous surface which commences at the various orifices of the face at which it is contiguous with the skin, and is continued through the lacrymal and nasal passages, and even the Eustachian tube, by the larynx on the one hand to the windpipe and bronchial membrane, and by the œsophagus on the other through the entire tract of the alimentary canal, at the opposite extremity of which it is again identified with the skin.

The distribution of the second division, or the genito-urinary mucous membrane, is slightly varied according to the differences of sex. In the male it is connected with the skin at the orifice of the urethra, from which it proceeds inwards toward the bladder, sending previously small prolongations through ducts on each side of the *veru montanum*, from which it is believed to be continued through the *vasa deferentia*, to the *vasa efferentia* of the testicle. Continued over the inner surface of the urinary bladder, it is prolonged through the ureters to the pelvis and infundibula of the kidney. In the female, besides passing in this direction, it ascends into the womb, and passes through the Fallopian or uterine tubes, at the upper extremity of which it terminates in an abrupt opening into the sac of the peritoneum—the only instance in the whole body in which a mucous and serous surface communicate freely and directly.

These two orders of membranous tissue have each two surfaces, an attached or adherent, and a free one. The adherent surface is attached, 1*st*, to muscles, as in the tongue, most of the mouth and fauces, œsophagus, and whole alimentary canal, and the bladder; 2*d*, to fibrous membranes, as in the nasal cavities and part of the larynx, in which it is attached to periosteum or perichondrium, the palate, ureter, and pelvis of the kidney; 3*d*, to fibro-cartilages, as in the windpipe (*trachea*), and bronchial tubes.

The free surface is not uniform or similar throughout. The appearance of the pituitary or Schneiderian mem-

General Anatomy.

Mucous membrane.

brane is different from that of the stomach or intestines; the surface of the tongue and mouth is different from that of the trachea; and the free surface of the urethra is unlike that of the bladder. These variations depend on difference of structure, and are connected with a difference in properties; yet anatomists have improperly applied to the whole what was peculiar to certain parts only, and have thus created a system in which some truth is blended with much misrepresentation.

Mucous membrane consists, like skin, of a *corion* or *derma*, and an *epidermis* or *cuticle.*

The mucous corion is a firm, dense, gray substance, which forms the ground-work of the membrane in most regions of the body, but which is evidently represented by the fibrous system, *e. g.* the periosteum or perichondrium, in some other situations. It is most distinctly seen in the mouth and throat, and in various parts of the alimentary canal. In the first situation it is more vascular, less gray and dense, than in the intestinal mucous membrane.

It possesses two surfaces, an inner, adherent to the submucous filamentous tissue, and an outer or proper mucous surface. In the stomach, the mucous corion is in the form of a soft but firm membranous substance, about $\frac{1}{6}$th or $\frac{1}{8}$th of a line thick, tough, of a dun-gray or fawn colour (intermediate between Sienna-yellow and ochre-yellow, Syme), slightly translucent, and sinking in water. The attached or inner surface is flocculent and tomentose, and a shade lighter than the outer, which presents a sort of shag or velvet, consisting of very minute piles. This, when examined by a good lens at oblique light, appears to consist of an infinite number of very minute roundish bodies closely set, but separated by equally minute linear pits, and occasionally circular depressions. In the ileum it presents much the same characters; but the minute bodies of its shaggy surface are still larger and more distinct, and may be seen by the naked eye. In the windpipe, again, it is rather thinner and lighter coloured; and while its outer surface presents numerous minute pores, it is much smoother than in the alimentary canal, and entirely destitute of those minute bodies seen in the latter. It nowhere presents any appearance of fibres.

The mucous corion rests on a layer of filamentous tissue, firm and dense, and of a bluish-white colour,—a character by which it is distinguished from the soft fawn-coloured mucous membrane. This submucous filamentous tissue is what is erroneously termed the *nervous coat* by Ruysch, Albinus, and some of the older anatomists.

In certain parts the mucous corion is covered by a thin transparent membrane, named the *epidermis* or cuticle, which is most easily shown by boiling or scalding a portion of mucous membrane, and then peeling off with care the outer pellicle. This experiment succeeds best in the mucous membrane of the mouth and palate, in which, therefore, the existence of mucous epidermis cannot be doubted. The observations of Wepfer, Haller, and Nicholls, and especially of Bleuland (*Observationes Anatomico-Medicæ de Sana et Morbosa Œsophagi Structura*, Lug. Bat. 1785), are sufficient to prove its existence in the œsophagus. Bichat admits that, though it may be demonstrated at the cutaneous junctions of the mucous surfaces, it cannot be recognised in the stomach, intestines, bladder, &c. From the numerous dissections of Home (*Phil. Trans.* 1807, 1810, 1813), it results that the mucous epidermis, both in the human subject and in most *mammalia* and birds, terminates abruptly at the cardiac orifice of the stomach. In ruminant animals the mucous *epidermis* is continued over the first two stomachs, but cannot be traced in the third and fourth. In the whale tribe, in which the stomach is also quadruple, the *epidermis* is confined to the first cavity. In birds of the grazing tribe, the mucous *epidermis* is continued over the gizzard, but terminates at the opening into the stomach. This conclusion as to the human subject is confirmed by Beclard, who further adds, that in the genito-urinary system it cannot be traced beyond the neck of the womb and that of the bladder.

General Anatomy.

Mucous membrane.

In most mucous membranes are found minute oval or spheroidal bodies, slightly elevated, and presenting an orifice leading to a blind or shut cavity. As they are believed to secrete a fluid analogous to or identical with mucus, they are named mucous glands; and from their shape and situation they are also denominated follicles (*folliculi*) and *cryptæ.* Though more or less abundant in all the mucous membranes, they have been most frequently examined in those of the alimentary canal, where they were first accurately described by Brunner and Peyer. (*Glandulæ Peyerianæ.*) In this situation they are situate in the substance of the mucous corion. Their structure is simple. The orifice leads into a saccular cavity, with a smooth, uniform surface, which secretes the fluid which oozes from them. This membranous sac is lodged in a reddish-coloured, dense, anormal matter, which is probably filamentous tissue enveloping minute blood-vessels; but of the minute structure of which nothing is accurately known. In the state of health these bodies are so minute that it is very difficult to recognise them. I have seen them, nevertheless, in the tracheo-bronchial membrane by the eye and by a lens. When the membranes are inflamed they become larger and more distinct. In the bladder, the womb, the gall-bladder, and the seminal vesicles, they are not distinctly seen, and cannot be satisfactorily demonstrated. It is unnecessary, however, to follow the example of Bichat in trusting to analogy to prove their existence; for they are not necessary to the secretion of mucous fluid, as he seems to imagine. Those in the urethra, first well described by William Cowper, are distinct examples of follicles in the genito-urinary surface. The sinuosities (*lacunæ*), first accurately described, if not discovered, by Morgagni (*Adversaria Anatomica*, iv. 8, 9, &c.), though not exactly the same in conformation and structure, seem to be very slightly different.

In certain regions of the mucous membranes, especially at their connections with the skin, are found minute conical eminences denominated *papillæ.* They are distinctly seen in the mucous membrane of the tongue, where they vary in size and shape, and in the body named *clitoris.* They are elevations belonging to the mucous corion, covered by epidermis, and they are liberally supplied by blood-vessels, the veins of which present an erectile arrangement, and with minute nervous filaments.

In the stomach, duodenum, and ileum, this membrane is collected into folds or plaits, which have received in the former situation the name of *rugæ*, or wrinkles; and in the latter the name of *plicæ*, or folds, and *valvulæ conniventes*, or winking valves. In the vagina also are transverse *rugæ*, which in like manner are folds or duplicatures of its mucous membrane. Those of the œsophagus, which have been described by Bleuland, are longitudinal. In the tracheo-bronchial membrane, and in the membranous and spongy portions of the urethra, we find them in the shape of minute plaits or wrinkles in the long direction of their respective tubes, but rarely of much length. The object of these folds, which are peculiar to the mucous membranes, appears to be to increase the extent of surface, and to allow the membrane to undergo considerable occasional distension.

In certain points, where a communication is observed between the general mucous surface and the cavities or recesses of particular regions, anatomists, unable to demonstrate a mucous membrane, have inferred its existence as a continuation of the general surface. In the tympanal cavity, to which the Eustachian tube leads, the existence of a mucous or fibro-mucous membrane is rather presumed from analogy than proved by observation. We know that, where the biliary and pancreatic ducts enter the duodenum, and for a considerable space towards the liver, the interior appearance is that of a fine mucous surface provided with *lacunæ* and villosities; but it is impossible to say at what point of the hepatic duct, or of the smaller canals of which it is formed, the mucous membrane terminates. The tracheal membrane, when traced to the bronchial divisions, presents no arrangement, either of *papillæ*, piles, or villosities; and nothing is perceived except a smooth uniform surface, of a colour between gray, dun, and red or purple, which is moistened with a viscid semi-transparent fluid, and which is as like the peritoneum as the intestinal mucous membrane. Lastly, the situation where the existence of the mucous system, though believed, is most uncertain, is in the interior of the *vasa deferentia*, where they take their origin from the *vasa efferentia* of the *testis*. Regarding the organization of these tubes, no sensible evidence can be obtained, and whatever is stated concerning it is the result of analogical inference.

Though these membranes have been designated by the general name of *mucous*, the action of their surface is not in every situation the same. It is not easy to limit the signification of the term *mucus;* for this fluid varies in the nasal passages, in the trachea and bronchial membrane, in the œsophagus, stomach, and intestines, and in the urinary bladder and ureters. But it may be stated that many parts of the two mucous surfaces never in the healthy state secrete any modification of this animal matter; and in others the membrane is almost always moistened by a different fluid. The mucous or villous membrane of the eyelids is never in the healthy state occupied by mucus, but is uniformly moistened with the tears; the membrane of the mouth and throat is moistened with saliva only; the urethra presents a peculiar viscid fluid, which seems to exude from many minute vessels opening along its surface, as in the *lacunæ*, but which is widely different from mucus. All those parts, in short, which are not in perpetual, but only occasional, contact with foreign or secreted substances, seem to present no mucus in the healthy state; whereas the surfaces of the stomach, intestines, gall-bladder, and urinary bladder, are constantly covered with a quantity, more or less considerable, of this animal secretion.

The chemical properties of mucous membranes are completely unknown. The analysis of the fluid secreted by them has been executed by Fourcroy, Berzelius, and others, but is foreign to the subject of this article.

That the mucous membranes are liberally supplied with blood by vessels both large and numerous, is proved not only by the phenomena of injections, but by the red colour of which many of their divisions are the seat. This coloration, as well as the injectibility, is not indeed uniform; for in certain regions mucous surfaces are pale or light blue, in others their redness is considerable.

Thus, in those regions in which the mucous membranes coalesce with the periosteum, forming fibro-mucous membranes, *e. g.* in the facial sinuses, the tympanal cavity and the mastoid cells, the colour is pale blue, or approaching to light lilac. In the bladder, in the large intestines, in the excretory ducts in general, though pale, this colouring becomes more vivid. In the pulmonic mucous membrane it is slate-blue, verging to pale pink. In the stomach, duodenum, small intestines, and the vagina, it becomes still more marked. In the uterus it varies according to the period or the intervals of menstruation.

Examined in the gastro-enteric mucous membrane, in which they are most numerous, these vessels are found to consist of an extensive net-work of capillaries divided to an infinite degree of minuteness, mutually intersecting and spreading over the upper or outer surface of the mucous corion. This vascular net-work, though demonstrated by Ruysch, Albinus, Haller, and Bichat, has been beautifully represented in the delineations of Bleuland, who thinks he has traced their minute ramifications into the *villi*. These minute vessels are derived from larger ones, which creep through the submucous cellular tissue, and penetrate the mucous corion, the substance of which receives few or no vessels, to be finally distributed at its exterior surface.

The arrangement of the vessels which supply the mucous surfaces is peculiar. Penetrating, in the form of considerable trunks, between the folds of the serous membranes, they divide in the subserous cellular tissue into branches of considerable size; and here they form those numerous anastomotic communications which constitute the arches so distinctly seen in the ileum. From the convexity of these arches are sent off most of the small vessels, which are then fitted, after passing through the muscular layer and the submucous tissue, to enter the mucous corion.

The capillary terminations, then, of these arteries, and their corresponding veins, constitute the physical cause of the coloration of the mucous membranes. This coloration, however, is not at all times of the same intensity in the same membrane, and varies chiefly according to the state of the organ which the membrane covers. The coloration of the gastro-enteric mucous membrane undergoes, even within the limits of health, many variations. Thus, according to the absence or presence of such foreign substances as are taken at meals, the mucous membrane is pale, or presents various shades of redness. At the period of menstruation the uterine mucous membrane becomes red and injected. Pressure on any of the venous vessels renders the mucous membranes blue, purple, or livid, as is seen in *prolapsus*, and more distinctly in *asphyxia*, in which all the mucous membranes assume a livid tint. (Bichat.) The varieties of red colour observed in the gastric mucous membrane by Dr Yellowly are to be ascribed partly to the latter cause, partly to the vascular redness which the presence of foreign bodies occasions. (*Medico-Chirurg. Trans.* vol. iv. p. 371.) The pulmonary division of this membrane is of an ash-gray or dun colour, inclining to pale blue or light red. These colours vary, nevertheless, according to the facility or the difficulty with which the blood moves through the pulmonary capillary system. It is also freely supplied with blood-vessels derived chiefly from the bronchial arteries. These vessels, after accompanying the bronchial tubes and their successive subdivisions, divide into minute branches which penetrate the mucous corion, which here is white, dense, and fibrous, and after anastomosing with the capillaries of the pulmonary artery and veins, form a minute delicate net-work on the outer surface of the pulmonary mucous membrane. According to Reisseissen, to whom we are indebted for a careful examination of these vessels, a successful injection of them from the bronchial arteries renders the whole mucous membrane of the *bronchi* entirely red to the unassisted eye. (*Ueber den Bau der Lungen*, u. s. w. Berlin, 1822.)

General Anatomy.

Mucous membrane.

The termination of arteries at the mucous surfaces has at all times occupied the attention of anatomists and physiologists; but it is not a matter of sensible demonstration. The thin serous or sero-mucous fluid with which they are moistened has led every author almost, and among the rest Haller and Bichat, to infer the existence of arteries with orifices, or what are termed exhalant vessels. It has been admitted, nevertheless, more on analogical than direct proofs. The injections of Bleuland, the only experiments, after those of Kawe Boerhaave, which tend to confirm the conclusion, require nevertheless to be repeated and varied.[1]

That lymphatics are distributed to mucous membranes, is a point well established. Cruikshank saw the lymphatics proceeding from the pulmonic mucous membrane loaded with blood in persons and animals dying of hæmoptoe. Their existence in the gastro-enteric mucous membrane has been long established.

The mucous surfaces are also freely supplied by nervous twigs and filaments, derived in general from the nerves of automatic life. It is a mistake, nevertheless, to ascribe to these filaments the sensibility and other properties of the mucous membranes, which possess intrinsically certain vital properties independently of the nervous filaments with which they are supplied; and the principal use of these filaments appears to be to regulate these properties, especially that of secretion.

The connection between the mucous membranes and the skin was first demonstrated by Bonn, who traces their mutual approximation and reciprocal transition into each other, and represents the former as an interior production of the latter, enveloping the internal as the skin incloses the external organs. This view has been adopted by Meckel and Beclard, to whom I refer for the proofs of its accuracy. I cannot conclude the subject, however, without observing that one of the most conclusive arguments in its favour is derived from the circumstances of the developement of the intestinal canal during the first months of uterine life. The history of this curious process, which has been investigated by Wolff, Oken, and Meckel, shows that at this period the gastro-enteric mucous membrane, which is previously formed by the vitellar membrane of the *ovum*, and the *allantois* or vesical membrane, which afterwards forms the genito-urinary mucous surface, are in direct communication on the median line, and afterwards at the navel, with the skin or exterior integument.

### *Serous Membrane, Transparent Membrane. (Membrana Pellucida, M. Serosa.—Tissu Sereux.)*

Serous membrane.

The *pleura* and *peritoneum* are the best examples of the tissue which has been named *serous*, from the fluid with which it is moistened, and which may be termed *transparent* or *diaphanous* as its distinctive character.

The distribution or mechanical arrangement of these membranes is peculiar, and though not well understood by anatomists, till Douglas, by his description of the peritoneum, rendered it clearer, may now be said, by the labours of Hunter, Carmichael Smyth, and Bichat, to be quite intelligible. In this, nevertheless, there are certain peculiarities which may perplex the beginner, and prevent him from obtaining at first a clear idea of the distribution and configuration of the pellucid membranes. Thus they have neither beginning nor termination; they have neither orifice nor egredient canal; and they are not continuous with any other membrane or texture.

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Serous membrane.

Every serous membrane consists of a hollow sac everywhere closed, and to the cavity or interior surface of which there is no natural entrance; a circumstance from which they have been denominated *shut sacs* (*sacci occlusi; sacs sans ouverture*). In every serous membrane one part is inverted or inflected, or reflected, as is commonly said, within the other, so that the inner surface of the former part is applied with more or less accuracy to the inner or like surface of the latter. This mode of disposition has suggested the homely and trite, but not inappropriate comparison of a serous membrane to a night-cap, one half of which is folded or doubled within the other, so that while one half of the inner surface is applied to the remaining half, no communication exists between the inner and the outer surface. Every serous membrane, in short, is a single sac, one half of which is doubled within the other.

In every serous membrane the outer surface of the unreflected portion is applied over the walls of the region which the serous membrane lines, while the outer surface of the inflected portion is applied over the organ or organs contained in that region. From this arrangement it results that each organ covered by serous membrane is not contained in that membrane, but is on its exterior surface, and that of every organ so situate, one part at least, viz. that at which its vessels and nerves enter, is always uncovered. Thus the lungs are on the outer surface of the *pleura;* the heart is on the outside of the *pericardium;* the stomach, intestines, liver, spleen, and pancreas, are on the outside of the *peritoneum;* and the testicles are on the outside of the *perididymis.* In the same manner the lungs, though invested by pleura before and behind, at their apex and their base, are uncovered at their roots, or the points where the bronchial tubes and great blood-vessels enter their substance; the heart is uncovered by pericardium at the upper part of the auricular cavities; and the intestinal canal is uncovered along the whole of that longitudinal but tortuous line by which the mesentery is attached, and at which its proper vessels and nerves are transmitted.

To comprehend more distinctly the arrangement of the pellucid membranes, it is expedient, by an effort of abstraction, to trace the course of any one of them, having previously thrown out of the question the means by which their interior free surface is exposed. In this mental process it is requisite to remember that there is no initial point save what is arbitrarily made. If, for example, the course of the *pleura* be traced, the membrane presents no natural boundary from which the anatomist is to commence his demonstration; and he must fix artificially on any point which he finds most convenient for the purpose. Commencing with this understanding, from the circumference of the spot termed *root* of the lungs, the membrane may be traced first along the internal surface of the chest formed by the ribs and intercostal muscles, forwards to the sternum, upwards to the first rib and *apex* of the thoracic cavity, downwards to the diaphragmatic insertions, and over the surface of that muscle, and the outer surface of the pericardium again to the circumference of the root or connection of the lungs. From this point again it may be traced over the surface and between the lobes of these organs, both of

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[1] *Experimentum Anatomicum, quo Arteriolarum Lymphaticarum existentia probabiliter adstruitur,* &c. a Jano Bleuland, M. D. Lugd. Bat. 1784. *Item,* Jani Bleuland, M. D. &c. *Vasculorum Intestinorum tenuium Tunicis subtilioris Anatomes Opera Detegendorum Descriptio Iconibus illustrata.* Trajecti, 1797.

which, as already stated, are thus situate on the outside of the pleura. The course first described is that of the *unreflected* or *exterior* division of the pleura. The second, or that over the organ covered, is the course of the *inflected* or *doubled* portion of the membrane, which is thus necessarily smaller, and less extensive, than the former.

The arrangement thus sketched, which may be easily shown to be applicable to all the serous membranes, demonstrates their twofold character of lining the walls of a cavity and covering the organs contained. From an idea of this property, the old anatomists applied to them the epithet of *membranæ succingentes.*

In tracing the course of the serous membranes, the anatomist observes that they present productions which float with more or less freedom in the cavity formed by the free surface, and which may be generally shown to consist of two folds of the single membrane produced beyond the inclosed organ, but still maintaining the unity of the membrane. Of these prolongations, the most distinct examples are the *epiploon* and the *appendices epiploicæ* of the peritoneum. Less manifest instances are the adipose folds of the *pleura* near the *mediastinum*, and the bladder-like appearance at the base of the heart, within the *pericardium.* The synovial fringes in the interior of the synovial membranes, which belong to a subsequent head, are nevertheless of the same general character. Between the folds of these productions there is invariably more or less adipose substance, which indeed is observed in some quantity in various parts of the filamentous tissue on the outer surface of the serous membranes in general.

Every serous membrane I have above represented as a hollow sac everywhere continuous, and the outer surface of which has no communication with the inner. To this character the only exception is the peritoneum in the female, which is perforated at two points, corresponding to the upper extremity or orifice of the Fallopian or oviferous tubes. This has been already mentioned as the only spot at which the mucous and serous surfaces communicate directly with each other.

Every serous membrane consists of a thin, colourless, transparent web or pellicle, through which the tissue of the subjacent organ or parts may be easily recognised; and every serous membrane presents two surfaces, an attached or adherent, and a free or unadherent.

The attached surface, which is also termed its *outer* one, is that by which it is connected to the tissue or organ which it covers; it is somewhat irregular, flocculent or tomentose, and is evidently connected by fine filamentous tissue. The degree of attachment is very variable in different membranes, and in different points of the same membrane. In general, serous membranes adhere much less firmly to the walls of cavities than to the surface of the contained organs. Thus, the abdominal *peritoneum* and the costal *pleura* are more easily removed than the intestinal *peritoneum* and the pulmonic *pleura.* The *peritoneum* adheres feebly to the bladder, to the liver, and to the pancreas—more intimately to the different regions of the intestinal tube, and seems to be almost identified with the substance of the female organs of generation. From the interior of the capsular *pericardium*, and from the vaginal coat, it is almost impossible to detach the serous pellicle. The former, however, is peculiar in having between the serous surface and the fibrous membrane no filamentous tissue, upon the abundance or deficiency of which the degree of adhesion depends.

The free or unadherent or *inner* surface is very smooth, polished, and uniform; moistened with a watery fluid, from which it derives its shining appearance; and destitute of fibres or any other trace of organic structure. From this smooth, polished aspect, which is a peculiar attribute of the free surface of serous membrane, all the organs covered by it derive their glistening appearance. Thus the exterior surface of the lungs derives its appearance from the pleura, the heart from the pericardium, and the liver and intestinal canal from the peritoneum. A successful injection of size or turpentine, coloured with vermilion, brings into view so many capillary blood-vessels in this membrane, that it might be supposed at first sight to consist entirely of minute arteries and veins. Further, by proper management, lymphatics may be injected in it with quicksilver to a degree equally minute and delicate. From these experiments, therefore, it may be concluded that serous membrane is chiefly composed of minute arteries and veins conveying colourless fluids, and of vessels connected with the general trunks of the lymphatic system. Whether it contains any thing else but vessels of this kind, or has a proper substance or tissue, remains to be ascertained. Though nerves are often seen passing along their outer or attached surface to the neighbouring tissues, none have hitherto been traced either into the pleura or peritoneum.

By most of the older anatomists, and among others by Haller, serous membrane is considered as of the nature of filamentous tissue or cellular membrane, more or less closely condensed (*tela cellulosa stipata*); and this view is adopted and maintained by Bordeu, Bichat, Meckel, and Beclard, the last of whom, however, thinks they partake of ligamentous characters. Macerated, they become soft, thick, and pulpy; and are finally resolved into flocculent filamentous matter. In the course of decomposition in the dead subject they first lose their glistening aspect, then become covered by a foul, dirty coating of viscid matter, which appears to exude from their surface; and eventually they are dissolved into shreds. Immersion in boiling water renders them thick, firm, and somewhat crisp. When dried they become thin, clear, and transparent, and, if preserved from humidity or the attacks of animals, may remain long unchanged. The experiments of Hatchett, Fourcroy, and Vauquelin, show that they contain gelatine and a little albumen; but no precise information on their chemical composition has yet been given.

The principal character of the serous membranes is that of isolating the organs which they cover, and to the structure of which they are adventitious, and forming shut cavities, in which there is incessant exhalation and absorption. In some instances they evidently contribute to facilitate the mutual motions of contiguous and corresponding surfaces. From their free surfaces is secreted a fluid containing a small portion of albumen (Hewson, *Experimental Inquiries*, vol. ii. chap. vii.; Bostock, Nicholson's *Journal*, vol. xiv. p. 147, and *Medico-Chirurgical Transactions*, vol. iv.), which is greatly augmented during the state of disease.

The mode of developement of the pellucid membranes is not well ascertained. The investigations regarding organogenesy by Oken, Meckel, and Tiedemann, disclose facts which induce Meckel to hazard the opinion that some of them are not at all times shut sacs. I doubt, however, whether the fact which he adduces for this purpose implies the open condition of the pericardium and the peritoneum. In the case of the former the developement of the heart proceeds from the basis generally, without affecting the integrity of the investing membrane. In the case of the latter there is more reason to believe that, at the navel, at least, the peritoneum is either open, or is continuous with the vitellar membrane.

In the fœtus the serous membranes are so thin, that

General Anatomy. Serous membrane.

they are much more transparent than in the adult. In small animals also, they are more transparent than in large, and in cold-blooded animals than in the mammiferous. Of some also the disposition varies at different periods. Thus the descent of the testicle,—a process which has been well explained by Albinus, Haller, Wrisberg, and Langenbeck,—is attended with a remarkable change in the arrangement of that portion of peritoneum which the gland impels before it.

*Synovial Membrane.* (*Membrana Synovialis; Bursæ Mucosæ.*)

Synovial membrane.

Bichat enumerates several circumstances in which he conceives that serous and synovial membranes differ from each other. Gordon, who doubts how far the distinctions are well founded as the basis of anatomical arrangement, admits, however, the following peculiarities.

Synovial membrane resembles serous membrane in being a thin, transparent substance, having one smooth free surface turned towards certain cavities of the body, and another connected by delicate cellular tissue to the sides of these cavities, or to the parts contained in them. But it differs from serous membrane in the following circumstances. 1*st*, It possesses little vascularity in the healthy state; no blood-vessels are almost ever seen in it after death, nor can they be made to receive the finest injection. 2*d*, Its lymphatics are quite incapable of demonstration. 3*d*, Very delicate fibres, like those of cellular substance, or like the finest filaments of tendon, are distinctly seen in it after slight maceration. 4*th*, It is considerably less strong than serous membrane. On these grounds, therefore, synovial membrane is to be anatomically distinguished from serous membrane.

The synovial membrane, as described above, is found not only in each of the movable articulations, but in those sheaths in which tendons are lodged, and in which they undergo considerable extent of motion, and in certain situations in the subcutaneous filamentous tissue.

The distribution of the synovial membranes is much the same in all these situations. They are known to line the ligamentous apparatus of each joint, capsular and funicular; and they are also continued over the cartilaginous extremities of the bones of which the articulation consists. This continuation, which was originally maintained by Nesbitt, Bonn, and William Hunter, and was demonstrated by various facts by Bichat, has been lately questioned by Gordon and Magendie, the former of whom especially thinks it unsusceptible of anatomical proof. The cartilaginous synovial membrane is certainly not so easily demonstrable as the capsular, for the same reason which I have already assigned regarding the difficulty of isolating the capsular pericardium, the ovarian peritoneum, and the serous covering of the *tunica albuginea*,—the want of filamentous tissue.

The presence of synovial membrane in the articular cartilages is nevertheless established by sundry facts. 1*st*, If a portion of articular cartilage be divided obliquely, and examined by a good glass, it is not difficult to recognise at one extremity of the section a thin pellicle, differing widely in aspect, colour, and structure, from the bluish-white appearance of the cartilage. 2*d*, If the free surface of the cartilage be scraped gently, it is possible to detach thin shavings, which are also distinct from cartilage in their appearance. 3*d*, The free surface of the cartilage is totally different from the attached surface, or from a section of its substance, and derives its peculiar smooth polished appearance from a very thin transparent pellicle uniformly spread over it. 4*th*, If articular cartilage be immersed in boiling water, this thin pellicle becomes opaque, while the cartilage is little changed. 5*th*, Immersion in nitric or muriatic acid, which detaches the cartilage from the bone, gives this surface a cracked appearance, which is not seen in the attached surface, and which is probably to be ascribed to irregular contraction of two different animal substances. 6*th*, The existence of this cartilaginous synovial membrane is demonstrated by the morbid process with which the tissue is liable to be affected. On the whole, therefore, little doubt can be entertained that the representation of their course, as given originally by Nesbitt, Bonn, and Hunter, is well founded.

General Anatomy. Synovial membrane.

The same views may be applied to the synovial linings of the tendinous sheaths, which are equally to be regarded as shut sacs.

Attached to the free surface of each synovial membrane is a peculiar fringe-like substance, which was long supposed to be an apparatus of glands (glands of Havers) for secreting synovial fluid. It is now known that these fringes are merely puckered folds of synovial membrane, and that, although synovia is abundantly secreted by them, this depends merely on the great extent of surface which is the necessary consequence of their puckered arrangement. This arrangement is easily demonstrated by immersing an articulation containing the fringed processes in clear water, when they are unfolded and made to float, and show their connections, figure, and terminations. They are analogous to the free processes of serous membranes, and like them are double, and contain adipose matter.

The synovial sheaths (*bursæ mucosæ*) are very numerous, and are generally found in every tendon which is exposed to frequent or extensive motion.

Though the fluid prepared by these membranes has been examined by Margueron, Fourcroy, John Davy, Orfila, and other chemists, it cannot be said that its chemical composition is accurately determined. It is said to contain water, albumen, incoagulable matter regarded as mucilaginous gelatine, a ropy matter, and salts of soda, lime, and some uric acid. On the presence of the incoagulable gelatine depends its utility in diminishing friction in the finer kinds of metallic machinery employed in watches and chronometers.

END OF VOLUME SECOND.

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Published by A & C Black, Edinburgh 1853.

they are much more transparent than in the adult. In small animals also, these are more transparent than in large, and in cold-blooded animals than in the mammiferous. [illegible] that the peritoneum varies at different periods. Thus the thinness of the peritoneum,—a property which has been well explained by Albinus, Haller, Walther, and Lieutaud,—[illegible] with a remarkable change in the [illegible] portion of peritoneum [illegible] the gland [illegible] below it.

*Synovial Membrane. (Membrana Synovialis; Synovial Membrane.)*

Bichat enumerates several circumstances by which the proper serous and synovial membranes differ from each other. Gordon, who doubts how far the distinctions are well founded as the basis of anatomical arrangement, admits, however, the following peculiarities.

Synovial membrane resembles serous membrane in being a thin, transparent substance, having one smooth free surface turned towards certain cavities of the body, and the other connected by delicate cellular tissue to the sides of these cavities, or to the parts contained in them. But it differs from serous membrane in the following circumstances. 1st, It possesses little vascularity in the healthy state; no blood-vessels are almost ever seen in it after death, nor can they be made to receive the finest injection. 2d, Its lymphatics are quite incapable of demonstration. 3d, Very delicate fibres, like those of cellular substance, or like the finest filaments of tendon, are distinctly seen in it after slight maceration. 4th, It is considerably less strong than serous membrane. On these grounds, therefore, synovial membrane is to be anatomically distinguished from serous membrane.

The synovial membrane, as described above, is found not only in each of the movable articulations, but in the sheaths in which tendons are lodged, and in which they undergo considerable extent of motion, and in certain situations in the subcutaneous filamentous tissue.

The distribution of the synovial membranes is much the same in all these situations. They are known to line the ligamentous apparatus of each joint, capsular and funicular; and they are also continued over the cartilaginous extremities of the bones of which the articulation consists. This continuation, which was originally maintained by Nesbitt, Bonn, and William Hunter, and was demonstrated by various facts by Bichat, has been lately questioned by Gordon and Magendie, the former of whom especially thinks it unsusceptible of anatomical proof. The cartilaginous synovial membrane is certainly not so easily demonstrable as the capsular, for the same reason which I have already assigned regarding the difficulty of isolating the capsular pericardium, the ovarian peritoneum, and the serous covering of the *tunica albuginea*,—the want of filamentous tissue.

The existence of synovial membrane in the articular cartilages [illegible]. 1st, It is [illegible] and [illegible] or a [illegible] from the [illegible] ing widely in aspect, colour, and structure [illegible] [illegible]-white appearance of the cartilage. 2d, If the surface of the cartilage be scraped gently, it is possible to detach thin shavings, which are also distinct from cartilage in their appearance. 3d, The free surface of the cartilage is [illegible] different from the attached surface, or from a section of its substance, and derives its peculiar smooth polished appearance from a very thin transparent pellicle uniformly spread over it. 4th, If articular cartilage be immersed in boiling water, this thin pellicle becomes opaque, while the cartilage is little changed. 5th, [illegible] in nitric or muriatic acid, which detaches the cartilage from the bone, gives this surface a crackled appearance, which is not seen in the attached surface, and which is probably to be ascribed to irregular contraction of two different animal substances. 6th, The existence of the cartilaginous synovial membrane is demonstrated by the morbid process with which the tissue is liable to be affected. On the whole, therefore, little doubt can be entertained that the representation of their course, as given originally by Nesbitt, Bonn, and Hunter, is well founded.

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END OF VOLUME SECOND.

NEILL AND CO., PRINTERS, EDINBURGH.

Fig. 1.

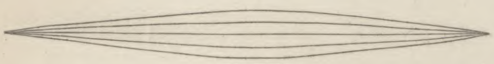


Fig. 2.

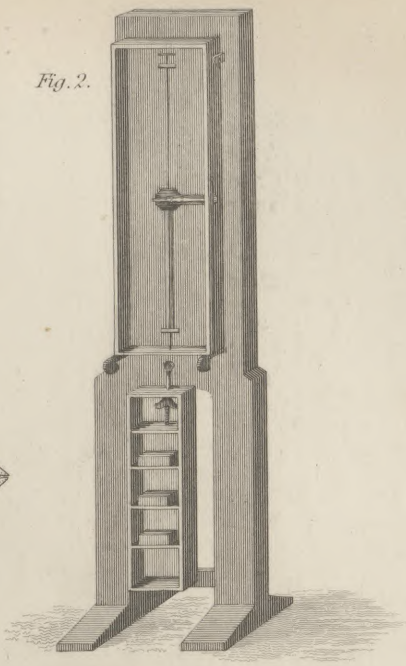


Fig. 11.

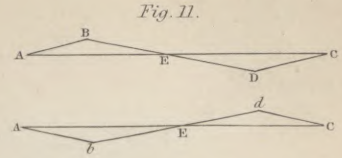



Fig. 10.


Fig. 9.

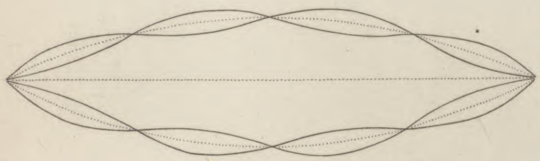


Fig. 13.

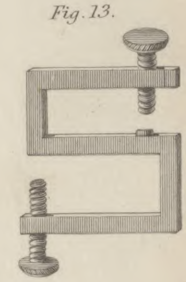


Fig. 3.

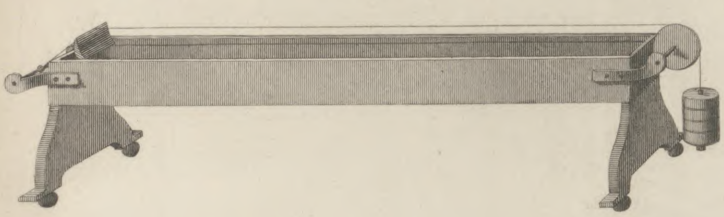
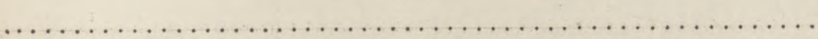


Fig. 12.

Fig. 4.



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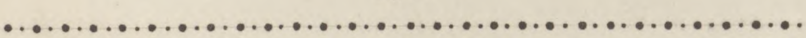

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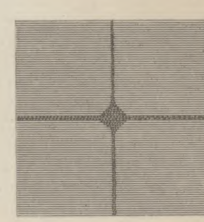
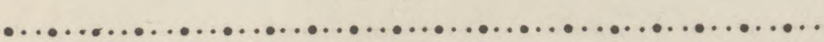


Fig. 6.



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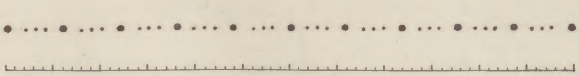
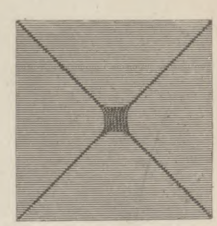


Fig. 15.



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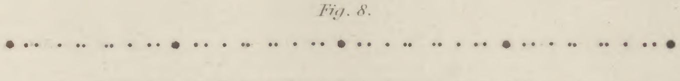

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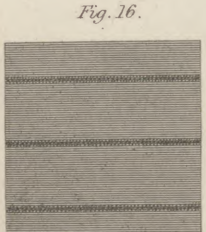
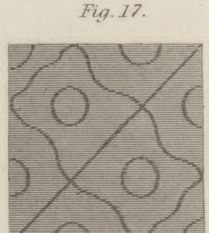


Fig. 17.



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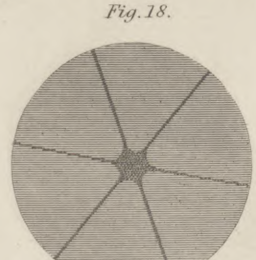
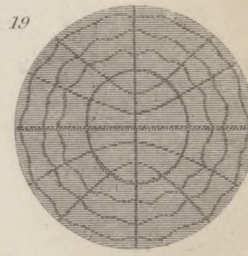


Fig. 19.



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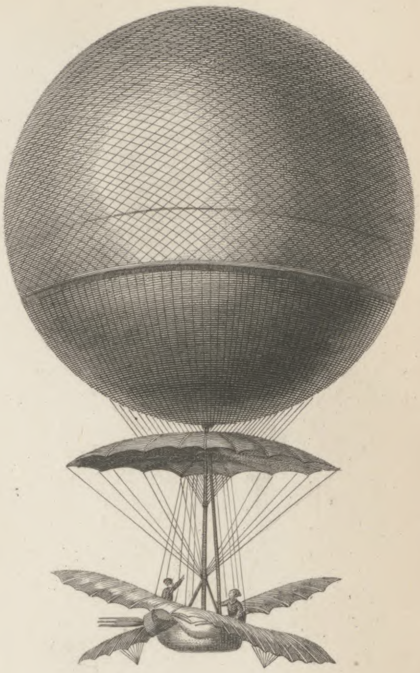
Published by A.&C. Black, Edinburgh, 1853.

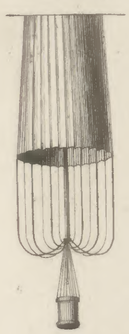
Published by A. & C. Black, Edinburgh.

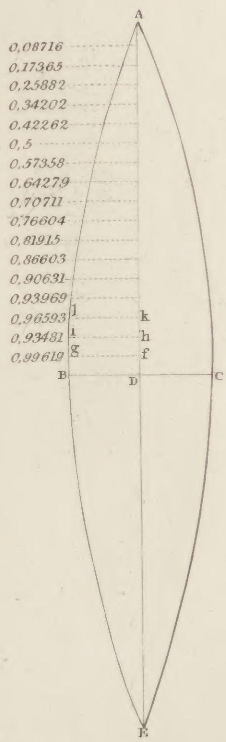
MONTGOLFIER'S BALLOON

BLANCHARD'S BALLOON



GARNERIN'S PARACHUTE
*in ascending*

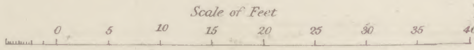





GARNERIN'S PARACHUTE
*in descending*

LUNARDI'S BALLOON

CHARLES' & ROBERTS' BALLOON

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Edinburgh, Published by A. & C. Black.

Engraved by Sidney Hall.

PLATE III.


NORTH ATLANTIC OCEAN
EUROPE
TURKEY
ASIA
PERSIA
ARABIA
BARBARY
SAHARA OR GREAT DESERT
NUBIA
SOUDAN
GUINEA
ABYSSINIA
SOMAULIES
MEDITERRANEAN SEA
Black Sea
Caspian Sea
Red Sea
Persian Gulf
Gulf of Aden
Gulf of Guinea
Bay of Biscay
Adriatic Sea
Tropic of Cancer
FEZZAN
Tibesti
Borgoo
Darfour
Kordofan
Ireland
ENGLAND
London
Brussels
Paris
FRANCE
PORTUGAL
SPAIN
Madrid
Lisbon
Corsica
Sardinia
Sicily
Rome
Vienna
Constantinople
Cyprus
Candia
Tripoli
Alexandria
CAIRO
Jerusalem
Damascus
Baghdad
Basra
Medina
Mecca
Mocha
Aden
Socotra
Madeira
CANARY ISLANDS
Timbuctoo
Furthest point reached by the Egyptian Expeditions


Edinburgh, Published by A. & C. Black.

Engraved by S. Hall Bury Str. Bloomsby.

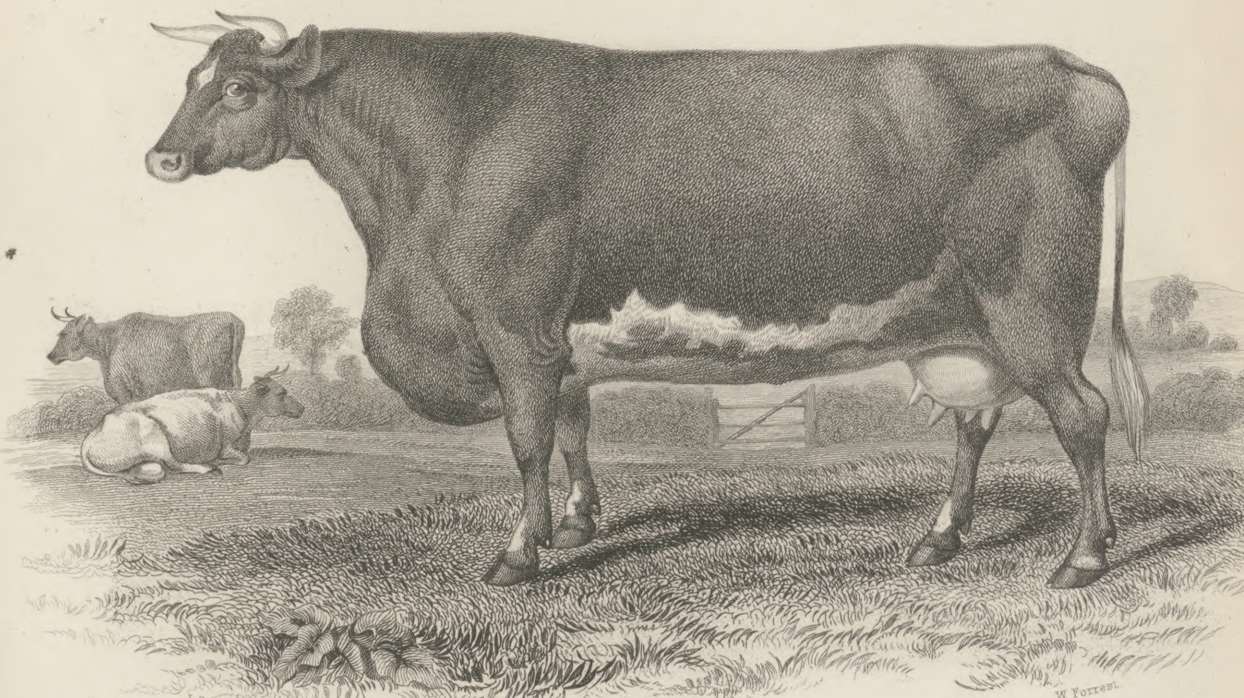

AFRICA,
NORTH PART.
English Miles.

Published by A.&C. Black. Edinburgh. 1853.

SHORT-HORNED BULL

PHŒNIX.

*Bred by and the property of Mr. Crisp. Hawkhill. Northumberland. Winner in 1852 of the First Prizes given by the Agricultural Societies of England, Scotland & Ireland.*



J. Stewart. W. Forrest.

SHORT-HORNED COW

CHARITY.

*Bred by and the Property of Mr. Booth. Warlaby. Yorkshire.*

Published by A.&C. Black. Edinburgh. 1853.

Galloway Bull.

Argyleshire Bull.

Black faced Ram.

Howe Pinx.

Eng.d by G. Aikman Edin.r

Published by A. & C. Black. Edinburgh, 1853.

Published by A & C. Black, Edinburgh 1853

BULL, HEREFORD BREED

*Bred by the Right Hon^ble the Earl of Talbot.*


EWE & LAMB, SOUTH DOWN BREED

*Bred by Thomas Ellman, Esq^r. Beddingham.*

Published by A.& C.Black, Edinburgh, 1853.

Published by A & C. Black. Edinburgh, 1853.

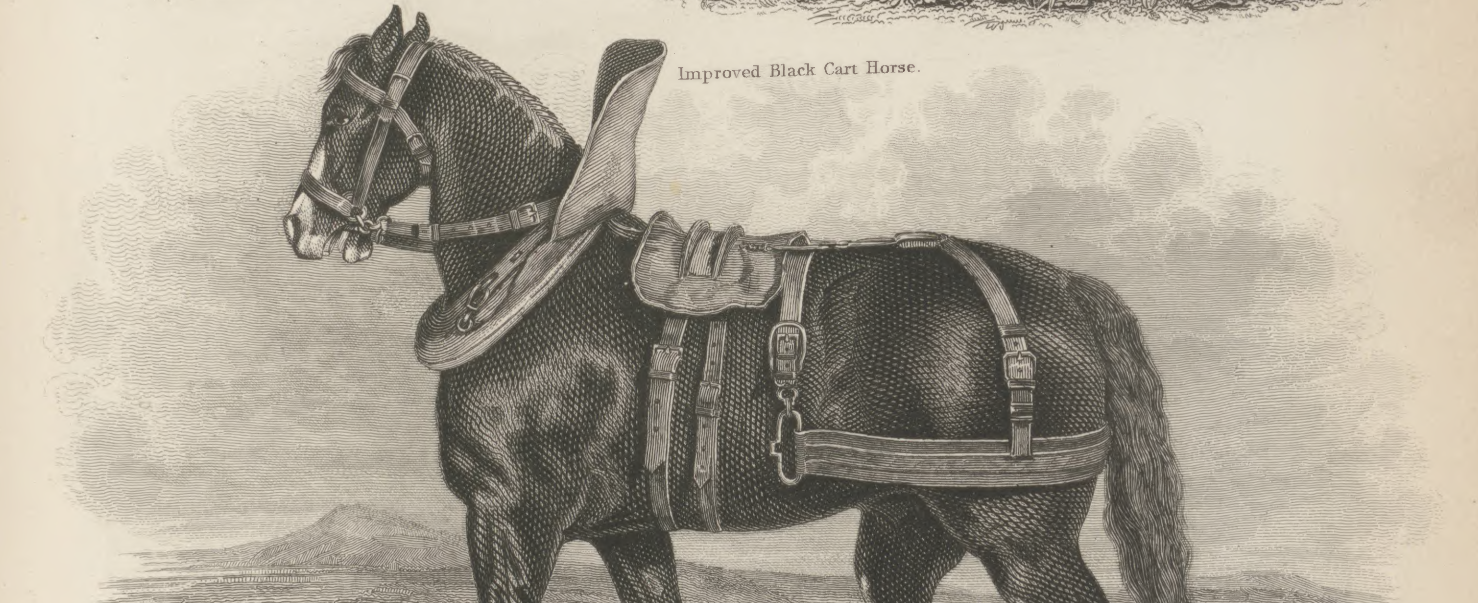
Ayrshire Cow.

Howe Pinxᵗ — Clydesdale Horse. — Highland Pony. — Engᵈ by G. Aikman.

Published by A. & C. Black. Edinburgh, 1853.

Suffolk Punch.

Improved Black Cart Horse.



Eng.d by G. Aikman Edin.r

Published by A. & C. Black, Edinburgh, 1853

Published by A.& C. Black. Edinburgh 1853.

LEICESTER RAM

*Bred by. and the Property of Mr. Dickinson. Magdalene Hall. Roxburghshire.*


LEICESTER EWE

*Bred by. and the Property of Mr. George Thomson. Haymount. Roxburghshire.*

Published by A. & C. Black. Edinburgh. 1853.

Published by A.& C. Black. Edinburgh. 1853.

CHEVIOT EWE

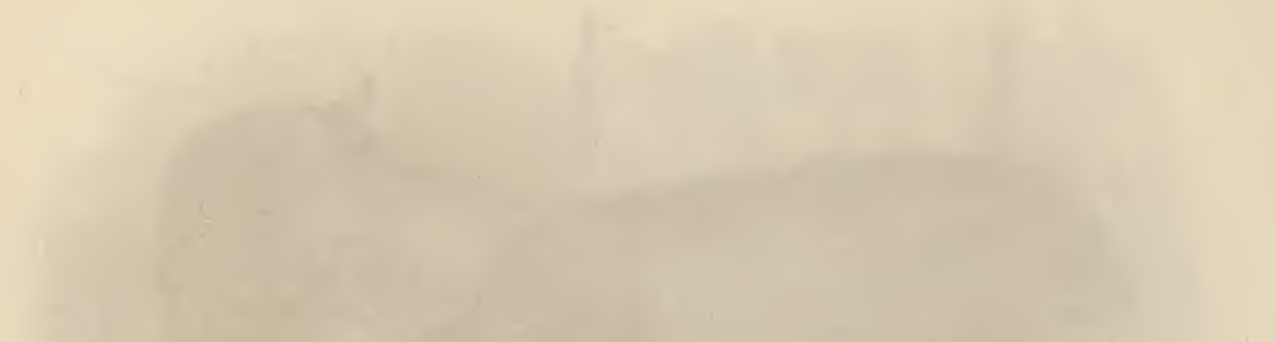
*Bred by, and the Property of Mr. Thomas Elliott, Hyndhope, Roxburghshire.*

THE BLACK-FACED HEATH BREED

One Year Old.

*Bred by Mr. Thomas Robertson, Broomlea, County of Peebles.*

Published by A.& C. Black, Edinburgh, 1853.



Published by A.&C. Black. Edinburgh. 1853.

THE ROMNEY MARSH BREED

Ewe, in her second fleece.

*Bred by Mr. Bishop of Losenham House, Kent.*

NEAPOLITAN BREED

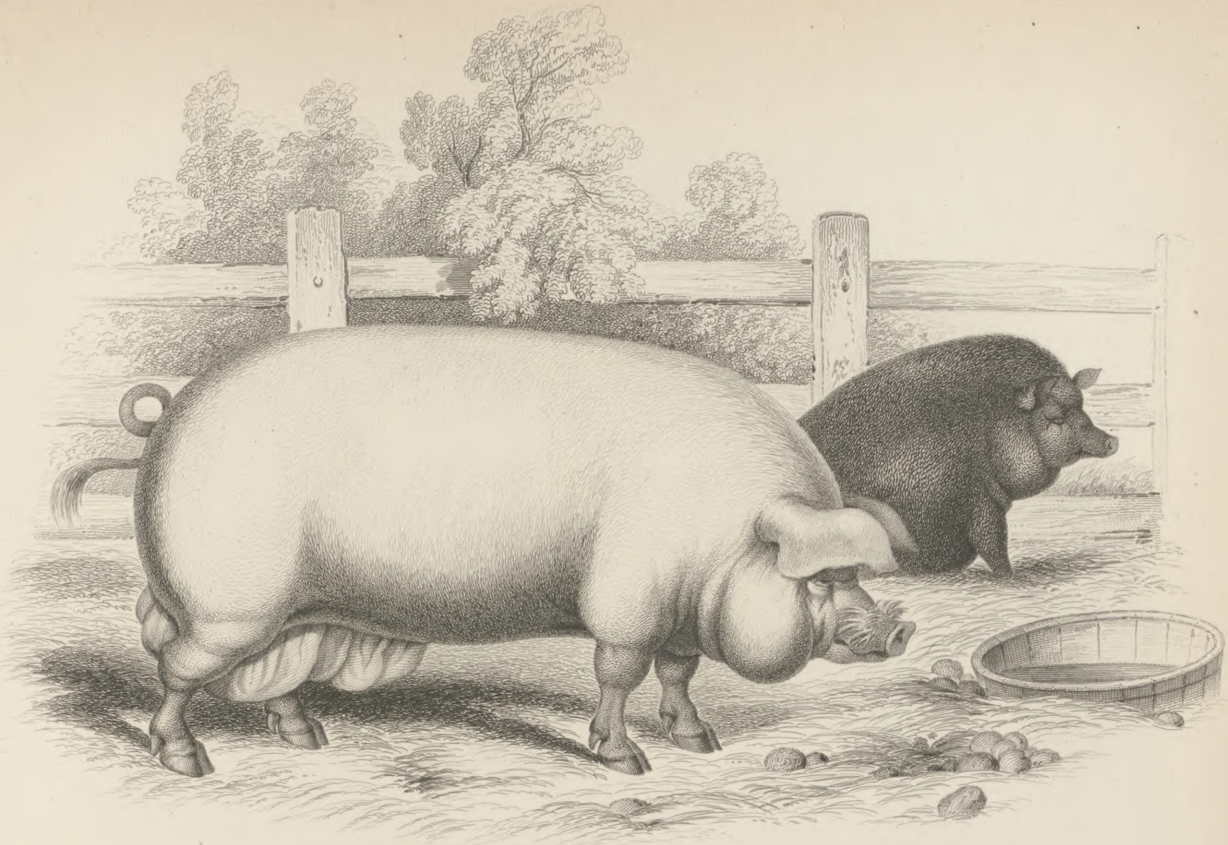
Boar and Sow.

*The Property of the Right Hon. Earl Spencer; imported from Naples by the Hon. Captain Spencer.*

Published by A. & C. Black. Edinburgh. 1853.

BOAR OF THE LARGE ENGLISH BREED

SOW OF THE LARGE ENGLISH BREED



BOAR OF THE LARGE ENGLISH BREED

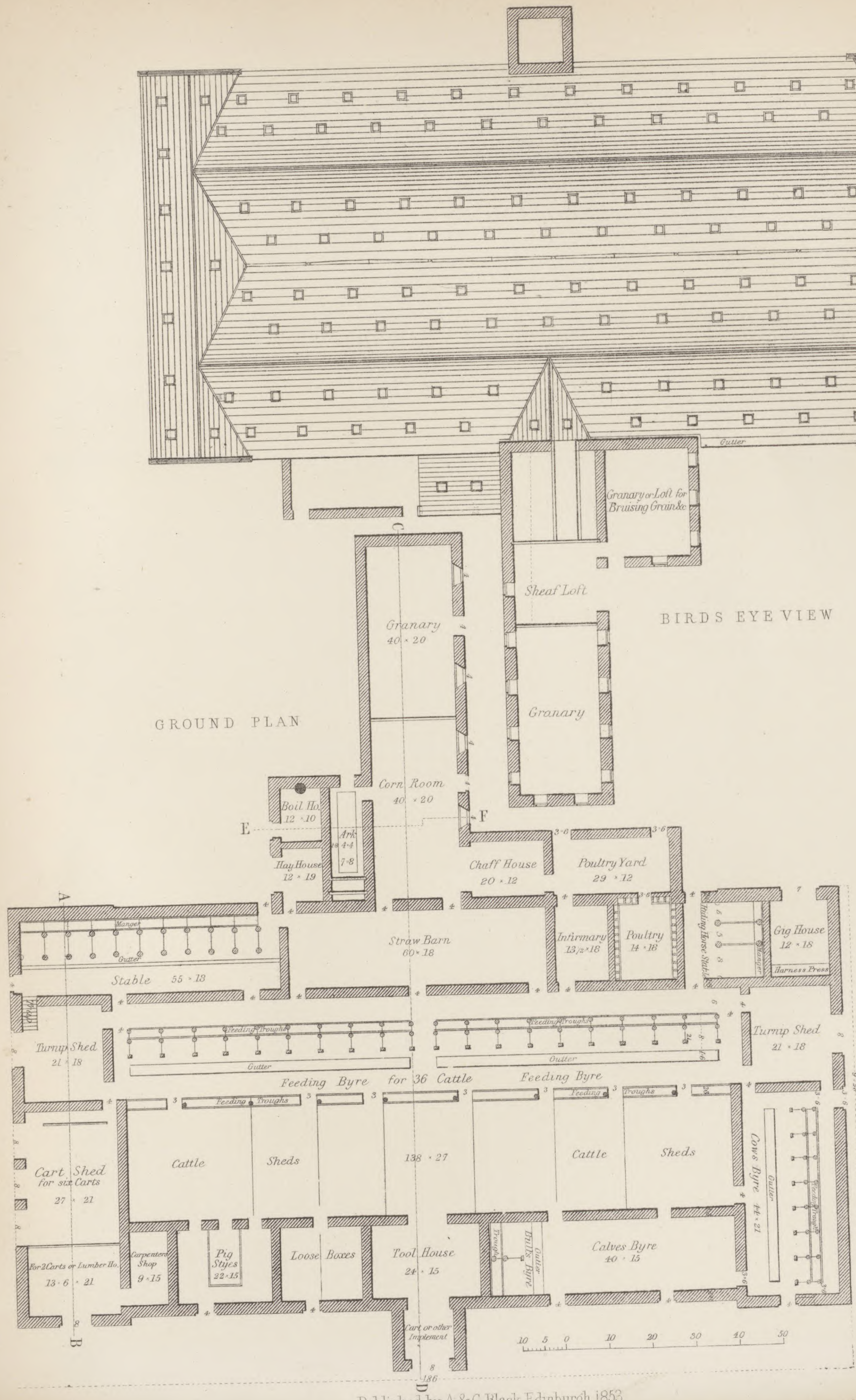
*Bred by, and the Property of Mr Eddison, Yorkshire.*


SOW OF THE LARGE ENGLISH BREED

*Bred by, and the Property of Mr Eddison, Yorkshire.*

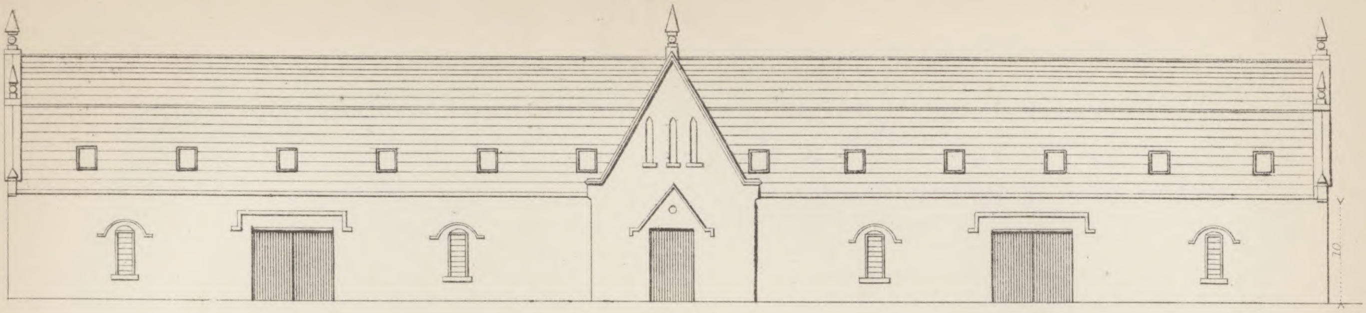
Published by A. & C. Black, Edinburgh, 1853.


8
186

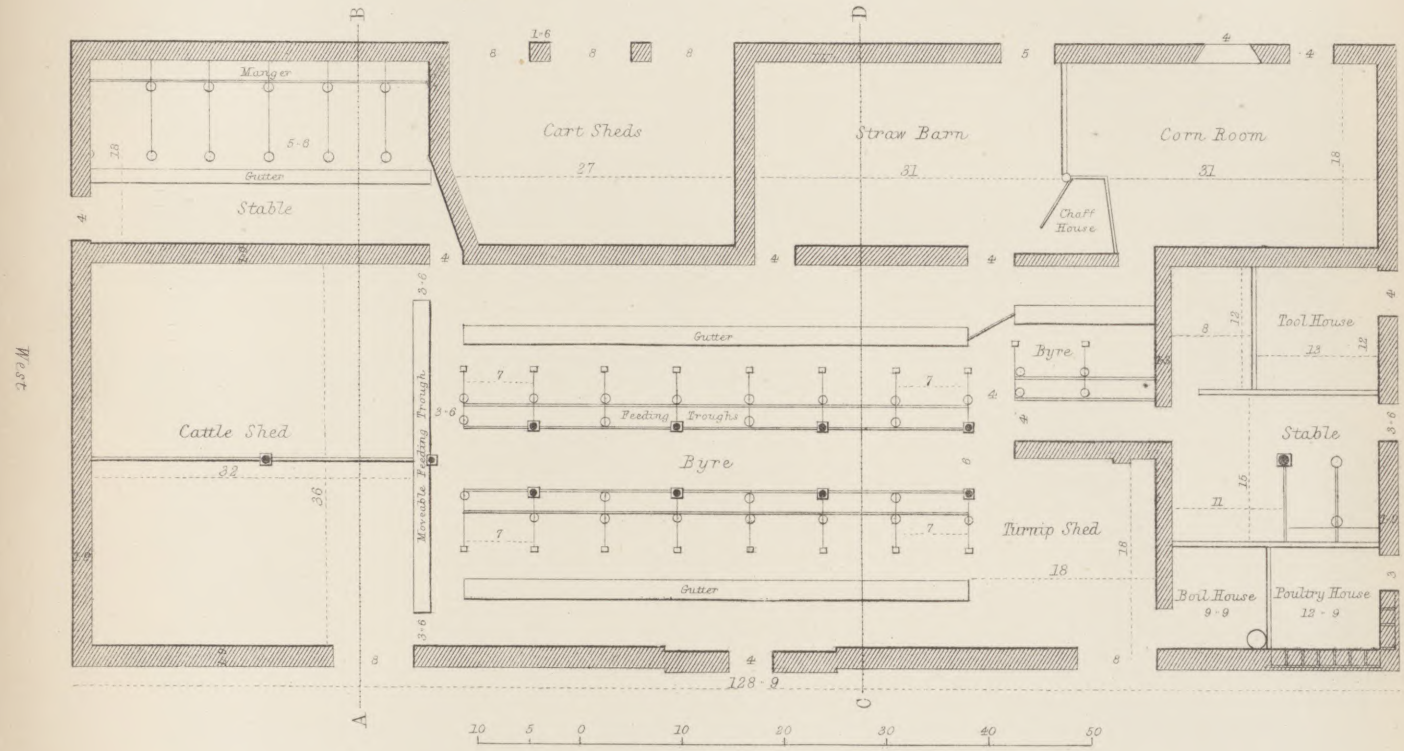



Published by A. & C. Black. Edinburgh 1853.

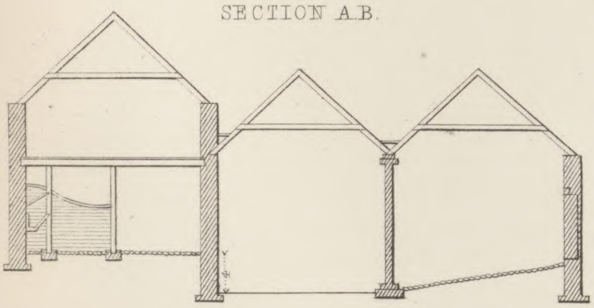

Stable
SECTION C.D.
EAST ELEVATION.



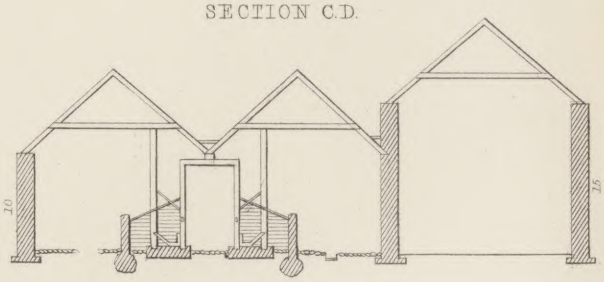
FRONT ELEVATION




SECTION A.B.

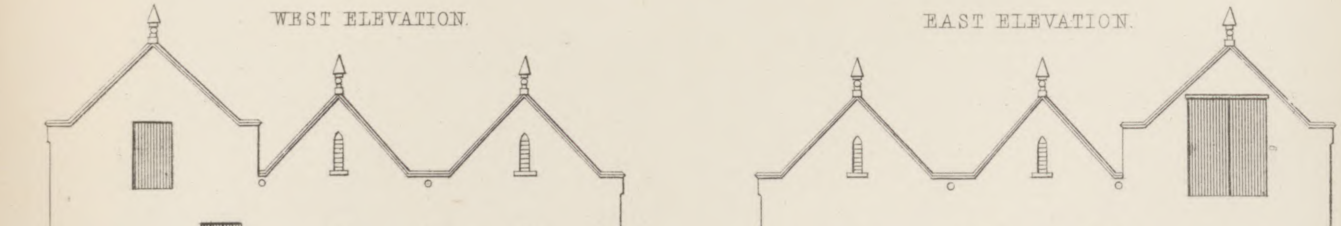


SECTION C.D.



WEST ELEVATION.

EAST ELEVATION.



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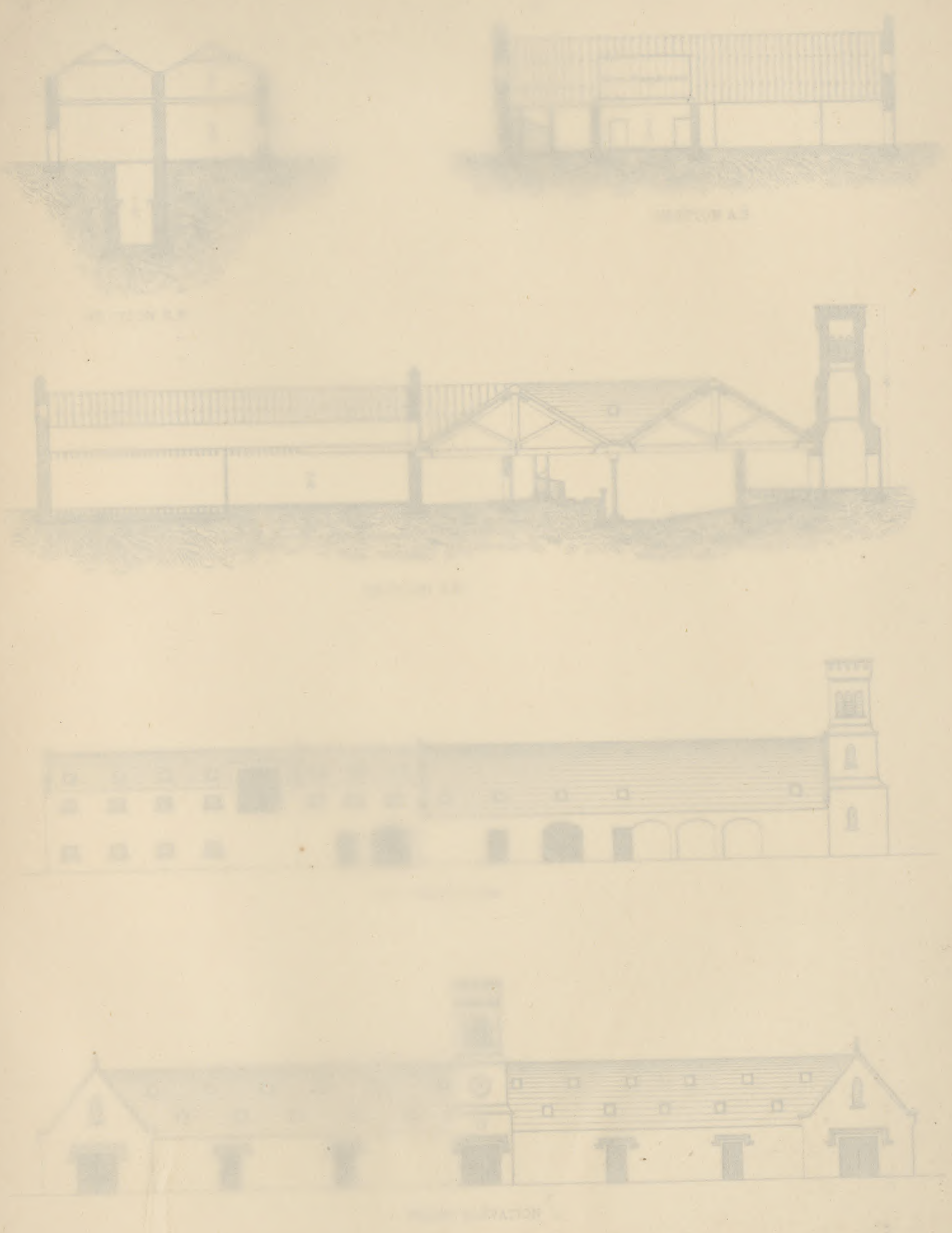
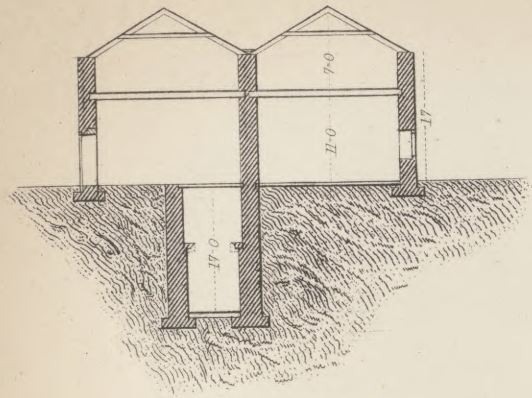
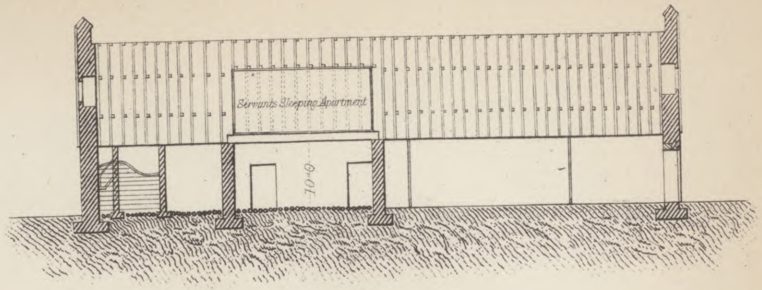
G. Aikman.

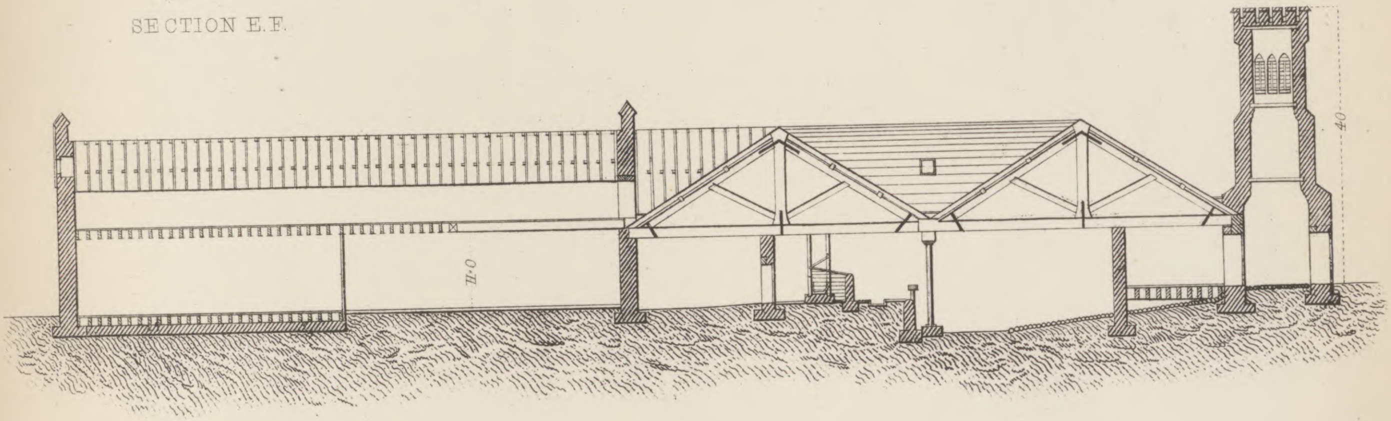




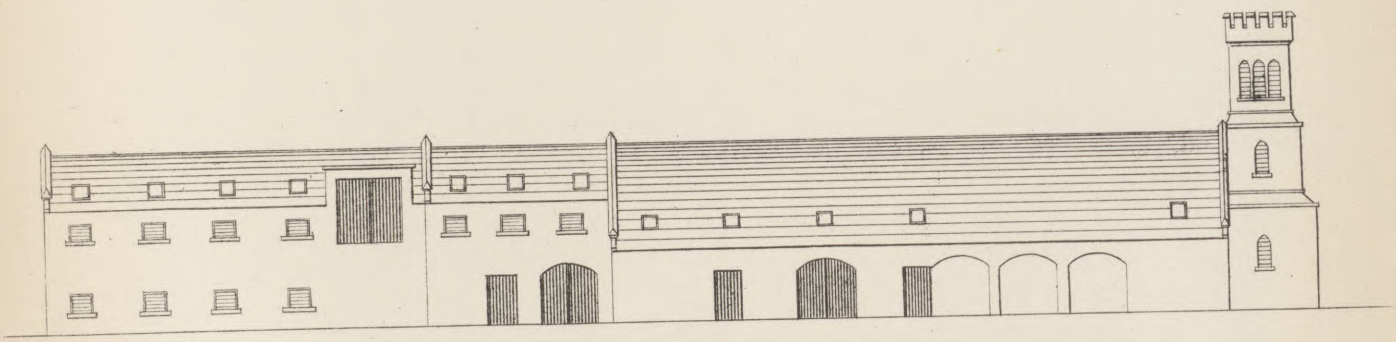

SECTION E.F.



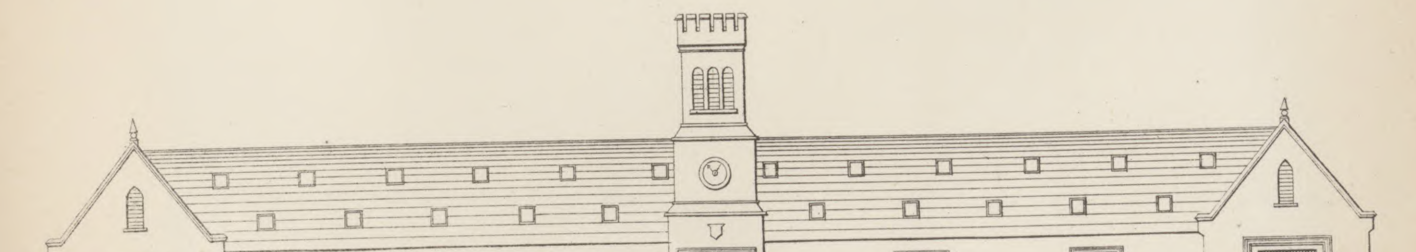

SECTION A.B.



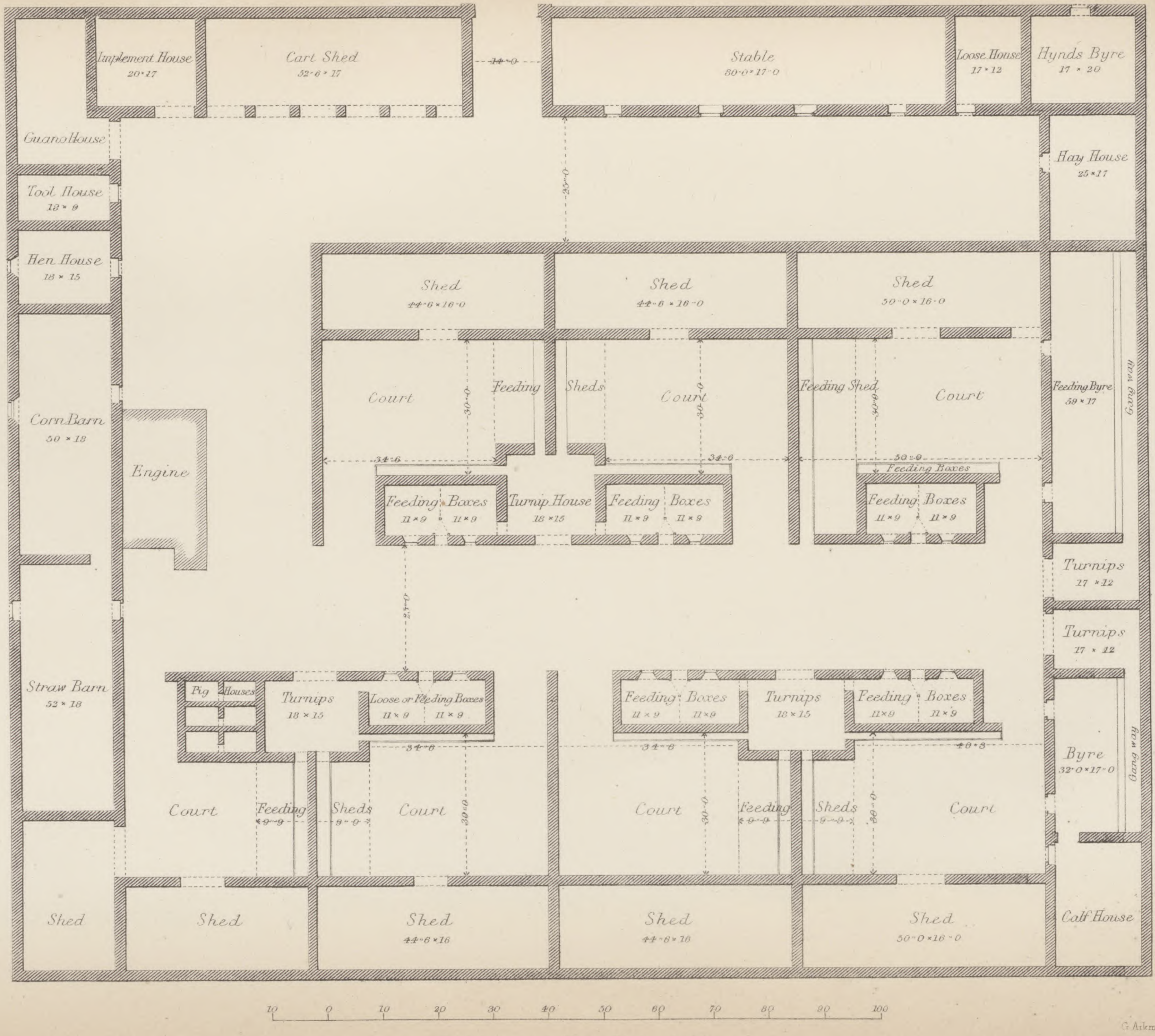

SECTION C.D.



END ELEVATION.

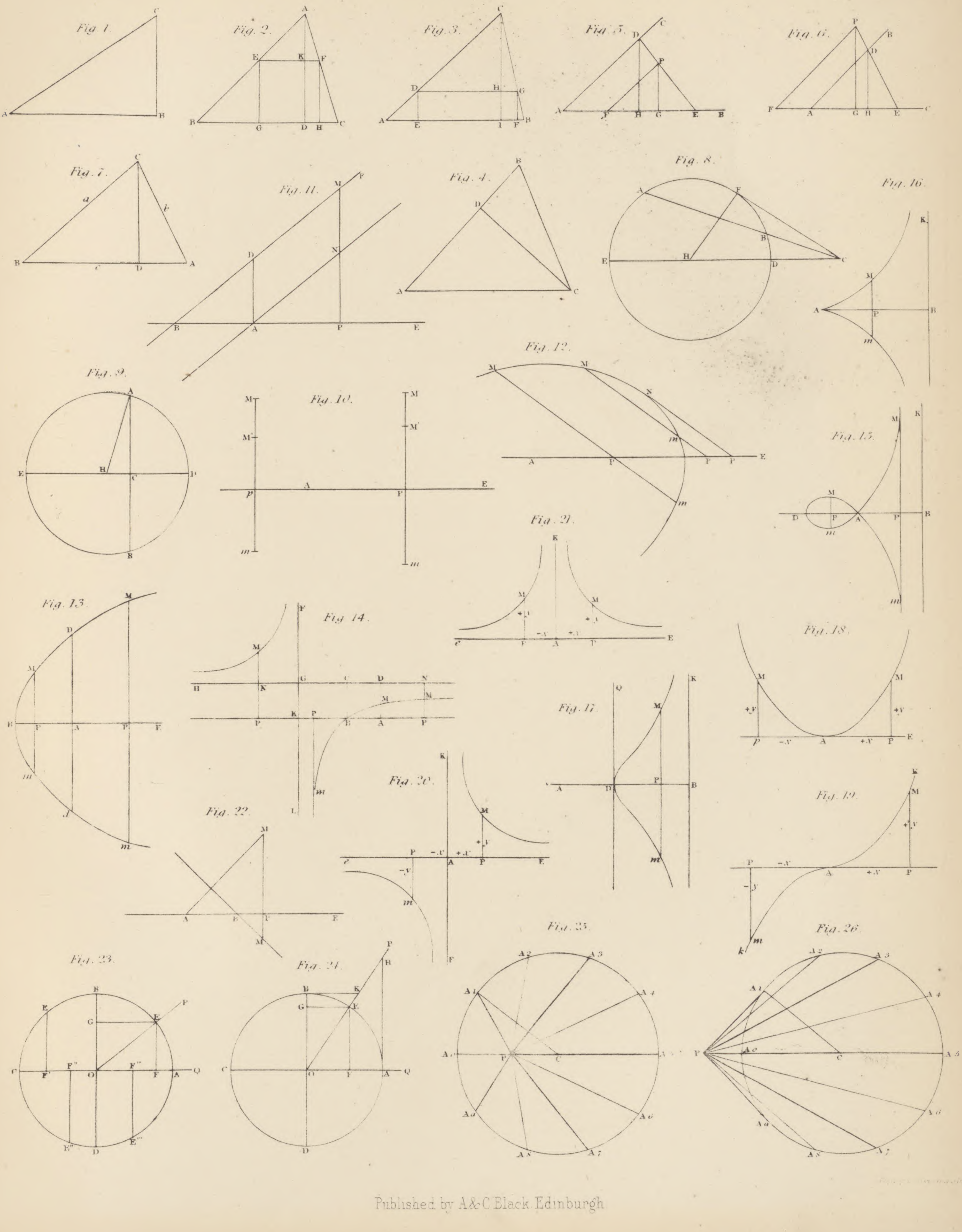


FRONT ELEVATION.




Published by A & C Black Edinburgh 1853.

ALGEBRA. PLATE XVII.

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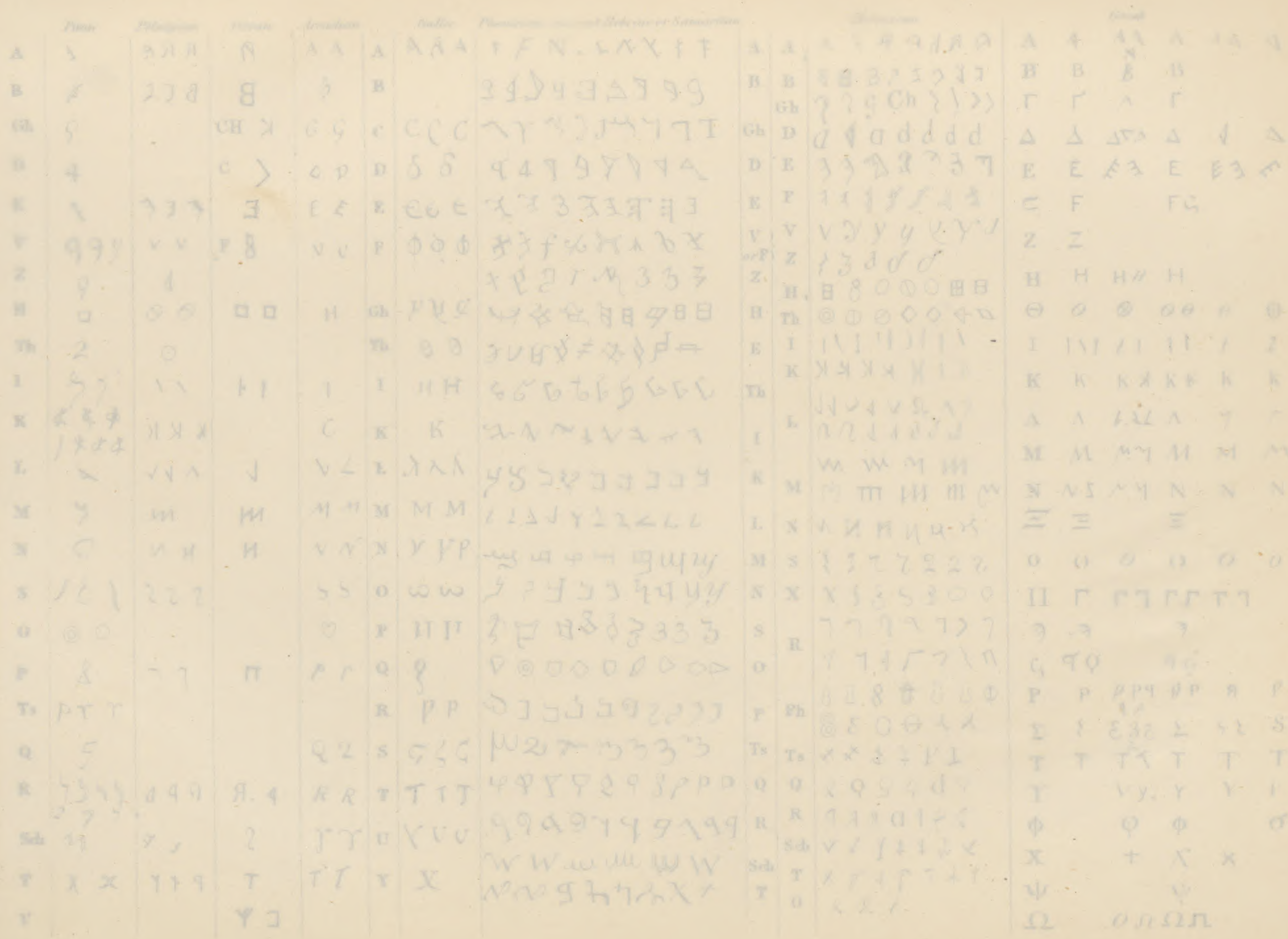
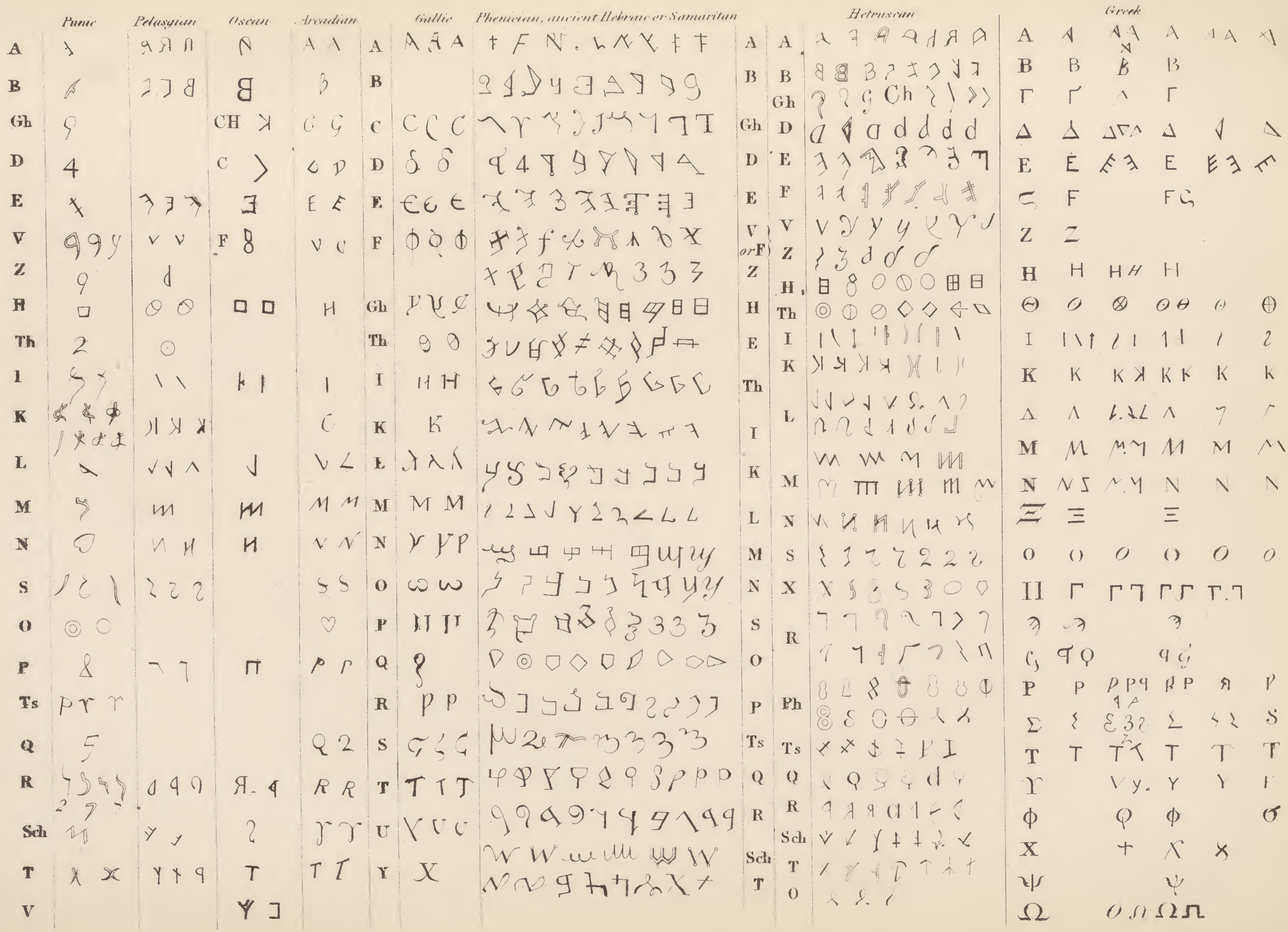
# ANCIENT ALPHABETS.





# ANCIENT ALPHABETS.




Eng.d by G. Aikman Edin.

Published by A.& C. Black, Edinburgh.

# ANCIENT ALPHABETS.

Comparative Table of Hieroglyphic and Alphabetic Characters.


Engd by G. Aikman, Edinr.

Published by A.&C. Black, Edinburgh.

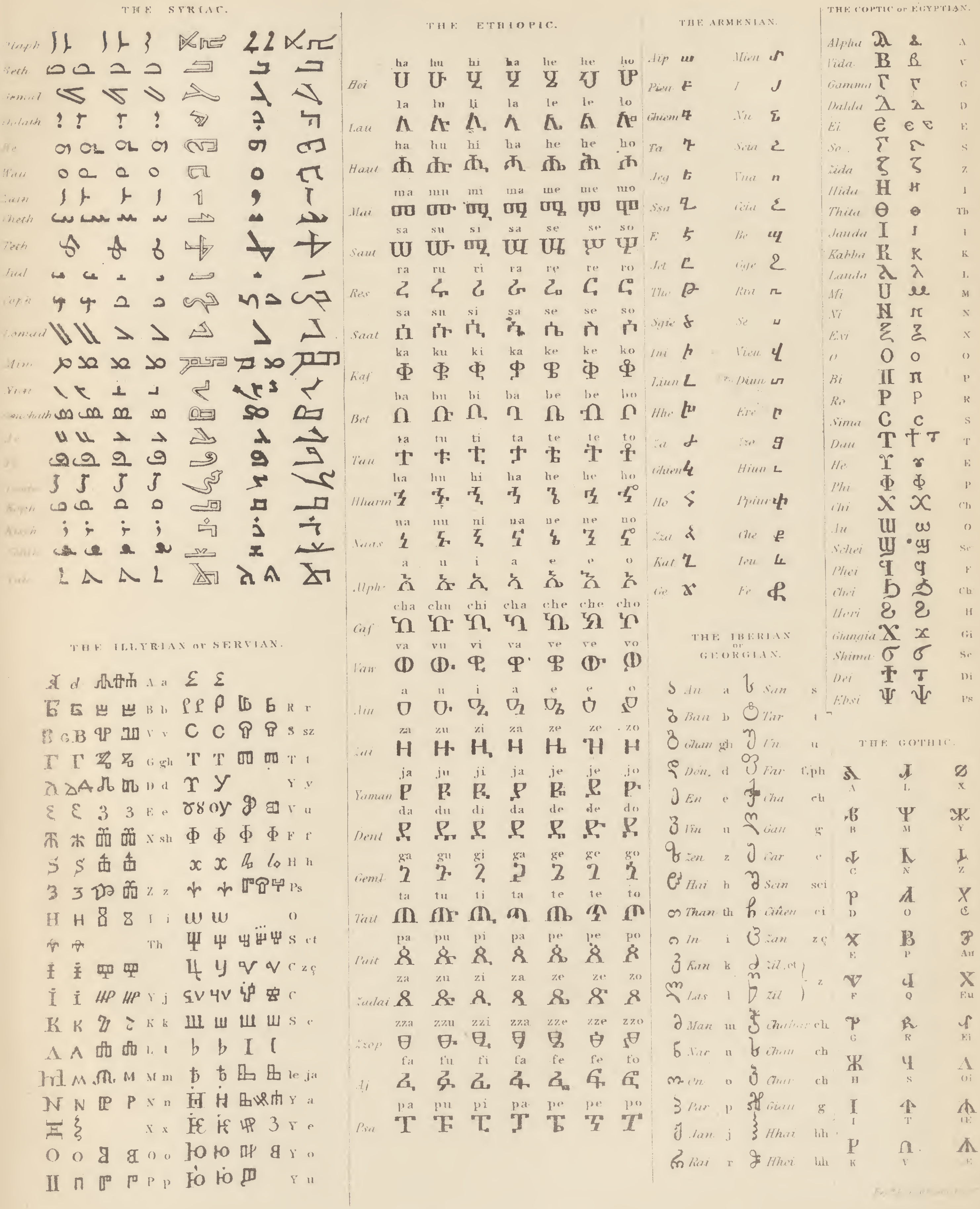



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PLATE XXII

Sea of Behring
Kamtschatka
ARCTIC OCEAN
Cape East
Norton Sd.
Cooks Inlet
Liverpool B.
Banks's Land
N.w GEORGIA
PARRY
North Devon
Roes Welcome
Melville Peninsula
HUDSONS BAY
Southampton I.
Hudsons Strait
Frobishers Str.
Cumberland I.
DAVIS STRAIT
Disco I.
GREENLAND
Arctic Circle
C. Farewell
East Greenland
Davy's Sound
Liverpool Coast
Shannon I.
ICELAND
Reikiavig
Mt. Hecla
L. Michigan
L. Superior
L. Huron
L. Erie
NOVA SCOTIA
NEWFOUNDLAND
Halifax
Bermuda Is.d


Engraved by Sidney Hall.

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CARIBBEAN SEA
NORTH ATLANTIC OCEAN
S. PACIFIC OCEAN
Equator or Equinoctial Line
GUATIMALA
NEW GRANADA
VENEZUELA
GUIANA
BRITISH
FRENCH
EQUADOR
PERU
BOLIVIA
BRAZIL
MATTO GROSSO
GOYAZ
MINAS GERAES
BAHIA
PERNAMBUCO
MARANHAM
PIAUHY
SOLIMOENS
TRINIDAD
Tobago
CAYENNE
Mth. of the AMAZON or MARANON
Mth. of the Orinoco
Dragons Mouth
Serpents Mth.
QUITO
Cotopaxi
Chimborazo
LIMA
Callao
TRUXILLO
PUNO
Titicaca L.
LA PAZ
Illimani
LA PLATA
Chuquisaca
Potosi
Arica
Tarapaca
Cuzco
Guayaquil
G. of GUAYAQUIL
C. Blanco
Payta
Sechura B.
SANTA FE DE BOGOTA
Popayan
Cartagena
CARTHAGENA
SANTA MARTA
Rio Hacha
MARACAYBO
G. of Maracaybo
Caracas
Cumana
Margarita
Curazao
Oruba
Buen Ayre
Angostura
Essequibo
New Amsterdam
GEORGE TOWN
Paramaribo
R. Orinoco
R. Negro
R. Amazon
R. Madeira
R. Tapajos or Topayos R.
R. Xingu
R. Tocantins
R. Araguay
R. Beni
R. Purus
Manoas
Rio Negro
Barcellos
S. Carlos
Taracums
Para
S. LUIS DE MARANHAM
Natal
C. S. Roque
Paraiba
OLINDA or Pernambuco
C. S. Augustin
Alagoas
R. S. Francisco
Sergipe
BAHIA or S. Salvador
Ilheos
Porto Seguro
Esp. S.to or Victoria
Villa Rica
Cayapos
VILLA BOA
Villa Bella
Diamantino
Cuyaba
Bay of Choco
Buenaventura
Panama
G. of PANAMA
Porto Bello
Darien
Chagres
Cartago
Bluefields
Pearl K. Lagoon
Providence
Nicoya
G. of Dulce
Quibo
Morro de Puercos
Tropic of Capricorn
Bay of Mexillones
Morro Jorgel
Salta
80
70
60
50
40
10
0
10
20

x